Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Federal-State Joint Board on	)	CC Docket No. 96-45
Universal Service	)	
	)	
Forward-Looking Mechanism	)	CC Docket No. 97-160
for High Cost Support for	)	
Non-Rural LECs	)	

TENTH REPORT AND ORDER

Adopted: October 21, 1999 **Released: November 2, 1999**

By the Commission: Commissioner Tristani issuing a separate statement; Commissioner Furchtgott-Roth dissenting and issuing a statement.

TABLE OF CONTENTS

I. INTRODUCTION

1. In the Telecommunications Act of 1996 (1996 Act),[360] Congress directed this Commission and the states to take the steps necessary to establish explicit support mechanisms to ensure the delivery of affordable telecommunications service to all Americans. In response to this directive, the Commission has taken action to put in place a universal service support system that will be sustainable in an increasingly competitive marketplace. In the *Universal Service Order*, the Commission adopted a plan for universal service support for rural, insular, and high-cost areas to replace longstanding federal support to incumbent local telephone companies with explicit, competitively neutral federal universal service support mechanisms.[361] The Commission adopted the recommendation of the Federal-State Joint Board on Universal Service (Joint Board) that an eligible carrier's level of universal service support should be based upon the forward-looking economic cost of constructing and operating the network facilities and functions used to provide the services supported by the federal universal service support mechanisms.[362]

2. In this Report and Order, we complete the selection of a model to estimate forward-looking cost by selecting input values for the synthesis model we previously adopted.[363] These input values include such things as the cost of switches, cables, and other network components necessary to provide supported services, in addition to various capital cost parameters. The forward-looking cost of providing supported services estimated by the model will be used as part of the Commission's methodology to determine high-cost support for non-rural carriers beginning January 1, 2000. This methodology is established in a companion

[360] Pub. L. No. 104-104, 110 Stat. 56. The 1996 Act amended the Communications Act of 1934, 47 U.S.C. §§ 151 *et. seq.* (Act). Hereinafter, all citations to the Act will be to the relevant section of the United States Code unless otherwise noted.

[361] *Federal-State Joint Board on Universal Service*, Report and Order, CC Docket No. 96-45, 12 FCC Rcd 8776 (1997) (*Universal Service Order*), as corrected by *Federal-State Joint Board on Universal Service*, Errata, CC Docket No. 96-45, FCC 97-157 (rel. June 4, 1997). *See also Texas Office of Public Utility Counsel v. FCC and USA*, 183 F.3d 393 (5th Cir. 1999) (affirming in relevant part the Commission's decisions regarding implementation of the high-cost support system).

[362] *Universal Service Order*, 12 FCC Rcd at 8888, para. 199. The Commission also determined that high-cost support for rural carriers should continue essentially unchanged and should not be based on forward-looking costs until 2001, at the earliest. *Universal Service Order*, 12 FCC Rcd at 8889, para. 203. The Commission adopted the Joint Board's recommendation to define "rural carriers" as those carriers that meet the statutory definition of a "rural telephone company." *Universal Service Order*, 12 FCC Rcd at 8943, para. 310 (*citing* 47 U.S.C. § 153(37)).

[363] *Federal-State Joint Board on Universal Service*, Fifth Report and Order, CC Docket Nos. 96-45, 97-160, 13 FCC Rcd 21323 (1998) (*Platform Order*).

order.[364]

II. PROCEDURAL HISTORY

A. *Universal Service Order*

3. Prior to the 1996 Act, three explicit interstate universal service programs provided assistance to small incumbent local exchange carriers (LECs) and LECs that served rural and high-cost areas: high-cost loop support;[365] dial equipment minutes (DEM) weighting; and the Long-Term Support (LTS) program.[366] Other mechanisms also have historically contributed to maintaining affordable rates in rural areas, including support implicit in geographic toll rate averaging, intrastate rates, and interstate access charges. Section 254 of the Communications Act of 1934, as amended, directed the Commission to reform universal service support mechanisms to ensure that they are compatible with the pro-competitive goals of the 1996 Act, and it required the Commission to institute a Joint Board on universal service and to implement the recommendations from the Joint Board by May 8, 1997.[367] After receiving the recommendations of the Joint Board on November 7, 1996,[368] the Commission adopted the *Universal Service Order* on May 7, 1997.

4. In the *Universal Service Order*, the Commission adopted a forward-looking economic cost methodology to calculate support for non-rural carriers. Under this methodology, a forward-looking economic cost mechanism selected by the Commission, in consultation with the Joint Board, would be used to estimate non-rural carriers' forward-looking economic cost of providing the supported services in high-cost areas.[369]

---

[364] *Federal-State Joint Board on Universal Service*, Ninth Report and Order and Eighteenth Order on Reconsideration, CC Docket No. 96-45, FCC 99-306 (adopted Oct. 21, 1999) (*Methodology Order*).

[365] Although the existing high-cost loop fund has historically been known as the "Universal Service Fund," we will avoid this terminology because of the confusion it may create with the new universal service support mechanisms that the Commission has created pursuant to section 254 of the Communications Act.

[366] The Commission's rules governing these programs are set forth at 47 C.F.R. §§ 36.601 *et. seq.* (high-cost loop fund); 47 C.F.R. § 36.125(b) (DEM weighting); and 47 C.F.R. §§ 69.105, 69.502, 69.603(e), 69.612 (LTS).

[367] 47 U.S.C. § 254(a).

[368] *Federal-State Joint Board on Universal Service*, First Recommended Decision, CC Docket No. 96-45, 12 FCC Rcd 87 (1996) (*First Recommended Decision*).

[369] *Universal Service Order*, 12 FCC Rcd at 8890, para. 206. In the *Universal Service Order*, the Commission concluded that the federal universal service support mechanism would support 25 percent of the difference between the forward-looking economic cost of providing the supported service and a nationwide revenue benchmark. *See Universal Service Order*, 12 FCC Rcd at 8888, para. 201. In response to issues raised by commenters and state Joint Board members, the Commission referred back to the Joint Board questions related to how federal support

B. *1997 Further Notice* and the Input Value Development Process

5. In a July 18, 1997 *Further Notice of Proposed Rulemaking*, the Commission established a multi-phase plan to develop a federal universal service support mechanism that would send the correct signals for entry, investment, and innovation.[370] The *1997 Further Notice* divided questions related to the cost models into "platform design" issues and "input value" issues.[371] The *1997 Further Notice* subdivided each of the platform and input issues into the following four topic groups: (1) customer location; (2) outside plant design; (3) switching and interoffice; and (4) general support facilities (GSF) and expense issues.[372]

6. After reviewing the comments received in response to the *1997 Further Notice*, the Common Carrier Bureau (Bureau) released two public notices to guide parties wishing to submit cost models for consideration as the high-cost federal mechanism.[373]

7. In addition to the *1997 Further Notice*, the Bureau has solicited comment and allowed interested parties the opportunity to participate in the development of the input values to be used in the forward-looking cost model. On May 4, 1998, the Bureau released a *Public Notice* to update the record on several input-related issues.[374] The Bureau also issued data

---

should be determined. *See Federal-State Joint Board on Universal Service*, Order and Order on Reconsideration, CC Docket No. 96-45, 13 FCC Rcd 13749 (1998) (*Referral Order*). *See also Federal-State Joint Board on Universal Service*, Second Recommended Decision, CC Docket No. 96-45, 13 FCC Rcd 24744 (1998) (*Second Recommended Decision*).

[370] *Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, Further Notice of Proposed Rulemaking, CC Docket Nos. 96-45, 97-160, 12 FCC Rcd 18514 at 18519, para. 5 (1997) (*1997 Further Notice*).

[371] Generally, there is a platform component for each portion of the local exchange network being modeled. Examples of platform design issues are the establishment of switch capacity limitations and the routing of feeder and distribution cables. Examples of input values are the price of various network components, their associated installation and placement costs, and capital cost parameters such as debt-equity ratios. *See 1997 Further Notice*, 12 FCC Rcd at 18516-18, paras. 17-18.

[372] *See generally 1997 Further Notice*.

[373] *Guidance to Proponents of Cost Models in Universal Service Proceeding: Switching, Interoffice Trunking, Signaling, and Local Tandem Investment*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 97-1912 (rel. Sept. 3, 1997) (*Switching and Transport Public Notice*); *Guidance to Proponents of Cost Models in Universal Service Proceeding: Customer Location and Outside Plant*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 97-2372 (rel. Nov. 13, 1997) (*Customer Location & Outside Plant Public Notice*).

[374] *Common Carrier Bureau Requests Further Comment On Selected Issues Regarding The Forward-Looking Economic Cost Mechanism For Universal Service*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-848 (rel.

requests designed to acquire information that could be useful in determining the final input values,[375] and conducted a series of public workshops designed to elicit further comment from interested parties in selecting final input values.[376] Finally, the Bureau conducted numerous *ex parte* meetings with interested parties throughout this proceeding.[377]

C. *Platform Order* and *Second Recommended Decision*

8. In the *Platform Order*, released on October 28, 1998, the Commission adopted the forward-looking cost model platform to be used in determining federal universal service high-cost support for non-rural carriers.[378] The model platform that the Commission adopted combined elements from each of the three models under consideration in this proceeding: (1) the BCPM, Version 3.0 (BCPM);[379] (2) the HAI Model, Version 5.0a (HAI);[380] and (3) the Hybrid Cost Proxy Model, Version 2.5 (HCPM).[381] In the *Platform Order*, the Commission also specified several issues that would be addressed in the inputs stage of this proceeding. These issues include: (1) the geocode data source to determine customer locations;[382] (2) the road

May 4, 1998) (*Inputs Public Notice*).

375 *Federal-State Joint Board on Universal Service*, Order, CC Docket No. 96-45, 12 FCC Rcd 9803 (1997) (*1997 Data Request*).

376 *Common Carrier To Hold Three Workshops On Input Values To Be Used To Estimate Forward-Looking Economic Costs For Purposes Of Universal Service Support*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-2406 (rel. Nov. 25, 1998) (*Workshop Public Notice*).

377 *See, e.g.*, Letter from W. Scott Randolph, GTE, to Magalie Roman Salas, FCC, dated March 2, 1999; Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated, February 26, 1999; Letter from Chris Frentrup, MCI, to Magalie Roman Salas, FCC, dated February 9, 1999.

378 *See Platform Order*.

379 Submission in CC Docket Nos. 96-45 and 97-160 by BellSouth Corporation, BellSouth Telecommunications, Inc., U S WEST, Inc., and Sprint Local Telephone Company (BCPM proponents), dated Dec. 11, 1997 (BCPM Dec. 11, 1997 submission).

380 Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, FCC, dated Dec. 11, 1997 (HAI Dec. 11, 1997 submission). HAI was submitted by AT&T and MCI (HAI sponsors). *See also* Letter from Richard Clarke, AT&T, to Magalie Roman Salas, FCC, dated February 3, 1998 (HAI Feb. 3 submission).

381 HCPM was developed by Commission staff members William Sharkey, Mark Kennet, C. Anthony Bush, Jeffrey Prisbrey, and Commission contractor Vaikunth Gupta of Panum Communications. *Common Carrier Bureau Announces Release of HCPM Version 2.0*, Public Notice, DA 97-2712 (rel. Dec. 29, 1997). *See also* United States Government Memo from W. Sharkey, FCC, to Magalie Roman Salas, FCC, dated Feb. 6, 1998.

382 *Platform Order*, 13 FCC Rcd at 21338, para. 34.

surrogate method to determine the location of non-geocoded customer locations;[383] and (3) the use of the local exchange routing guide (LERG) to identify the existing host-remote switch relationships.[384]

9. On November 25, 1998, the Joint Board released the *Second Recommended Decision*, in which it recommended that the Commission compute federal high-cost support for non-rural carriers through a two-step process.[385] First, the Joint Board recommended that the Commission should estimate the total support amount necessary in those areas considered to have high costs relative to other areas. Second, the Joint Board recommended that the Commission should consider, in a consistent manner across all states, any particular state's ability to support high-cost areas within the state.[386] The Joint Board recommended that federal support should be provided to the extent that the state would be unable to support its high-cost areas through its own reasonable efforts.[387] In addition, the Joint Board recommended that the Commission continue to work with the Joint Board to select the input values to complete a forward-looking cost model and to finalize the methodology for distributing federal high-cost support.[388]

D. *Inputs Further Notice* and *Seventh Report and Order*

10. On May 28, 1999, the Commission released the *Inputs Further Notice* and the *Seventh Report and Order*.[389] In the *Inputs Further Notice*, we proposed and sought comment on

[383] *Platform Order*, 13 FCC Rcd at 21341, para. 41.

[384] *Platform Order*, 13 FCC Rcd at 21355, para. 76. The LERG is a database of switching information maintained by Telcordia Technologies (formerly Bellcore) that includes the existing host-remote relationships.

[385] *Second Recommended Decision*, 13 FCC Rcd at 24746, para. 5.

[386] *Second Recommended Decision*, 13 FCC Rcd at 24746, para. 5.

[387] *Second Recommended Decision*, 13 FCC Rcd at 24746-47, para. 5.

[388] *Second Recommended Decision*, 13 FCC Rcd at 24757, para. 28.

[389] *Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, Further Notice of Proposed Rulemaking, CC Docket Nos. 96-45, 97-160, FCC 99-120 (rel. May 28, 1999) (*Inputs Further Notice*); *Federal-State Joint Board on Universal Service, Access Charge Reform*, Seventh Report and Order and Thirteenth Order on Reconsideration in CC Docket No. 96-45; Fourth Report and Order in CC Docket No. 96-262; and Further Notice of Proposed Rulemaking, CC Docket Nos. 96-45, 96-262, 14 FCC Rcd 8078 (1999) (*Seventh Report and Order*). *See also Common Carrier Bureau Releases Preliminary Results Using Proposed Input Values In The Forward-Looking Cost Model For Universal Service*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 99-1165 (rel. June 16, 1999) (*Preliminary Input Values Public Notice)*; *Common Carrier Bureau Releases Revised Spreadsheet For Estimating Universal Service Support Using Proposed Input Values In The Forward-Looking Cost Model*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 99-1322 (rel. July 2, 1999).

a complete set of input values for use in the model, such as the cost of switches, cables, and other network components.[390] For the most important inputs, we provided a detailed description of the methodology that was used to arrive at the proposed values.[391]

11. In the *Seventh Report and Order*, we adopted revisions to the federal support mechanisms, in light of the Joint Board's recommendations, to permit rates to remain affordable and reasonably comparable across the nation, consistent with the 1996 Act. To accomplish these goals, we established and sought comment on a methodology for determining non-rural carriers' support amounts, based on the forward-looking costs estimated using a national cost model, and a national cost benchmark, that will begin on January 1, 2000.[392]

III. ESTIMATING FORWARD-LOOKING ECONOMIC COST

A. Designing a Forward-Looking Wireline Local Telephone Network

12. To understand the assumptions made in the mechanism, it is necessary to understand the layout of the current wireline local telephone network.[393] In general, a telephone network must allow any customer to connect to any other customer. In order to accomplish this, a telephone network must connect customer premises to a switching facility, ensure that adequate capacity exists in that switching facility to process all customers' calls that are expected to be made at peak periods, and then interconnect that switching facility with other switching facilities to route calls to their destinations. A wire center is the location of a switching facility. The wire center boundaries define the area in which all customers are connected to a given wire center. The *Universal Service Order* required the models to use existing incumbent LEC wire center locations in estimating forward-looking cost.[394]

[390] *See Inputs Further Notice* at Appendix A.

[391] *See generally Inputs Further Notice*.

[392] *See generally Seventh Report and Order*.

[393] We also note that technologies such as wireless services are likely to become more important over time in providing universal service. We will continue to review suggestions for incorporating such technologies into the forward-looking mechanism for future years. *See, e.g.*, Letter from David L. Sieradzki, on behalf of Western Wireless, to Magalie Roman Salas, FCC, dated January 26, 1999 (submitting the "Wireless Cost Model"). In addition, we intend to initiate a proceeding in the near future to consider how changes in technologies and other related factors should be accounted for in the model.

[394] The *Universal Service Order* established ten criteria to ensure consistency in calculations of federal universal service support. *Universal Service Order*, 12 FCC Rcd at 8913, para. 250. Criterion one requires that a model must include incumbent LECs' wire centers as the center of the loop network and the outside plant should terminate at incumbent LECs' current wire centers.

13. Within the boundaries of each wire center, the wires and other equipment that connect the central office to the customers' premises are known as outside plant. Outside plant can consist of either copper cable or a combination of optical fiber and copper cable, as well as associated electronic equipment. Copper cable generally carries an analog signal that is compatible with most customers' telephone equipment. The range of an analog signal over copper is limited, however, so thicker, more expensive cables or loading coils must be used to carry signals over greater distances. Optical fiber cable carries a digital signal that is incompatible with most customers' telephone equipment, but the quality of a signal carried on optical fiber cable is superior at greater distances when compared to a signal carried on copper wire. Generally, when a neighborhood is located too far from the wire center to be served by copper cables alone, an optical fiber cable will be deployed to a point within the neighborhood, where a piece of electronic equipment will be placed that converts the digital light signal carried on optical fiber cable to an analog, electrical signal that is compatible with customers' telephones. This equipment is known as a digital loop carrier remote terminal, or DLC, which is connected to a serving area interface (SAI). From the SAI, copper cables of varying gauge extend to all of the customer premises in the neighborhood. Where the neighborhood is close enough to the wire center to be served entirely on copper cables, copper trunks connect the wire center to the SAI, and copper cables will then connect the SAI to the customers in the serving area. The portion of the loop plant that connects the central office with the SAI or DLC is known as the feeder plant, and the portion that runs from the DLC or SAI throughout the neighborhood is known as the distribution plant.

14. The model's estimate of the cost of serving the customers located within a given wire center's boundaries includes the calculation of switch size, the lengths, gauge, and number of copper and fiber cables, and the number of DLCs required. These factors depend, in turn, on how many customers the wire center serves, where the customers are located within the wire center boundaries, and how they are distributed within neighborhoods. Particularly in rural areas, some customers may not be located in neighborhoods at all but, instead, may be scattered throughout outlying areas. In general, the model divides the area served by the wire center into smaller areas known as serving areas. For serving areas sufficiently close to the wire center, copper feeder cable extends from the wire center to a SAI where it is cross-connected to copper distribution cables. If the feeder is fiber, it extends to a DLC terminal in the serving area, which converts optical digital signals to analog signals. Individual circuits from the DLC are cross-connected to copper distribution cables at the adjacent SAI.

15. The model assumes that wire centers are interconnected with one another using optical fiber networks known as Synchronous Optical Network (SONET) rings.[395] The

[395] SONET is a set of standards for optical (fiber optic) transmission. It was developed to meet the need for transmission speeds above the T3 level (45 Mbps) and is generally considered the standard choice for transmission devices used with broadband networks. BCPM Dec. 11 submission, Model Methodology at 68.

infrastructure to interconnect the wire centers is known as the interoffice network, and the carriage of traffic among wire centers is known as transport. In cases where a number of wire centers with relatively few people within their boundaries are located in close proximity to one another, it may be more economical to use the processor capacity of a single switch to supervise the calls of the customers in the boundaries of all the wire centers. In that case, a full-capacity switch (known as a host) is placed in one of the wire centers and less expensive, more limited-capacity switches (known as remotes) are placed in the other wire centers. The remotes are then connected to the host with interoffice facilities. Switches that are located in wire centers with enough customers within their boundaries to merit their own full-capacity switches and that do not serve as hosts to any other wire centers are called stand-alone switches.

16. There are also a number of expenses and general support facilities (GSF) costs associated with the design of a forward-looking wireline telephone network.[396] GSF costs include the investment related to vehicles, land, buildings, and general purpose computers. Expenses include: plant-specific expenses, such as maintenance of facilities and equipment expenses; plant non-specific expenses, such as engineering, network operations, and power expenses; customer services expenses, such as marketing, billing, and directory listing expenses; and corporate operations expenses, such as administration, human resources, legal, and accounting expenses.[397]

B. Synthesis Model

1. Historical Background

17. The synthesis model adopted in the *Platform Order* allows the user to estimate the cost of building a telephone network to serve subscribers in their actual geographic locations, to the extent these locations are known.[398] To the extent that the actual geographic locations of customers are not available, the Commission determined that the synthesis model should assume that customers are located along roads.[399]

18. Once the customer locations have been determined, the model employs a clustering algorithm to group customers into serving areas in an efficient manner that takes into

[396] *See Platform Order*, 13 FCC Rcd at 21357-61, paras. 81-91.

[397] *Platform Order*, 13 FCC Rcd at 21357-58, para. 82.

[398] *Platform Order*, 13 FCC Rcd at 21337, para. 33. *See also* discussion of customer location data, *infra* section IV.

[399] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40. *See also* discussion of road surrogating method, *infra*.

consideration relevant engineering constraints.[400] After identifying efficient serving areas, the model designs outside plant to the customer locations.[401] In doing so, the model employs a number of cost minimization principles designed to determine the most cost-effective technology to be used under a variety of circumstances, such as varying terrain and density.[402]

19. The Commission concluded that the federal universal service mechanism should incorporate, with certain modifications, the HAI 5.0a switching and interoffice facilities module to estimate the cost of switching and interoffice transport.[403] The Commission noted that it would consider adopting the LERG at the inputs stage of this proceeding to determine the deployment of host and remote switches.[404] In addition, the Commission adopted the HAI platform module for calculating expenses and capital costs, such as depreciation.[405]

20. The Commission noted that technical improvements to the cost model will continue, both before implementation of the model for non-rural carriers and on an ongoing basis, as necessary.[406] The Commission therefore delegated to the Bureau the authority to make changes or direct that changes be made to the model platform as necessary and appropriate to ensure that the platform of the federal mechanism operates as described in the *Platform Order*.[407] As contemplated in the *Platform Order*, Commission staff and interested parties have continued to review the model platform to ensure that it operates as intended. As a result, some refinements have been made to the model platform adopted in the *Platform Order*.[408] All changes to the model platform are posted on the Commission's Web site.[409]

---

[400] *Platform Order*, 13 FCC Rcd at 21342, para. 44.

[401] *Platform Order*, 13 FCC Rcd at 21346, para. 55.

[402] *Platform Order*, 13 FCC Rcd at 21348, para. 61.

[403] *Platform Order*, 13 FCC Rcd at 21354-55, para. 75.

[404] *Platform Order*, 13 FCC Rcd at 21355, para. 76.

[405] *Platform Order*, 13 FCC Rcd at 21357, para. 81.

[406] *Platform Order*, 13 FCC Rcd at 21329, para. 13.

[407] *Platform Order*, 13 FCC Rcd at 21329, para. 13.

[408] *Common Carrier Bureau To Post On The Internet Modifications To The Forward-Looking Economic Cost Model For Universal Service Support*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-2533 (rel. Dec. 15, 1998).

[409] Model platform changes can be found at http://www.fcc.gov/ccb/apd/hcpm. Changes to the model are detailed in the "History.doc" file. The model platform was not modified after June 2, 1999, in order to allow parties an opportunity to evaluate the model platform, the proposed inputs to the model, and issues related to the

2. Validation

21. In the *Universal Service Order*, the Commission concluded that high-cost support should be based on forward-looking costs.[410] Since that time, the Commission has continued to work to adopt a cost model that is reasonably accurate and verifiable.[411] Although we have remained confident in our ability to adopt a model, in the *Inputs Further Notice*, we sought comment on how the Commission might determine support levels without using a model, "[i]n the unlikely event that the model is not ready for timely implementation."[412] A few commenters offered concrete suggestions in response to this request, virtually all of which involved the use of carriers' book costs in lieu of the model.[413]

22. As an initial matter, we affirm the Commission's decision to base support calculations on forward-looking costs. We have repeatedly articulated our reasons for believing that forward-looking costs represent a superior method for determining support amounts. The most significant of these is that forward-looking costs are the basis of economic decisions in a competitive market, and therefore send the correct signals for entry and investment.

23. Moreover, the Commission and its staff have undertaken a thorough review of the model and its input values over the past six months. In so doing, the staff has coordinated extensively with and received substantial input from the Joint Board staff and interested outside parties. As a result of this examination of the model, we are convinced that it generates reasonably accurate estimates of forward-looking costs and that the model is the best basis for determining non-rural carriers' high-cost support in a competitive environment.

24. After this review of the model, we find that none of the criticisms of the model undermine our decision to use it for calculating non-rural carriers' high-cost support. For example, some parties have observed that the model seems to generate unexpectedly high cost estimates for certain states, such as Mississippi and Alabama.[414] Because of the high levels of

---

methodology for determining high-cost support. After release of this Order, we will post a revised model platform on the Commission's Web site, including the input values adopted herein.

410 *Universal Service Order*, 12 FCC Rcd at 8899-8900, paras. 224-226.

411 *See, e.g.*, *1997 Further Notice*; *Inputs Public Notice*; *Workshop Public Notice*; *Inputs Further Notice*.

412 *Inputs Further Notice* at para. 243.

413 *See, e.g.*, Bell Atlantic *Inputs Further Notice* comments at 5-6, GTE *Inputs Further Notice* comments at 89-91, USTA *Inputs Further Notice* comments at 4-5. *But see* US West *Inputs Further Notice* comments at 70-71.

414 Bell Atlantic *Inputs Further Notice* comments at 4.

cost estimated in these states, they receive larger shares of forward-looking support than they receive under the current mechanism, and also receive higher levels of support than some other states (such as the sparsely populated Western and Midwestern states) that many parties expected to lead the list of high-cost states. After further review, however, we have found several factors that explain the model's results.

25. We first sought to verify the model's results by determining whether the model generated higher costs in areas where customers are more dispersed. Although there are other relevant factors, most people agree that telephone plant costs tend to be highest when customers are spread thinly over a large area. We used a "minimum spanning tree" measurement to determine relative dispersion of customers.[415] We found that the model's cost estimates were highly correlated with dispersion of customers. This provides a preliminary, objective check on the model's accuracy.

26. This analysis does not, however, explain why the model estimates higher costs in some states relative to others in a distribution that differs from carriers' book costs and from some observers' expectations. In researching this issue, we discovered that significant differences exist among the states in the territory served by larger carriers, which are typically considered non-rural carriers under the Act.[416] It is important to remember that the present model runs only cover the territory served by non-rural carriers. The costs estimated by the model will be significantly affected by the type of territory served by those carriers in the state whose costs are being calculated, and to the extent that a rural territory is being served by a rural carrier that is not receiving high-cost support under this mechanism, the cost of serving that territory will not be reflected in the level of support for that state determined in this phase of the proceeding. In general, we found that the states where the model estimated the highest costs were those states in which the territory served by the non-rural carriers, which are typically larger carriers, included more rural areas than in other states. We also found that some states that are generally perceived as rural are served primarily by small carriers, so that the remaining territory in the state, which would be served by the non-rural carrier, is less rural than the state as a whole. For example, in Mississippi, the large incumbent LEC serves the vast majority of the state's territory, including many very rural areas. By contrast, in Montana for example, the large incumbent LEC serves less than a third of the state's territory, and its serving area includes all but one of the largest cities in the state. Small rural carriers serve the most sparsely populated rural areas in Montana. As a result, considering only the non-rural carriers' territory, Mississippi appears to be a considerably more rural state than Montana. As discussed above, our analysis showed that the model's cost estimates were highly correlated with dispersion -- that is, the areas

[415] *See* C.A. Bush et al., *The Hybrid Cost Proxy Model Customer Location and Loop Design Modules*, Dec. 15, 1998 at 13-14 (*HCPM Dec. 15, 1998 documentation*).

[416] *See* 47 U.S.C. § 153(37).

with the most dispersed customers were estimated by the model to have the highest costs. Although this results in relative cost estimates among states that differ from some people's expectations, we believe that this may primarily reveal that those expectations were based on a lack of information or incorrect premises about non-rural carriers' service territories.

27. Moreover, our investigation revealed that most of the variations between carriers' book cost levels and the model's estimated forward-looking costs can be explained by three factors. The first is the percentage of business lines in the study area. Study areas with a lower percentage of business lines tend to have lower book costs relative to forward-looking costs. The second factor is the percentage of customers in rural areas. Study areas with a higher percentage of rural customers also tend to have lower relative book costs. These two factors, taken together, suggest that the book cost of the existing network is more likely to be below the model's estimate of the cost of a forward-looking network in rural areas with fewer business customers. This may suggest that these areas are served by networks of a different quality standard than that assumed in the model, or that the networks in these areas have not been upgraded or experienced much growth in some time and therefore are substantially depreciated on carriers' books. The third factor is discrepancies in line counts between the data used in the model and the most current carrier-reported data. We have taken steps to correct these discrepancies in the line count data that we adopt in this Order.[417]

28. We believe that the model, as used in the methodology we set out in the companion *Methodology Order*, is the best way to generate non-rural carriers' support amounts for the funding year beginning January 1, 2000. We also recognize, however, that the model must evolve as technology and other conditions change. We therefore have committed to initiating a proceeding to study how the model should be used in the future (e.g., how often inputs data should be updated) and how the model itself should change to reflect changing circumstances. We anticipate releasing a further notice of proposed rulemaking on these issues in early 2000, and hope to reach significant decisions on these issues during the course of that year.

C. Selecting Forward-Looking Input Values

29. In the *Universal Service Order*, the Commission adopted ten criteria to be used in determining the forward-looking economic cost of providing universal service in high-cost areas.[418] These criteria provide specific guidance for our selection of input values for use in the synthesis model. Rather than reflecting existing incumbent LEC facilities, the technology assumed in the model "must be the least-cost, most-efficient, and reasonable technology for

[417] *See infra* para. 61.

[418] *Universal Service Order*, 12 FCC Rcd at 8913-16, para. 250.

providing the supported services that is currently being deployed."[419] As noted below, existing LEC plant in a particular area may not reflect forward-looking technology or design choices.[420] Similarly, the input values we adopt in this Order are not intended to replicate any particular company's embedded or book costs. Criterion three directs that "costs must not be the embedded cost of the facilities, functions, or elements."[421] Rather, the model "must be based upon an examination of the current cost of purchasing facilities and equipment."[422]

30. As discussed below, we generally adopt nationwide, rather than company-specific, input values in the federal mechanism. In many cases, the only data for various inputs on the record in this proceeding are embedded cost, company-specific data. We have used various techniques to convert these data to forward-looking values. For example, we modify the switching data to adjust for the effects of inflation and the cost changes unique to the purchase and installation of digital switches.[423] Where possible, we have tried to account for variations in costs by objective means. For example, the model reflects differences in structure costs by using different values for the type of plant, the density zone, and geological conditions. There may be additional modifications we can make in the future to more accurately reflect variations in forward-looking costs based on objective criteria. For example, we do not adjust our maintenance expense estimates to reflect regional wage differences, as discussed below, because we have not found and no party has suggested a specific data source or methodology that would be useful in making such adjustments.[424] We certainly remain open to considering data sources in the future of the model proceeding that would permit us to vary these or other input values to reflect differences in forward-looking cost that can be measured objectively.

31. Although the BCPM sponsors have provided nationwide default values, they and other LECs generally advocate company-specific input values. For purposes of determining federal universal service support amounts, however, we believe that nationwide default values generally are more appropriate than company-specific values. Under the new federal universal service support mechanism, support is based on the estimated costs that an efficient carrier would incur to provide the supported services, rather than on the specific carrier's book costs. We also believe that it would be administratively unworkable to use company-specific values in

---

[419] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion one).

[420] *See infra* paras. 63, 351.

[421] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion three).

[422] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion three).

[423] *See infra* para. 311.

[424] *See infra* paras. 361-64.

the federal nationwide model. Finally, we note that, for most inputs, we have no means of adopting company-specific input values, except possibly by relying on embedded data for each company. We make no finding as to whether nationwide values would be appropriate for purposes other than determining federal universal service support.[425]

32. For universal service purposes, we find that using nationwide averages is appropriate. The Commission has not considered what type of input values, company-specific or nationwide, nor what specific input values, would be appropriate for any other purposes. The federal cost model was developed for the purpose of determining federal universal service support, and it may not be appropriate to use nationwide values for other purposes, such as determining prices for unbundled network elements. We caution parties from making any claims in other proceedings based upon the input values we adopt in this Order.

IV. DETERMINING CUSTOMER LOCATIONS

A. Background

33. The determination of customer locations relative to the wire center heavily influences a forward-looking cost model's design of outside plant facilities. This is because assumptions about the locations of customers will determine the predicted loop length, which in turn will have a large impact on the cost of service and the technologies employed by the model.[426] Each of the models under consideration in the *Platform Order* provided a methodology for determining customer locations.[427] The Bureau sought comment on these proposals and solicited alternative proposals from interested parties for locating customers.[428]

34. In the *Platform Order*, the Commission concluded that HAI's proposal to use actual geocode data, to the extent that they are available, and BCPM's proposal to use road network information to create "surrogate" customer locations where actual data are not available, provided the most reasonable method for determining customer locations.[429] The Commission

[425] State commissions, for example, may find that it is not appropriate to use nationwide values in determining state universal service support or prices for unbundled network elements and may choose instead to use statewide or company-specific values.

[426] *See 1997 Further Notice*, 12 FCC Rcd at 18535, para. 44.

[427] *Platform Order*, 13 FCC Rcd at 21337, para. 31.

[428] *See, e.g.*, *1997 Further Notice*, 12 FCC Rcd at 18535, para. 44; *Inputs Public Notice* at 3-4; *Common Carrier Bureau Seeks Comment On Model Platform Development*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 98-1587 (rel. Aug. 7, 1998) (*Platform Public Notice*) at 2-4.

[429] *Platform Order*, 13 FCC Rcd at 21337, para. 31. The term "geocode data" refers to the identification of each customer location by precise latitude and longitude coordinates. Surrogating methods, and customer location data

concluded that "the source or sources of geocode data to use in determining customer location will be decided at the inputs phase of this proceeding."[430] The Commission also concluded that "the selection of a precise algorithm for placing road surrogates pursuant to these conclusions should be conducted in the inputs stage of this proceeding as part of the process of selecting a geocode data set for the federal mechanism."[431]

35. In the *Inputs Further Notice,* we tentatively concluded that no source of actual geocode data had been made sufficiently available for review to be used in the model at that time.[432] Therefore, we tentatively concluded that a road surrogate algorithm would be used to locate customers in the federal mechanism until a source of actual geocode data is selected by the Commission. In doing so, we tentatively adopted the road surrogate algorithm proposed by PNR Associates (PNR) to develop road surrogate customer locations.[433]

B. Customer Location Data

1. Geocode Data

36. While we affirm our conclusion in the *Platform Order* that geocode data should be used to locate customers in the federal mechanism, we conclude that no source of actual geocode data has yet been made adequately accessible for public review. We conclude below that we will use an algorithm based on the location of roads to create surrogate geocode data on customer locations for the federal mechanism until a source of actual geocode data is identified and selected by the Commission. We reiterate our expectation that a source of accurate and verifiable actual geocode data will be identified in the future for use in the federal mechanism.[434]

37. In the *Platform Order*, we concluded that a model is most likely to select the least-cost, most-efficient outside plant design if it uses the most accurate data for locating

provided by the Census Bureau, constitute geocode data. For purposes of clarity, however, we will use the term "geocode" data to refer only to actual precise latitude and longitude data, unless we specifically refer to the data as "surrogate geocode" data.

[430] *Platform Order*, 13 FCC Rcd at 21337-38, para. 34.

[431] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40.

[432] *Inputs Further Notice* at paras. 25-28.

[433] *Inputs Further Notice* at para. 29.

[434] In the upcoming proceeding on future changes to the model, *see supra* note 34, we intend to consider alternatives for obtaining customer location data.

customers within wire centers, and that the most accurate data for locating customers within wire centers are precise latitude and longitude coordinates for those customers' locations.[435] We noted that commenters generally support the use of accurate geocode data in the federal mechanism where available.[436] We further noted that the only actual geocode data in the record were those prepared for HAI by PNR, but also noted that "our conclusion that the model should use geocode data to the extent that they are available is not a determination of the accuracy or reliability of any particular source of the data."[437] Although commenters supported the use of accurate geocode data, several commenters questioned whether the PNR geocode data were adequately available for review by interested parties.[438]

38. In the *Universal Service Order*, the Commission required that the "model and all underlying data, formulae, computations, and software associated with the model must be available to all interested parties for review and comment."[439] In an effort to comply with this requirement, the Commission has made significant efforts to encourage parties to submit geocode data on the record in this proceeding.[440] PNR took initial steps to comply with this requirement in December 1998 by making available the "BIN" files[441] derived from the geocoded points to interested parties pursuant to the *Protective Order*.[442] PNR also has continued to provide access to the underlying geocode data at its facility in Pennsylvania. Several commenters argue, however, that the availability of the BIN data alone is not sufficient to comply with the requirements of criterion eight, particularly in light of the expense and conditions imposed by PNR in obtaining access to the geocode point data.[443] In addition, PNR

---

435 *Platform Order*, 13 FCC Rcd at 21337, para. 33.

436 *Platform Order*, 13 FCC Rcd at 21337-38, para. 34.

437 *Platform Order*, 13 FCC Rcd at 21338, para. 34.

438 *Platform Order*, 13 FCC Rcd at 21338, para. 34.

439 *Universal Service Order*, 12 FCC Rcd at 8915, para. 250 (criterion eight).

440 *See Federal-State Joint Board on Universal Service*, Protective Order, CC Docket Nos. 96-45, 97-160, 13 FCC Rcd 13910 (1998) (*Protective Order*). *See also Inputs Public Notice* at 3-4.

441 BIN files are the output of the clustering routine in the synthesis model platform derived from the actual geocode customer locations and, as such, do not reveal the actual geocoded customer locations. The BIN files allow users to run all aspects of the model except for the clustering. PNR has made the BIN files available to interested parties for a fee of $25.00, pursuant to the terms of the *Protective Order*. *See* Letter from William M. Newman, PNR, to Magalie Roman Salas, FCC, dated December 17, 1998 (PNR Dec. 17 *ex parte*).

442 *See* PNR Dec. 17 *ex parte*.

443 *See, e.g.*, Bell Atlantic Petition for Reconsideration at 5-6; BellSouth Petition for Reconsideration at 3-4; GTE Petition for Reconsideration at 21; Sprint *Inputs Further Notice* comments at 11.

acknowledges that its geocode database relies on third-party data that PNR is not permitted to disclose.[444]

39. Consistent with our tentative conclusion in the *Inputs Further Notice*, we conclude that interested parties have not had an adequate opportunity to review and comment on the accuracy of the PNR actual geocode data set. The majority of commenters addressing this issue support this conclusion.[445] We note that a nationwide customer location database will, by necessity, be voluminous, relying on a variety of underlying data sources. In light of the concerns expressed by several commenters relating to the conditions and expense in obtaining geocode data from PNR, we find that no source of actual geocode data has been made sufficiently available for review. While PNR has made some effort to satisfy the requirements of criterion eight, we prefer to adopt a data set that is more readily available for meaningful review. In particular, we note that the geocode points are available only on-site at PNR's facilities, making it difficult for parties to verify the accuracy of those points. We recognize, however, that more comprehensive actual geocode data are likely to be available in the future, and we encourage parties to continue development of an actual geocode data source that complies with the criteria outlined in the *Universal Service Order* for use in the federal mechanism.[446]

2. Road Surrogate Customer Locations

40. We conclude that PNR's road surrogating algorithm should be used to develop geocode customer locations for use in the federal universal service mechanism to determine high-cost support for non-rural carriers beginning January 1, 2000. In the *Platform Order,* we concluded that, in the absence of actual geocode customer location data, associating road networks and customer locations provides the most reasonable approach for determining customer locations.[447]

41. As we noted in the *Platform Order*, "associating customers with the distribution of roads is more likely to correlate to actual customer locations than uniformly distributing customers throughout the Census Block, as HCPM proposes, or uniformly distributing customers

[444] Letter to Thomas W. Mitchell, on behalf of GTE, from Charles A. White, PNR, dated April 29, 1999 (PNR April 29 *ex parte*) at 1.

[445] *See, e.g.*, Ameritech *Inputs Further Notice* comments at 2; GTE *Inputs Further Notice* comments at 36-37; SBC *Inputs Further Notice* comments at 4; Sprint *Inputs Further Notice* comments at 11.

[446] We note that AT&T and MCI have suggested that the Commission condition receipt of universal service funding on the provision of customer location data by the carrier. *See* AT&T/MCI *Inputs Further Notice* comments at 5. We decline to adopt this suggestion at this time, but will consider this and other alternatives to obtaining customer location data in the upcoming proceeding on future changes to the model.

[447] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40.

along the Census Block boundary, as HAI proposes."[448] We therefore concluded in the *Platform Order* that the selection of a precise algorithm for placing road surrogates should be conducted in the inputs stage of this proceeding.[449] In the *Inputs Further Notice*, we tentatively adopted the PNR road surrogate algorithm to determine customer locations.[450]

42. Currently, there are two road surrogating algorithms on the record in this proceeding - those proposed by PNR and Stopwatch Maps. On March 2, 1998, AT&T provided a description of the road surrogate methodology developed by PNR for locating customers.[451] On January 27, 1999, PNR made available for review by the Commission and interested parties, pursuant to the terms of the *Protective Order*, the road surrogate point data for all states except Alaska, Iowa, Virginia, Puerto Rico and eighty-four wire centers in various other states.[452] On February 22, 1999, PNR filed a more detailed description of its road surrogate algorithm.[453] Consistent with the conditions set forth in the *Inputs Further Notice*, PNR has now made available road surrogate data for all fifty states and Puerto Rico.[454]

43. In general, the PNR road surrogate algorithm utilizes the Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) files, which contain all the road segments in the United States.[455] For each Census Block, PNR determines how many customers and which roads are located within the Census Block.[456] For each Census

---

[448] *Platform Order*, 13 FCC Rcd at 21340-41, para. 40.

[449] *Platform Order*, 13 FCC Rcd at 21341, para. 41.

[450] *Inputs Further Notice* at para. 34.

[451] Letter from Michael Liebermann, AT&T, to Magalie Roman Salas, FCC, dated March 2, 1998 (AT&T March 2 *ex parte*).

[452] Letter from William M. Newman, PNR, to Magalie Roman Salas, FCC, dated January 27, 1999 (PNR Jan. 27 *ex parte*). PNR has made available by mail to interested parties the road surrogate point data for a fee of $25.00, pursuant to the terms of the *Protective Order.*

[453] Letter from Charles A. White, PNR, to Magalie Roman Salas, FCC, dated February 22, 1999 (PNR Feb. 22 *ex parte*).

[454] Letter from Charles A. White, PNR, to Magalie Roman Salas, FCC, dated July 29, 1999 (PNR July 29 *ex parte*).

[455] PNR Feb. 22 *ex parte* at 1. A road segment is a length of road between two intersections. The Census Bureau classifies and numbers each of these road segments. PNR uses a slightly modified version of the Census Bureau road classifications. *Id.* at 2

[456] The PNR National Access Line Model is used to determine the number of residential and business customer locations in a given wire center. *See* PNR Feb. 22 *ex parte* at 1.

Block, PNR also develops a list of road segments. The total distance of the road segments within the Census Block is then computed. Roads that are located entirely within the interior of the Census Block are given twice the weight as roads on the boundary. This is because customers are assumed to live on both sides of a road within the interior of the Census Block. In addition, the PNR algorithm excludes certain road segments along which customers are not likely to reside.[457] For example, PNR excludes highway access ramps, alleys, and ferry crossings.[458] The total number of surrogate points is then divided by the computed road distance to determine the spacing between surrogate points. Based on that distance, the surrogate customer locations are uniformly distributed along the road segments.[459] In order to ensure that its road surrogate data set includes all currently served customers, PNR has made minor adjustments to its methodology in some instances. For example, Census Blocks that are not assigned to any current wire center have been assigned to the nearest known wire center, based on the "underpinned of the census block in relation to the wire center's central office location."[460]

44. Stopwatch Maps has compiled road surrogate customer location files for six states suitable for use in the federal mechanism.[461] We conclude, however, that until a more comprehensive data set is made available, the Stopwatch data set will not comply with the *Universal Service Order's* criterion that the underlying data are available for review by the public. Only GTE endorses the use of the Stopwatch data set.[462] In addition, we note that the availability of customer locations for only six states is of limited utility in a nationwide model designed to be implemented on January 1, 2000.

45. AT&T and MCI contend that the exclusive use of a road surrogate algorithm to locate customers produces a 2.7 percent upward bias in loop cost on average on a study area basis when compared to a data set consisting of PNR actual geocode data, where available, and surrogate locations where actual data are unavailable.[463] AT&T and MCI argue that this occurs

[457] PNR Feb. 22 *ex parte* at 2.

[458] PNR Feb. 22 *ex parte* at 2.

[459] PNR Feb. 22 *ex parte* at 2.

[460] *See* PNR July 29 *ex parte*. PNR has also filled in the states and wire centers that were missing from earlier versions of its road surrogate customer location data set.

[461] *See* Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated December 11, 1998 (Sprint Dec. 11 *ex parte*).

[462] GTE *Inputs Further Notice* comments at 38.

[463] AT&T/MCI *Inputs Further Notice* comments at 3. Because the PNR actual geocode data set does not provide a complete data set of customer locations, AT&T and MCI compare a combination of actual and surrogate data with the use of all surrogate data. The percentage of actual geocoded customer data varies in different areas.

because the road surrogate methodology uniformly disperses customers along roads, failing to take into consideration actual, uneven customer distributions that tend to cluster customer locations more closely.[464] AT&T and MCI therefore suggest a downward adjustment to produce more accurate outside plant cost estimates.[465] GTE disagrees and contends that, because the PNR actual geocode data create serving areas that are too dense, it is not surprising that AT&T and MCI have found that the use of road surrogate data produces costs that are slightly higher.[466] GTE argues that there is no evidence to conclude, therefore, that a uniform dispersion of customers is likely to overstate outside plant costs.[467] Sprint contends that the decision to optimize distribution plant in the model mitigates any concern that the road surrogate algorithm overstates the amount of outside plant.[468]

46. We agree with GTE and Sprint that there should be no downward adjustment in cost to reflect the exclusive use of a road surrogate algorithm. In doing so, we note that, although the Commission has gone to great lengths to identify a source of actual, nationwide customer locations, no satisfactory data source has been identified. In fact, only one source of such data, the PNR geocode data, has been placed on the record. As noted above, however, we have rejected the PNR geocode data set at this time because it has not been made adequately available for review. In the absence of a reliable source of actual customer locations by which to compare the surrogate locations, it is impossible to substantiate AT&T and MCI's contention that the road surrogate algorithm overstates the dispersion of customer locations in comparison to actual locations.[469] Although LECG has made comparisons between Ameritech geocode locations and the PNR road surrogate locations, the validity of that comparison is dependent on the accuracy of the geocode data used in that comparison.[470] As Ameritech has not filed that data on the record, we have no way of verifying the accuracy of its geocoded locations. In

---

464 AT&T/MCI *Inputs Further Notice* comments at 3 (contending that customers tend to cluster unevenly along roads and even leave stretches unpopulated). *See also* Ameritech *Inputs Further Notice* comments at 5 (contending that PNR surrogate locations tend to spread customers more evenly than when compared to Ameritech's geocoded customer data).

465 AT&T/MCI *Inputs Further Notice* reply comments at 10.

466 GTE *Inputs Further Notice* reply comments at 4-5.

467 GTE *Inputs Further Notice* reply comments at 5.

468 Sprint *Inputs Further Notice* comments at 13.

469 As noted above, AT&T and MCI rely on the PNR actual geocode data that we have rejected for lack of a meaningful verification process. In the absence of a verifiable, actual geocode data source, it is impossible to make the type of comparison suggested by AT&T and MCI to determine the accuracy of the road surrogate algorithm.

470 Letter from Celia Nogales, Ameritech, to Magalie Roman Salas, FCC, dated July 14, 1999 (Ameritech July 14 *ex parte*). LECG is an economic consulting firm.

addition, we note that Ameritech agrees that the PNR road surrogate "is a reasonable method for locating customers in the absence of actual geocode data."[471] Having no reliable evidence that the PNR road surrogate algorithm systematically overstates customer dispersion, we conclude that no downward adjustment to the outside plant cost estimate is required.

47. We also disagree with Bell Atlantic's contention that road surrogate data is inherently random and likely to misidentify high-cost areas.[472] As noted in the *Platform Order*, we believe that it is reasonable to assume that customers generally reside along roads and, therefore, associating customers with the distribution of roadways is a reasonable method to estimate customer locations. We note that PNR's methodology of excluding certain road segments is consistent with the Commission's conclusion in the *Platform Order* that certain types of roads and road segments should be excluded because they are unlikely to be associated with customer locations.[473] In addition, we note that PNR's reliance on the Census Bureau's TIGER files ensures a degree of reliability and availability for review of much of the data underlying PNR's road surrogate algorithm, in compliance with criterion eight of the *Universal Service Order*.[474] The PNR road surrogate algorithm is also generally supported by commenters addressing this issue.[475] While AT&T and MCI advocate the use of actual geocode data points, AT&T and MCI endorse the PNR road surrogate algorithm to identify surrogate locations in the absence of actual geocode data.[476] We therefore affirm our tentative conclusion in the *Inputs Further Notice* and adopt the PNR road surrogate algorithm and data set to determine customer locations for use in the model beginning on January 1, 2000.

3. Methodology for Estimating the Number of Customer Locations

48. In addition to selecting a source of customer data, we also must select a methodology for estimating the number of customer locations within the geographic region that

---

[471] Ameritech *Inputs Further Notice* comments at 3.

[472] Bell Atlantic *Inputs Further Notice* comments at 8. As noted, the decision to use a surrogating algorithm based on roads was made by the Commission in the *Platform Order*. Our purpose in this Order is not to revisit that decision but to select the road surrogate algorithm that will be used in the federal mechanism.

[473] *Platform Order*, 13 FCC Rcd at 21341, para. 41.

[474] We also note that PNR has made the road surrogate data points available to interested parties pursuant to the provisions of the *Protective Order* in this proceeding. *See* PNR Jan. 27 *ex parte*; PNR Feb. 9 *ex parte*; PNR Feb. 22 *ex parte*.

[475] *See, e.g.*, Ameritech *Inputs Further Notice* at 3; AT&T/MCI *Inputs Further Notice* comments at 6-7; Sprint *Inputs Further Notice* at 12.

[476] AT&T/MCI *Inputs Further Notice* comments at 6-7.

will be used in developing the customer location data. In addition, we must determine how demand for service at each customer location should be estimated and how customer locations should be allocated to each wire center. In the *Inputs Further Notice*, we tentatively concluded that PNR's methodology for estimating the number of customer locations based on households should be used for developing the customer location data.[477] In addition, we also tentatively concluded that we should use PNR's methodology for estimating the demand for service at each location, and for allocating customer locations to wire centers.[478] We now affirm these tentative conclusions.

49. In the *Universal Service Order*, the Commission concluded that a "model must estimate the cost of providing service for all businesses and households within a geographic region."[479] The Commission has sought comment on the appropriate method for defining "households," or residential locations, for the purpose of calculating the forward-looking cost of providing supported services.[480] Interested parties have proposed alternative methods to comply with this requirement.[481]

50. AT&T, MCI, and Ameritech support the methodology devised by PNR, which is based upon the number of households in each Census Block, while BellSouth, GTE, SBC, USTA, and US West propose that we use a methodology based upon the number of housing units in each Census Block.[482] A household is an occupied residence, while housing units include all residences, whether occupied or not.[483]

---

[477] *Inputs Further Notice* at para. 43.

[478] *Inputs Further Notice* at para. 43.

[479] *Universal Service Order*, 12 FCC Rcd at 8915, para. 250 (criterion 6).

[480] *Inputs Public Notice* at 4-6. *See also Inputs Further Notice* at para. 46.

[481] We note that the question of which residential and business locations should be included for purposes of estimating the forward-looking cost of providing the supported services is distinct from the question of which lines should be supported. *See Universal Service Order*, 12 FCC Rcd at 8829, paras. 95-96 (declining to adopt the Joint Board's recommendation to restrict universal service high-cost support to primary residential lines and single-line businesses).

[482] Ameritech *Inputs Further Notice* comments at 6; AT&T/MCI *Inputs Further Notice* comments at 7-8; BellSouth *Inputs Further Notice* comments at B-2; GTE *Inputs Further Notice* comments at 40; SBC *Inputs Further Notice* comments at 6; USTA *Inputs Further Notice* comments at 2-3; US West *Inputs Further Notice* comments at 45-46.

[483] These definitions reflect the Census Bureau's methodology for housing unit and household estimates. *See* http://www.census.gov/population/methods/sthhmet.txt.

51. In the *Inputs Further Notice*, we tentatively adopted the use of the PNR National Access Line Model, as proposed by AT&T and MCI, to estimate the number of customer locations within Census Blocks and wire centers.[484] The PNR National Access Line Model uses a variety of information sources, including: survey information; the LERG; Business Location Research (BLR) wire center boundaries; Dun & Bradstreet's business database; Metromail's residential database; Claritas's demographic database; and U.S. Census Bureau estimates. PNR's model uses these sources in a series of steps to estimate the number of residential and business locations, and the number of access lines demanded at each location.[485] The model makes these estimates for each Census Block, and for each wire center in the United States.[486] In addition, each customer location is associated with a particular wire center.[487] We conclude that PNR's process for estimating the number of customer locations should be used for developing the customer location data. We also conclude that we should use PNR's methodology for estimating the demand for service at each location, and for allocating customer locations to wire centers.[488] We believe that the PNR methodology is a reasonable method for determining the number of customer locations to be served in calculating the cost of providing supported services.

52. PNR's process for estimating the number of customer locations results in an estimate of residential locations that is greater than or equal to the Census Bureau's estimate of households, by Census Block Group, and its estimate is disaggregated to the Census Block level. PNR's estimate of demand for both residential and business lines in each study area will also be greater than or equal to the number of access lines in the Automated Reporting and Management Information System (ARMIS) for that study area.

53. The BCPM model relied on many of the same data sources as those used in PNR's National Access Line Model. For example, BCPM 3.1 used wire center data obtained from BLR and business line data obtained from PNR.[489] In estimating the number of residential locations, however, the BCPM model used Census Bureau data that include household and housing unit

---

[484] HAI Dec. 11, 1997 submission, Model Description at 21.

[485] *See Inputs Further Notice* at Appendix B.

[486] HAI Dec. 11, 1997 submission, Model Description at 21.

[487] Customer locations in unserved areas, as reflected by BLR wire center boundaries, are not associated with particular wire centers. *See* Letter from Charles A. White, PNR, to Magalie Roman Salas, FCC, dated April 12, 1999. PNR has, however, taken steps to assign such customer locations to the nearest wire center. PNR July 29 *ex parte*.

[488] *See Inputs Further Notice* at Appendix B for a complete description of the PNR methodology for estimating the number of customer locations.

[489] BCPM April 30, 1998 documentation, Model Methodology at 26-27.

counts from the 1990 Census, updated based upon 1995 Census Bureau statistics regarding household growth by county. In addition, rather than attempting to estimate demand by location at the Block level, the BCPM model builds two lines to every residential location and at least six lines to every business.

54. A number of commenters contend that the total cost estimated by the model should include the cost of providing service to all possible customer locations, even if some locations currently do not receive service.[490] Some commenters further contend that, if total cost is based on a smaller number of locations, support will not be sufficient to enable carriers to meet their carrier-of-last-resort obligations. These commenters argue that basing the estimate of residential locations on households instead of housing units will underestimate the cost of building a network that can provide universal service.[491] They therefore assert that residential locations should be based on the number of housing units -- whether occupied or unoccupied.[492] These commenters contend that only this approach reflects the obligation to provide service to any residence that may request it in the future.[493]

55. Some commenters also contend that the PNR National Access Line Model has not been made adequately available for review.[494] As noted above, the National Access Line Model is a multi-step process used to develop customer location counts and demand and associate those customer locations with Census Blocks and wire centers.[495] As a result, PNR contends that the National Access Line Model cannot be provided in a single, uniform format.[496] The HAI sponsors have provided a description of the National Access Line Model process in the HAI

[490] BellSouth *Inputs Further Notice* at B-2; GTE *Inputs Further Notice* at 40; SBC *Inputs Further Notice* comments at 6; USTA *Inputs Further Notice* comments at 2-3; US West *Inputs Further Notice* comments at 45-46.

[491] BellSouth *Inputs Further Notice* comments at B-2; GTE *Inputs Further Notice* comments at 40; PRTC *Inputs Further Notice* comments at 5.

[492] *See*, *e.g.*, BellSouth *Inputs Further Notice* at B-2; GTE *Inputs Further Notice* at 40; SBC *Inputs Further Notice* comments at 6; USTA *Inputs Further Notice* comments at 2-3; US West *Inputs Further Notice* comments at 45-46.

[493] *See*, *e.g.*, BellSouth *Inputs Further Notice* comments at B-2; GTE *Inputs Further Notice* comments at 40; US West *Inputs Further Notice* comments at 45-46.

[494] Bell Atlantic *Inputs Further Notice* comments at 14-15; GTE *Inputs Further Notice* comments at 37-38; Sprint *Inputs Further Notice* comments at 13-14; US West *Inputs Further Notice* reply comments at 12.

[495] HAI has provided a complete description of the process by which PNR's National Access Line Model develops customer counts. *See* HAI Dec. 11, 1997, Model Description at 21.

[496] PNR *Inputs Further Notice* reply comments at 2.

model documentation.[497] PNR has made the National Access Line Model process available for review through on-site examination and has provided more detailed explanation of the National Access Line Model upon request from interested parties. PNR notes that several parties have taken advantage of this opportunity.[498] PNR also notes that the National Access Line Model computer code is available for review on-site.[499] PNR also has filed with the Commission the complete output of the National Access Line Model process.[500] In addition, Bell Atlantic and Sprint argue that the National Access Line Model produces line counts that vary significantly from actual line counts.[501]

56. In adopting the PNR approach for developing customer location counts, we note that the synthesis model currently calculates the average cost per line by dividing the total cost of serving customer locations by the current number of lines. Because the current number of lines is used in this average cost calculation, we agree with AT&T and MCI that the total cost should be determined by using the current number of customer locations. As AT&T and MCI note, "the key issue is the consistency of the numerator and denominator" in the average cost calculation. According to AT&T and MCI, other proposed approaches result in inconsistency because they use the highest possible cost in the numerator and divide by the lowest possible number of lines in the denominator, and therefore result in larger than necessary support levels.[502] AT&T and MCI also assert that, in order to be consistent, housing units must be used in the determination of total lines if they are used in the determination of total costs.[503] MCI points out that "[i]f used consistently in this manner, building to housing units as GTE proposes is unlikely to make any difference in cost per line."[504] Although SBC advocates the use of housing units, it agrees that the number of lines resulting from this approach should also be used in the denominator of any cost per line calculation to prevent the distortion noted by AT&T and MCI.[505] We agree with AT&T and MCI that, as long as there is consistency in the development

497 *See* HAI Dec. 11, 1997, Model Description at 21.

498 PNR *Inputs Further Notice* reply comments at 2.

499 PNR *Inputs Further Notice* reply comments at 2-3.

500 Letter from Charles White, PNR, to Magalie Roman Salas, FCC, dated October 6, 1999.

501 Bell Atlantic *Inputs Further Notice* comments at 14-15; Sprint *Inputs Further Notice* comments at 13-14.

502 AT&T and MCI *ex parte*, Dec. 23, 1997.

503 Letter from Chris Frentrup, MCI, to Magalie Roman Salas, FCC, dated March 5, 1999 (MCI March 5 *ex parte*).

504 MCI March 5 *ex parte* (Issues 1 and 2).

505 SBC *Inputs Further Notice* comments at 6.

of total lines and total cost, it makes little difference whether households or housing units are used in determining cost per line. For the reasons discussed below, we believe that PNR's methodology based on households is less complex and more consistent with a forward-looking methodology than housing units.

57. To the extent that the PNR methodology includes the cost of providing service to all currently served households, we conclude that this is consistent with a forward-looking cost model, which is designed to estimate the cost of serving current demand. As noted by AT&T and MCI, adopting housing units as the standard would inflate the cost per line by using the highest possible numerator (all occupied and unoccupied housing units) and dividing by the lowest possible denominator (the number of customers with telephones).[506]

58. If we were to calculate the cost of a network that would serve all potential customers, it would not be consistent to calculate the cost per line by using current demand. In other words, it would not be consistent to estimate the cost per line by dividing the total cost of serving all potential customers by the number of lines currently served. The level and source of future demand, however, is uncertain. Future demand might include not only demand from currently unoccupied housing units, but also demand from new housing units, or potential increases in demand from currently subscribing households. We also recognize that population or demographic changes may cause future demand levels in some areas to decline. Given the uncertainty of future demand, we noted in the *Inputs Further Notice* that we are concerned that including such a highly speculative cost of future demand may not reflect forward-looking cost and may perpetuate a system of implicit support. Ameritech and AT&T and MCI also note that adopting the proposed conservative fill factors will ensure sufficient plant to deal with any customer churn created as a result of temporarily vacant households.[507]

59. In addition, we do not believe that including the cost of providing service to all housing units would necessarily promote universal service to unserved customers. We note that there is no guarantee that carriers would use any support derived from the cost of serving all housing units to provide service to these customers. Many states permit carriers to charge substantial line extension or construction fees for connecting customers in remote areas to their network. If that fee is unaffordable to a particular customer, raising the carrier's support level by including the costs of serving that customer in the model's calculations would have no effect on whether the customer actually receives service. In fact, as long as the customer remains unserved, the carrier would receive a windfall. We recognize that providing service to currently unserved customers in such circumstances is an important universal service goal and the Commission is addressing this issue more directly in another proceeding.[508]

[506] AT&T and MCI *ex parte*, Dec. 23, 1997.

[507] Ameritech *Inputs Further Notice* comments at 7; AT&T/MCI *Inputs Further Notice* comments at 8. *See infra* section V for discussion of fill factors.

[508] *See Federal-State Joint Board on Universal Service: Promoting Deployment and Subscribership in*

60. We also find that interested parties have been given a reasonable opportunity to review and understand the National Access Line Model process for developing customer counts. The HAI sponsors have documented the process by which the National Access Line Model derives customer location counts and PNR has made itself available to respond to inquiries from interested parties. The National Access Line Model is a commercially licensed product developed by PNR, and we do not find it unreasonable for PNR to place some restriction on its distribution to the public. In addition, we agree that the National Access Line Model is more correctly characterized as a process consisting of several steps, and therefore we find no practical alternative to on-site review. Even if it were possible for PNR to turn the National Access Line Model over to the public in a single format, we believe that this would be of limited utility without a detailed explanation of the entire process. We therefore conclude that PNR has made reasonable efforts to ensure that interested parties understand the underlying process by which the National Access Line Model develops customer counts and has made that process reasonably available to interested parties. In addition, unlike the case with PNR's geocode data points, PNR's road surrogate customer location points are available for review and comparison by interested parties.

61. In response to Bell Atlantic and Sprint's concern regarding the line counts generated by the National Access Line Model, we note that the line count data proposed in the *Inputs Further Notice* had been trued up by PNR to 1996 ARMIS line counts. We subsequently have modified those data to reflect the most currently available ARMIS data. Accordingly, the input values that we adopt in this Order will true up the line counts generated by the National Access Line Model to 1998 ARMIS line counts. While the Commission has requested line count data from the non-rural LECs,[509] no party has suggested, and we have not been able to discern, any feasible way of associating such data with wire centers used in the model. The Commission intends to continue to review this issue in addressing future refinements to the forward-looking cost model.

62. In the *Inputs Further Notice*, we also noted that the accuracy of wire center boundaries is important in estimating the number of customer locations.[510] PNR currently uses BLR wire center information to estimate wire center boundaries.[511] As noted above, the BCPM

Unserved and Underserved Areas, Including Tribal and Insular Areas, Further Notice of Proposed Rulemaking, CC Docket No. 96-45, FCC 99-204 (rel. Sept. 3, 1999) at paras. 120-121.

[509] *See Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, Order, CC Docket Nos. 96-45, 97-160, DA 99-1406 (rel. July 19, 1999).

[510] *Inputs Further Notice* at para. 47.

[511] HAI Dec. 11, 1997 submission, Model Description at 21.

model also uses BLR wire center boundaries, as does Stopwatch Maps in its road surrogate customer location files.[512] A few commenters support the use of BLR wire center boundaries, noting widespread use by the model proponents.[513] Others advocate the use of actual wire center boundaries.[514] These commenters acknowledge, however, that this information is generally considered confidential and may not be released publicly by the incumbent LEC.[515] We conclude that the BLR wire center boundaries are the best available data that are open to inspection and that they provide a reasonably reliable estimation of wire center boundaries. We note that both the BCPM and HAI proponents have utilized the BLR wire center data in their respective models. While use of actual wire center boundaries may be preferable, we agree that such information is currently unavailable or proprietary. We therefore approve the use of the BLR wire center boundaries in the current customer location data set.

V. OUTSIDE PLANT INPUT VALUES

A. Introduction

63. In this section, we consider inputs to the model related to outside plant. The *Universal Service Order's* first criterion specifies that "[t]he technology assumed in the cost study or model must be the least-cost, most efficient, and reasonable technology for providing the supported services that is currently being deployed."[516] Thus, while the model uses existing incumbent LEC wire center locations in designing outside plant, it does not necessarily reflect existing incumbent LEC loop plant.[517] Indeed, as the Commission stated in the *Platform Order*, "[e]xisting incumbent LEC plant is not likely to reflect forward-looking technology or design choices."[518] The *Universal Service Order's* third criterion specifies that "[o]nly long-run forward-looking costs may be included."[519] We select input values consistent with these criteria.

---

[512] *See* Sprint Dec. 11, 1998 *ex parte*, attachment at 1.

[513] AT&T/MCI *Inputs Further Notice* comments at 8; PNR *Inputs Further Notice* reply comments at 3.

[514] PRTC *Inputs Further Notice* comments at 6; SBC *Inputs Further Notice* comments at 6.

[515] SBC *Inputs Further Notice* comments at 6; PNR *Inputs Further Notice* reply comments at 3.

[516] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

[517] *Inputs Further Notice* at para. 11; *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

[518] *Platform Order*, 12 FCC Rcd at 21350, para. 66. "Instead, incumbent LECs' existing plant will tend to reflect choices made at a time when different technology options existed or when the relative cost of equipment to labor may have been different than it is today." *Id.*

[519] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

64. As the Commission noted in the *Platform Order*, outside plant, or loop plant, constitutes the largest portion of total network investment, particularly in rural areas.[520] Outside plant investment includes the copper cables in the distribution plant and the copper and optical fiber cables in the feeder plant that connect the customers' premises to the central office. Cable costs include the material costs of the cable, as well as the costs of installing the cable.[521]

65. Outside plant consists of a mix of aerial, underground, and buried cable.[522] Aerial cable is strung between poles above ground. Underground cable is placed underground within conduits for added support and protection. Buried cable is placed underground but without any conduit. A significant portion of outside plant investment consists of the poles, trenches, conduits, and other structure that support or house the copper and fiber cables. In some cases, electric utilities, cable companies, and other telecommunications providers share structure with the LEC and, therefore, only a portion of the costs associated with that structure are borne by the LEC. Outside plant investment also includes the cost of the SAIs and DLCs that connect the feeder and distribution plant.

B. Engineering Assumptions and Optimizing Routines

66. As noted in the *Inputs Further Notice*, the model determines outside plant investment based on certain cost minimization and engineering considerations that have associated input values.[523] In the *Inputs Further Notice*, we recognized that it was necessary to examine certain input values related to the engineering assumptions and optimization routines in the model that affect outside plant costs.[524] Specifically, we tentatively concluded that: (1) the optimization routine in the model should be fully activated; (2) the model should not use T-1 feeder technology; and (3) the model should use rectilinear distances and a "road factor" of one.[525]

1. Optimization

[520] *Platform Order*, 13 FCC Rcd at 21335, para. 27.

[521] As discussed below, cable installation costs for buried cable often are included with the structure costs.

[522] The phrase "plant mix" refers to the ratio of outside plant that is aerial, underground, or buried in a network or particular area.

[523] *See Inputs Further Notice* at paras. 56-63.

[524] *Inputs Further Notice* at para. 56.

[525] *Inputs Further Notice* at paras. 58, 61-62.

67. When running the model, the user has the option of optimizing distribution plant routing via a minimum spanning tree algorithm discussed in the model documentation.[526] The algorithm functions by first calculating distribution routing using an engineering rule of thumb and then comparing the cost with the spanning tree result, choosing the routing that minimizes annualized cost.[527] The user has the option of not using the distribution optimization feature, thereby saving a significant amount of computation time, but reporting network costs that may be significantly higher than with the optimization. The user also has the option of using the optimization feature only in the lowest density zones.

68. In reaching our tentative conclusion that the model should be run with the optimization routine fully activated in all density zones, we recognized that using full optimization can substantially increase the model's run time.[528] We noted that a preliminary analysis of comparison runs with full optimization versus runs with no optimization indicated that, for clusters with line density greater than 500, the rule of thumb algorithm results in the same or lower cost for nearly all clusters.[529] Accordingly, we sought comment on whether an acceptable compromise to full optimization would be to set the optimization factor at "-p500," as described in the model documentation.[530]

69. We adopt our tentative conclusion that the model should be run with the optimization routine fully activated in all density zones when the model is used to calculate the forward-looking cost of providing the services supported by the federal mechanism. The first of the ten criteria pronounced by the Commission to ensure consistency in calculations of federal universal support specifies that "[t]he technology assumed in the cost study or model must be the least-cost, most efficient, and reasonable technology for providing the supported services that is currently being deployed."[531] As we explained in the *Inputs Further Notice*, running the model with the optimization routine fully activated complies with this requirement.[532] In contrast,

[526] The model uses a minimum spanning tree algorithm based on the Prim algorithm. The model always optimizes feeder plant. *See* HCPM Dec. 15, 1998 documentation at 13.

[527] HCPM Dec. 15, 1998 documentation at 11.

[528] *Inputs Further Notice* at para. 58.

[529] *See Inputs Further Notice* at para. 58 n. 135. Since, under full optimization, the model chooses the least cost of the full optimization algorithm or the rule of thumb algorithm, a comparison run as described above can show how well the full optimization performs as a function of density.

[530] *See* HCPM Dec. 15, 1998 documentation at 30-31; *see also* Design History of HCPM, April 6, 1999 at http://www.fcc.gov/ccb/apd/hcpm.

[531] *Universal Service Order,* 12 FCC Rcd at 8913, para. 250.

[532] *Inputs Further Notice* at para. 58.

running the model with the optimization routine disabled may result in costs that are significantly higher than with full optimization. The majority of commenters that address the optimization issue support the use of full optimization.[533] GTE opposes any implementation of optimization.[534]

70. We agree with AT&T and MCI and GTE that it is inappropriate to deviate from full optimization merely to minimize computer run time.[535] While the rule of thumb algorithm generally results in costs that are approximately the same as the spanning tree algorithm for dense clusters, for some dense clusters the spanning tree algorithm will result in lower costs. For this reason, we believe that any choice in maximum density clusters in which the minimum spanning tree algorithm is not applied may result in an arbitrary overestimate of costs for some clusters. Accordingly, running the model with full optimization is consistent with ensuring that the model uses the least-cost, most efficient, and reasonable distribution plant routings for providing the supported services.

71. As explained above, the model seeks to minimize costs by selecting the lower of the cost estimates from the spanning tree algorithm and the rule of thumb algorithm. Both GTE and US West challenge the selection of the routing that minimizes annualized cost on the basis of a comparison between an engineering rule of thumb and the spanning tree result.[536] US West claims that use of the rule of thumb approach is inappropriate because combining it with the spanning tree analytical approach to determine the amount of needed plant biases the results downward and will produce inappropriately low results.[537]

72. We find that US West's concerns are misplaced. Contrary to US West's

[533] *See e.g.*, AT&T and MCI *Inputs Further Notice* comments at 9-10; US West *Inputs Further Notice* comments at 21; SBC *Inputs Further Notice* comments at 7. We note that SBC supports full optimization so long as its application produces a significant difference in the results. As we explain, application of full optimization does produce a significant difference in the results. Moreover, SBC states that the optimization routine offers "the most cost effective design." *Id.*

[534] GTE *Inputs Further Notice* comments at 33-35; GTE *Inputs Further Notice* reply comments at 9-11.

[535] AT&T and MCI *Inputs Further Notice* comments at 10; GTE *Inputs Further Notice* comments at 33. We note that although GTE opposes any implementation of optimization, GTE also specifically addressed whether the compromise to full optimization on which we sought comment was acceptable.

[536] US West *Inputs Further Notice* comments at 18-21; GTE *Inputs Further Notice* comments at 34-35.

[537] US West contends that, because the optimization algorithm functions by choosing between the lowest value produced by the rule of thumb or the spanning tree, the optimization algorithm retains those instances where the rule of thumb underestimates the amount of plant needed while eliminating all estimates that exceed the more analytically derived results, thereby biasing the results downward. In order to remedy this flaw, US West recommends that the model be modified to consider only the minimum spanning tree results for distribution design.

characterization, the rule of thumb used in the model is not an averaging methodology.[538] Instead, it is a methodology that determines a sufficient amount of investment to serve each customer in every cluster using a standardized approach to network design. This approach connects every populated microgrid cell to the SAI using routes which are placed along the vertical and horizontal boundaries of the microgrid cells constructed in the distribution algorithm.[539] The rule-of-thumb algorithm is somewhat similar in its functioning to the so-called "pinetree" methodology proposed by both the early HAI and BCPM models for building feeder plant. Thus, the rule of thumb provides an independent calculation of sufficient outside plant for each cluster. The minimum spanning tree algorithm connects drop terminal points to the SAI using a more sophisticated algorithm in which routes are not restricted to following the vertical and horizontal boundaries of microgrid cells. The algorithm "chooses" a path independently of the set route structure defined by the rule-of-thumb,but still connects all drop terminals to the SAI. Since both the rule of thumb algorithm and the spanning tree algorithm use currently available technologies and generate investments that are sufficient to provide supported services, an approach which selects the minimum cost based on an evaluation of both of the algorithms is fully consistent with cost minimization principles.[540]

73. We also disagree with GTE's assertion that the optimization routine should be disabled because it disproportionately affects lower density areas where universal service is needed most.[541] The task of the model is to estimate the cost of the least-cost, most-efficient network that is sufficient to provide the supported services. Moreover, we note that the model does not determine the level of high-cost support amounts. We have taken steps in our companion order to ensure that sufficient support is provided for rural and high-cost areas.

---

[538] *See* US West *Inputs Further Notice* comments at 18-21.

[539] Because the optimization routine allows for the possibility of some, but not all possible junction nodes (also called Steiner nodes), it is possible that the "rule of thumb" can provide a feasible lower cost result than the optimization routine in certain cases. As explained in the model documentation, junction nodes can sometimes reduce the cost of constructing a communications network. HCPM Dec.15, 1998 documentation at 14.

[540] US West's recommendation that only the minimum spanning tree results be recognized would have us ignore accepted practices in cost minimization. Because it is not possible in the general case to solve for the optimal solution, it is accepted practice in cost minimization analysis to examine the results of various available alternative cost minimization methodologies and choose the lowest cost result, provided that each alternative meets the appropriate design standards. This is the same principle on which Branch and Bond algorithms work. *See e.g.,* Mark S. Daskin, *Network and Discrete Location: Models, Algorithms, and Applications* (1995). In so doing, the result that is chosen is the result that is closer to the least cost, while providing a sufficient amount of plant to provide the supported services. For these reasons, the optimization algorithm employed in the model produces results superior to those produced by the application of only a single cost minimization methodology.

[541] GTE asserts that an analysis of GTE's service area in Oregon reveals that a majority of the cost impact occurs when the spanning tree algorithm optimizes clusters with less than 100 lines per square mile. GTE *Inputs Further Notice* reply comments at 11.

74. We also reject GTE's claim that the optimization routine does not work as intended.[542] GTE bases this contention on the observation that in some instances when the optimization factor is increased from -p100 to -p200 (i.e. going from density zones less than or equal to 100 lines per square mile to density zones less than or equal to 200 lines per square mile), both loop investment and universal service requirements increase. This, according to GTE, would not happen if the optimization worked properly.[543]

75. We disagree. Optimizing the distribution plant is not synonymous with optimizing the entire network. Because the model's optimization routine optimizes distribution and feeder sequentially, and the starting point for the optimization of feeder plant is the distribution plant routing chosen, there are occasions when the optimal feeder plant will be more costly than it would be if distribution plant and feeder plant had been optimized simultaneously. In some cases, the lower distribution investment produced by the optimization routine may be offset by higher feeder investment, resulting in higher total outside plant costs than produced by the rule of thumb algorithm.[544] Contrary to GTE's assertion, this phenomenon does not demonstrate that the optimization works improperly. To the contrary, it demonstrates that optimization occurs properly within the constraints of the model's design.

76. Moreover, we conclude that such rare occurrences do not outweigh the benefits of the optimization routine. The magnitude of the difference between the network cost produced by the optimization routine in these instances and the rule of thumb algorithm is *de minimis*. Furthermore, altering the model to optimize distribution investment and feeder investment simultaneously would greatly add to the complexity of the model.

2. T-1 Technology

77. A user of the model also has the option of using T-1 on copper technology as an

[542] GTE *Inputs Further Notice* reply comments at 11.

[543] GTE also claims that there are numerous cases where the optimization routine has resulted in increased costs at the wire center level. GTE *Input Further Notice* comments at 34-35. Specifically, GTE contends that when the optimization logic is applied to clusters with fewer than 100 lines per square mile for GTE's Florida serving area, total monthly costs for eight wire centers were higher than without optimization.

[544] This situation can occur because the minimum spanning tree algorithm may increase the distance of some customers in a cluster from the serving area interface in order to achieve lower overall costs through more efficient routing. In some cases, this increased distance might cause a cluster that fell within the maximum copper distance constraint under the rule of thumb algorithm to exceed that constraint. The increased cost of serving the cluster with the fiber feeder system could then increase total cost even though the optimization worked as intended in the distribution portion of the model.

alternative to analog copper feeder or fiber feeder in certain circumstances.[545] T-1 is a technology that allows digital signals to be transmitted on two pairs of copper wires at 1.544 Megabits per second (Mbps). If the T-1 option is enabled, the optimizing routines in the model will choose the least cost feeder technology among three options: analog copper; T-1 on copper; and fiber.[546] For serving clusters with loop distances below the maximum copper loop length, the model could choose among all three options; between 18,000 feet and the fiber crossover point, which earlier versions of the model set at 24,000 feet, the model could choose between fiber and T-1, and above the fiber crossover point, the model would always use fiber. In the HAI model, T-1 technology is used to serve very small outlier clusters in locations where the copper distribution cable would exceed 18,000 feet.

78. In the *Inputs Further Notice*, we tentatively concluded that the T-1 option in the model should not be used at this time.[547] We noted that the only input values for T-1 costs on the record were the HAI default values and tentatively found that, because the model and HAI model use T-1 differently, it would be inappropriate to use the T-1 technology in the model based on these input values.[548] We also noted that the BCPM sponsors and other LECs maintained that T-1 was not a forward-looking technology and therefore should not be used in the model.[549] Other sources indicated that advanced technologies, such as HDSL, could be used to transmit information at T-1 or higher rates.[550] We sought comment on this issue.[551] We also sought comment on the extent to which HDSL technology presently is being used to provide T-1 service.[552]

79. We conclude that the T-1 option should not be employed in the current version of the model. We agree with those commenters addressing this issue that traditional T-1 using

[545] *See Inputs Further Notice* at para. 59.

[546] HCPM Dec. 15, 1998 documentation at 10.

[547] *Inputs Further Notice* at para. 61.

[548] *Inputs Further Notice* at para. 61.

[549] *Inputs Further Notice* at para. 59.

[550] HDSL (high data rate digital subscriber line) transmits 1.544 Mbps or 2.048 Mbps in bandwidths ranging from 80 kilohertz (kHz) to 240 kHz, rather than in a bandwidth of 1.5 megahertz (mHz) required for traditional T-1 services. *See* www.adsl.com/general_tutorial.

[551] *Inputs Further Notice* at para. 60.

[552] *Inputs Further Notice* at para. 60.

repeaters at 6000 foot intervals is not a forward-looking technology.[553] While HDSL and other DSL variants are forward-looking technologies, we do not at this time have sufficient information to determine appropriate input values for these technologies for use in the model. We conclude, therefore, that use of T-1 in the optimization routine as an alternative to analog copper or digital fiber feeder for certain loops under 24,000 feet is not appropriate at this time.[554] Accordingly, the model will be run for universal service purposes with the T-1 option disabled.

3. Distance Calculations and Road Factor

80. In the distribution and feeder computations within the model, costs for cable and structure are computed by multiplying the route distances by the cost per foot of the cable or the structure facility, which depends on capacity and terrain factors. Distances between any two points in the network are computed using either of two distance functions.[555] The model allows a separate road factor for each distance function, and every distance measurement made in the model is multiplied by the designated factor. Road factors could be computed by comparing average distances between geographic points along actual roads with distances computed using either of the two distance functions. Given sufficient data, these factors could be computed at highly disaggregated levels, such as the state, county, or individual wire center.

81. In the *Inputs Further Notice*, we tentatively concluded that the model should use rectilinear distance in calculating outside plant distances, rather than airline distance, because

---

[553] *See e.g.*, GTE *Inputs Further Notice* comments at 62; SBC *Inputs Further Notice* comments at 7; AT&T and MCI *Inputs Further Notice* comments at 11; AT&T and MCI *Inputs Further Notice* reply comments at 12-13. We note that, notwithstanding their support for the decision to not use T-1, AT&T and MCI encourage the Commission to modify the model to use T-1 technology in the same manner as does the HAI model, i.e., as a distribution alternative where, after using a fiber fed integrated digital loop carrier to link a main cluster of customer locations with a serving wire center, outlying customer locations beyond 18,000 feet from the main cluster's center are served by copper T-1 distribution loops. This recommendation, which would represent a platform change, will be considered in the upcoming proceeding on future changes to the model.

[554] SBC and GTE responded to our inquiry regarding the use and extent of advanced technologies to transmit information at T-1 on higher rates. SBC maintains that it is not reasonable to expect that HDSL will be used on T-1 technology. SBC *Inputs Further Notice* comments at 7. SBC explains that HDSL is being considered primarily for small pair gain (DLC) activation to meet specific customer needs or HI-CAP provisioning, and not for normal DLC activation. GTE maintains that HDSL can be and is used to provide 1.544 Megabit per second data rates over embedded copper plant, but its use is not an appropriate forward-looking technology. GTE *Inputs Further Notice* comments at 62. GTE adds that predominant uses of HDSL are to provision "short fuse" 1.544 Mbps service requests and extend the life of the embedded copper network. In sum, SBC and GTE assert that, even if augmented by advanced technology such as HDSL, T-1 is still not a forward-looking technology.

[555] A rectilinear measurement computes the distance between two points by constructing a rectangle with the two points as opposite vertices and measuring the distance of two adjacent sides of the rectangle. The airline distance is the length of the diagonal line that directly connects the two points.

rectilinear distance more accurately reflects the routing of telephone plant along roads and other rights of way.[556] We also tentatively concluded that the road factor in the model, which reflects the ratio between route distance and road distance, should be set equal to one.[557] In addition, we asked whether we should use airline miles with wire center specific road factors as an alternative to rectilinear distance.[558]

82. We reaffirm our tentative conclusion that the model should use rectilinear distance rather than airline distance in calculating outside plant distances.[559] As we noted in the *Inputs Further Notice*, research suggests that, on average, rectilinear distance closely approximates road distances.[560] We agree with SBC that the calculation of outside plant distances should reflect the closest approximation to actual route conditions and road distance.[561] We also conclude that it would be inappropriate to use airline distance in the model without simultaneously developing a process for determining accurate road factors (which would be uniformly greater than or equal to 1 in this case). While the use of geographically disaggregated road factors may merit further investigation, we note that the absence of such a data set on the record at this time precludes our ability to adopt that approach.[562] We therefore conclude that the model should use a rectilinear distance metric with a road factor of one.

C. Cable and Structure Costs

1. Background

83. The model uses several tables to calculate cable costs, based on the cost per foot of cable, which may vary by cable size (i.e., gauge and pair size) and the type of plant (i.e., underground, buried, or aerial). There are four separate tables for copper distribution and feeder

[556] *Inputs Further Notice* at para. 62.

[557] *Inputs Further Notice* at para. 62.

[558] *Inputs Further Notice* at para. 63.

[559] As BellSouth attests, cable rarely follows a straight-line "as the crow flies" route. BellSouth *Inputs Further Notice* comments, Attachment B at B-3.

[560] *Inputs Further Notice* at para. 62 n. 142 *citing* Robert F. Love *et al.*, *Facilities Location Models and Methods*, Chapter 10 (1988).

[561] SBC *Inputs Further Notice* comments at 7.

[562] We make no finding as to whether using airline miles with geographically disaggregated road factors, if available, would be a more appropriate method of calculating distances and intend to explore this issue further in the future of the model proceeding.

cable of two different gauges, and one table for fiber cable. The engineering assumptions and optimizing routines in the model, in conjunction with the input values in the tables, determine which type of cable is used.

84. The model also uses structure cost tables that identify the per foot cost of loop structure by type (aerial, buried, or underground), loop segment (distribution or feeder), and terrain conditions (normal, soft rock, or hard rock) for each of the nine density zones.[563]

85. After the model has grouped customer locations in clusters, it determines, based on cost minimization and engineering considerations, the appropriate technology type for the cluster and the correct size of cables in the distribution network. Every customer location is connected to the closest SAI by copper cable. The copper cable used in the local loop typically is either 24- or 26-gauge copper. Twenty-four gauge copper is thicker and, therefore, is expected to be more expensive than 26-gauge copper. Twenty-four gauge copper also can carry signals greater distances without degradation than 26-gauge copper and, therefore, is used in longer loops. In the model, if the maximum distance from the customer to the SAI is less than or equal to the copper gauge crossover point, then 26-gauge cable is used. Feeder cable is either copper or fiber. Fiber is used for loops that exceed 18,000 feet, the maximum copper loop length permitted in the model, as determined in the *Platform Order*.[564] When fiber is more cost effective, the model will use it to replace copper for loops that are shorter than 18,000 feet.

86. In the *1997 Further Notice*, the Commission sought comment on the input values that the model should use for cable and installation costs.[565] The Commission specifically sought comment on the accuracy of the default values in the BCPM and HAI models and encouraged companies to submit data to support their positions.[566] The Commission tentatively concluded that cable material and installation costs should be separately identified by both

---

563 The nine density zones (measured in terms of the number of lines per square mile) are as follows: (1) zero - 4.99; (2) 5 - 99.99; (3) 100 - 199.99; (4) 200 - 649.99; (5) 650 - 849.99; (6) 850 - 2549.99; (7) 2550 - 4999.99; (8) 5000 - 9,999.99; (9) 10,000+.

564 *Platform Order*, 13 FCC Rcd at 21352-53, para. 70.

565 *1997 Further Notice*, 12 FCC Rcd at 18544.

566 *1997 Further Notice*, 12 FCC Rcd at 18544. The BCPM and HAI default values are the default input values for the user-adjustable input values in the BCPM and HAI models, respectively. Although we had chosen a model platform and were no longer considering adoption of the BCPM and HAI models, we continued to consider the BCPM and HAI default input values for the inputs to be used in the model. As we explained in the *Inputs Further Notice*, for some inputs, these were the only values on the record. *Inputs Further Notice* at para. 51 n. 125. We also noted that although the BCPM model includes nationwide default values, the BCPM sponsors generally advocated the use of company-specific values and, in some cases, proposed such values.

density zone and terrain type.[567] Because the Commission had received no documentation confirming that feeder and distribution cable installation costs should differ, the Commission tentatively concluded that the federal mechanism should adopt HAI's assumption that such costs are identical.[568]

87. The Commission also sought comment and adopted tentative findings and conclusions relating to the cost of outside plant structure in the *1997 Further Notice*.[569] The Commission directed the HAI and BCPM sponsors to justify fully their default values for their mix of aerial, underground, and buried structure (i.e., plant mix) and sought comment on the input values that will accurately reflect the impact of varying terrain conditions on costs.[570] The Commission noted that "recent installations of outside structure may more closely meet forward-looking design criteria than do historical installations."[571] The Commission found that an efficient carrier will vary its plant mix according to the population density of an area and tentatively concluded that the assignment of plant mix defined by the model should reflect both terrain factors and line density zones.[572]

88. In the *Inputs Public Notice*, the Bureau sought comment on the analysis of David Gabel and Scott Kennedy of data from the Rural Utilities Service (RUS) regarding cable and structure costs.[573] On December 11, 1998, the Bureau held a public workshop designed to elicit comment on the input values for materials costs.[574] At the workshop, Dr. Gabel presented the methodology used by the Commission staff to derive preliminary values for cable costs for non-rural LECs based on his earlier analysis of the RUS data.

89. We sought to supplement the record with respect to cable and structure costs by requesting additional data from LECs, including competitive LECs, in the form of a voluntary

---

[567] *1997 Further Notice*, 12 FCC Rcd at 18544.

[568] *1997 Further Notice*, 12 FCC Rcd at 18544.

[569] *1997 Further Notice*, 12 FCC Rcd at 18541.

[570] *1997 Further Notice*, 12 FCC Rcd at 18541.

[571] *1997 Further Notice*, 12 FCC Rcd at 18541.

[572] *1997 Further Notice*, 12 FCC Rcd at 18541.

[573] *Inputs Public Notice* at 7. *See* David Gabel and Scott Kennedy, *Estimating the Cost of Switching and Cables Based on Publicly Available Data*, National Regulatory Research Institute NRRI 98-09, April 1998, (NRRI Study). Dr. Gabel and Mr. Kennedy are consultants for the Commission in this proceeding.

[574] *See Workshop Public Notice*.

survey of structure and cable costs.[575] Ten companies eventually responded to the survey.[576]

2. Nationwide Values

90. As discussed in this section, we adopt nationwide average values for estimating cable and structure costs in the model rather than company-specific values.[577] In reaching this conclusion, we reject the explicit or implicit assumption of most LEC commenters that company-specific values, which reflect the costs of their embedded plant, are the best predictor of the forward-looking cost of constructing the network investment predicted by the model. We find that, consistent with the *Universal Services Order's* third criterion, the forward-looking cost of constructing a plant should reflect costs that an efficient carrier would incur, not the embedded cost of the facilities, functions, or elements of a carrier.[578] We recognize that variability in historic costs among companies is due to a variety of factors and does not simply reflect how efficient or inefficient a firm is in providing the supported services. We reject arguments of the LECs, however, that we should capture this variability by using company-specific data rather than nationwide average values in the model. We find that using company-specific data for federal universal service support purposes would be administratively unmanageable and inappropriate. Moreover, we find that averages, rather than company-specific data, are better predictors of the forward-looking costs that should be supported by the federal high-cost mechanism. Furthermore, we note that we are not attempting to identify any particular company's cost of providing the supported services. We are estimating the costs that an efficient provider would incur in providing the supported services.

91. AT&T and MCI agree that nationwide input values generally should be used for the input values in the model.[579] AT&T and MCI concur with our tentative conclusion that the use of nationwide values is more consistent with the forward-looking nature of the high-cost

[575] After numerous discussions with industry during development of the survey, we distributed a final version on December 14, 1998, and requested responses by January 14, 1999.

[576] BellSouth, Ameritech, Pacific Bell, Nevada Bell, Southwestern Bell, Sprint, GTE, Aliant, SNET, and AT&T submitted data in response to the structure and cable cost survey. Several companies requested additional time to complete and submit their data. After receiving and reviewing the data, staff found that, despite detailed survey instructions, further discussions with a number of companies were required before we could assemble the data for comparison and analysis. In a number of cases, respondents filed revised data or clarified the data they had submitted.

[577] *See also supra* paragraphs 29-32 and *infra* paragraph 348 for further discussion of the adoption of nationwide average values for estimating costs and expenses in the model.

[578] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

[579] AT&T and MCI *Inputs Further Notice* reply comments at 3.

model because it mitigates the rewards to less efficient companies. Additionally, AT&T and MCI maintain that developing separate inputs values on a state-specific, study-area specific, or holding company-specific basis is not practicable. As AT&T and MCI contend, doing so would be costly and administratively burdensome.

92. While reliance on company-specific data may be appropriate in other contexts, we find that for federal universal service support purposes it would be administratively unmanageable and inappropriate. The incumbent LECs argue that virtually all model inputs should be company-specific and reflect their individual costs, typically by state or by study area.[580] For example, GTE claims that the costs that an efficient carrier incurs to provide basic service vary among states and even among geographic areas within a state.[581] GTE asserts that the only way for the model to generate accurate estimates, i.e., estimates that reflect these differences, is to use company-specific inputs rather than nationwide input values. As parties in this proceeding have noted, however, selecting inputs for use in the high-cost model is a complex process. Selecting different values for each input for each of the fifty states, the District of Columbia, and Puerto Rico, or for each of the 94 non-rural study areas, would increase the Commission's administrative burden significantly. Unless we simply accept the data the companies provide us at face value, we would have to engage in a lengthy process of verifying the reasonableness of each company's data. For example, in a typical tariff investigation or state rate case, regulators examine company data for one time high or low costs, pro forma adjustments, and other exceptions and direct carriers to adjust their rates accordingly. Scrutinizing company-specific data to identify such anomalies and to make the appropriate adjustments to the company-proposed input values to ensure that they are reasonable would be exceedingly time consuming and complicated given the number of inputs to the model.

93. Where possible, we have tried to account for variations in costs by objective means. As explained below, the model reflects differences in structure costs by using different values for the type of plant, the density zone, and geological conditions. As discussed below, we sought comment in the *Inputs Further Notice* on alternatives to nationwide plant mix values, but the algorithms on the record produce biased results. We continue to believe that varying plant mix by state, study area, or region of the country may more accurately reflect variations in forward-looking costs and intend to seek further comment on this issue in the future of the model proceeding.

---

[580] *See, e.g.,* Bell Atlantic *Inputs Further Notice* comments at 20-21; BellSouth *Inputs Further Notice* comments, Attachment B at B-16, B-18; GTE *Inputs Further Notice* comments at 10-11; Ameritech *Inputs Further Notice* comments at 8; Sprint *Inputs Further Notice* comments at 3-7.

[581] GTE *Inputs Further Notice* comments at 10-11. *See also* BellSouth *Inputs Further Notice* comments, Attachment A at A-5, A-8 - A-14.

3. Preliminary Cable Cost Issues

94. Use of 24-gauge and 26-gauge Copper. In the *Inputs Further Notice*, we tentatively concluded that the model should use both 24-gauge and 26-gauge copper in all available pair-sizes.[582] We based our tentative conclusion on a preliminary analysis of the results of the structure and cable cost survey, in which it appeared that a significant amount of 24-gauge copper cable in larger pair sizes currently is being deployed. We also noted that, while HAI default values assume that all copper cable below 400 pairs in size is 24-gauge and all copper cable of 400 pairs and larger is 26-gauge, the BCPM default values include separate costs for 24- and 26-gauge copper of all sizes.[583]

95. We conclude that the model should use both 24-gauge and 26-gauge copper in all available pair sizes. No commenter refuted our observation that a significant amount of 24-gauge copper cable in larger pair sizes currently is being deployed. Those commenters addressing this issue concur with our tentative conclusion.[584] SBC confirms our analysis of the survey data and notes that it deploys 24-gauge cable in sizes from 25 to 2400 pairs.[585] GTE explains, and we agree, that the model should use both 24-gauge and 26-gauge copper in all available pair sizes in order to stay within transmission guidelines when modeling 18 kilofoot loops.[586]

96. Distinguishing Feeder and Distribution Cable Costs. In the *Inputs Further Notice*, we reaffirmed the Commission's tentative conclusion in the *1997 Further Notice* that the same input values should be used for copper cable whether it is used in feeder or in distribution plant.[587] We adopt this tentative conclusion. Those commenters addressing this issue agree with our tentative conclusion.[588] GTE contends that it is both unnecessary and inappropriate to have

[582] *Inputs Further Notice* at para. 65.

[583] *Inputs Further Notice* at para. 65 n. 145 *citing* HAI Inputs Portfolio at 20.

[584] *See e.g.*, AT&T and MCI *Inputs Further Notice* comments at 13; GTE *Inputs Further Notice* comments at 47-48; Sprint *Inputs Further Notice* comments at 17-18; SBC *Inputs Further Notice* comments at 7-8.

[585] SBC *Inputs Further Notice* comments at 8.

[586] GTE *Inputs Further Notice* comments at 47. GTE asserts that it believes that, even for 12 kilofoot loops, a significant amount of 24-gauge cable will continue to be deployed in the network because of certain cost-saving reasons related to its larger diameter.

[587] *Inputs Further Notice* at para. 66.

[588] *See e.g.*, GTE *Inputs Further Notice* comments at 48; Sprint *Inputs Further Notice* comments at 18; SBC *Inputs Further Notice* comments at 8.

different costs for feeder and distribution cable material.[589] GTE explains that, although quantities of material and labor related to cable size may differ between feeder and distribution, the unit costs for each remain the same.[590] Similarly, Sprint agrees that the material cost of cable is the same whether it is used for distribution or feeder.[591] In sum, we find that the record demonstrates that it is appropriate to use the same input values for copper cable whether it is used in feeder or in distribution plant.

97. Distinguishing Underground, Buried, and Aerial Installation Costs. In the *Inputs Further Notice*, we also tentatively concluded that we should adopt separate input values for the cost of aerial, underground, and buried cable.[592] We reached this tentative conclusion on the basis of our analysis of cable cost data supplied to us in response to data requests and through *ex parte* presentations. We found considerable differences in the per foot cost of cable, depending upon whether the cable was strung on poles, pulled through conduit, or buried.

98. We conclude that separate input values for the cost of aerial, underground, and buried cable should be adopted. Those commenters addressing this issue confirm our analysis of the data, i.e., that there are differences, some significant, in placement costs for aerial, underground, and buried cable.[593] GTE explains that, from a material perspective, the cable may have different protective sheathing, depending on construction applications.[594] GTE adds that labor costs also differ depending on the type of placement.[595] Both SBC and Sprint identify the cost of labor as varying significantly depending upon the type of placement.[596] Based upon a review of the record in this proceeding, we conclude that separate input values for the cost of aerial, underground, and buried cable are, therefore, warranted.

---

589 GTE *Inputs Further Notice* comments at 47. *See also* SBC *Inputs Further Notice* comments at 8. SBC contends that the same input values should be used as long as density values, which reflect costs differences in varying degrees of urban and suburban construction, are properly reflected.

590 GTE *Inputs Further Notice* comments at 47.

591 Sprint *Inputs Further Notice* comments at 17. Sprint contends however that in actual practice, splicing costs may be somewhat higher for distribution cable due to such factors as more frequent tapering of cable sizes and branch splices, but this difference is not material for modeling purposes.

592 *Inputs Further Notice* at para. 68.

593 *See e.g.*, GTE *Inputs Further Notice* comments at 48; SBC *Inputs Further Notice* comments at 8; Sprint *Inputs Further Notice* comments at 18. *See also* AT&T and MCI *Inputs Further Notice* comments at 13.

594 GTE *Inputs Further Notice* comments at 48.

595 GTE *Inputs Further Notice* comments at 48.

596 SBC *Inputs Further Notice* comments at 8; Sprint *Inputs Further Notice* comments at 18.

99. Deployment of Digital Lines. We also conclude that two inputs, "pct_DS1" and "pct_1sa", should be modified to provide more accurate deployment of digital lines in the distribution plant. The model can deploy a portion of distribution plant on digital DS1 circuits by specifying these two user adjustable inputs. The input "pct_DS1" determines the percentage of switched business traffic carried on DS1 circuits, and the input "pct_1sa" determines the percentage of special access lines carried on DS1 circuits. Previously, we used default values for the inputs "pct_DS1" and "pct_1sa." We now adopt more accurate values for these inputs using 1998 line count data, following the methodology described below.

100. Initially the model determines the number of special access lines from a "LineCount" table in the database "hcpm.mdb," which provides for each wire center the number of residential lines, business lines, special access lines, public lines, and single business lines.[597] The Commission required incumbent LECs to provide line counts for business switched and non-switched access lines on a voice equivalent basis[598] and on a facilities basis.[599] Upon receipt of those filings, we determined industry totals for each of the line count items requested.[600] By applying the model's engineering conventions to the totals, the model determines the percentage of switched and non-switched lines provided as DS1-type service.[601] Thus, using the channel and facility counts submitted in response to the *1999 Data Request*, it is possible to determine the "pct_DS1" input value using the following formula: (1-pct_DS1)*channels + pct_DS1*channels/12 = facilities.[602] A similar calculation is performed to solve for the "pct_1sa" input value. For both switched business and special access lines, the number of digital lines is then determined by multiplying the respective line count by the input value "pct_DS1" or "pct_1sa." Since 24 communications channels can be carried by two pairs of copper wires, the number of copper cables required to carry digital traffic is computed by dividing the number of digital channels by 12. These percentages are used to adjust the wire center cable requirements by reducing the facilities needed to serve multi-line business and special access customers.

597 By model convention, business lines are reported as switched business lines.

598 For example, DS1 service provides 24 voice equivalent channels using two copper pairs.

599 *See Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, Order, CC Docket Nos. 96-45, 97-160, DA 99-1406 (rel. July 19, 1999) (*1999 Data Request*).

600 For these line count totals, we only use data from the responses that we found to be consistent with the definitions prescribed in the *1999 Data Request*. Submissions in which companies reported more facilities than channels are inconsistent with those definitions and do not reflect current industry practice.

601 We note that only DS0 or DS1 service is provided under the model's conventions. The model does not allow for the deployment of DS2 or DS3 services.

602 This equation is applied separately for switched and non-switched lines.

4. Cost Per Foot of Cable

a. Background

101. In the *Inputs Further Notice*, we tentatively concluded that we should use, with certain modifications, the estimates in the NRRI Study, *Estimating the Cost of Switching and Cables Based on Publicly Available Data*, for the per-foot cost of aerial, underground, and buried 24-gauge copper cable.[603] Concomitantly, we tentatively concluded that we should use, with certain modifications, the estimates in the NRRI Study for the per-foot cost of aerial, underground, and buried fiber cable.[604]

102. In reaching these conclusions, we rejected the default input values for cable costs provided by both the HAI and BCPM sponsors which are based upon the opinions of their respective experts, because they lacked additional support that would have enabled us to substantiate those opinions.[605] We also noted that we had received cable cost data from a number of LECs, including data received in response to the structure and cable cost survey, and were in the process of scrutinizing it.[606]

103. The HAI sponsors supported using the publicly available RUS data in the NRRI Study to estimate cable costs and structure costs.[607] In contrast, Sprint questioned the reliability and suitability of these data, and urged us instead to use the cable cost data provided by incumbent LECs.[608] Sprint pointed out that the RUS data only reflect information from the two lowest density zones.[609] Sprint explained that because longer loops are used in sparsely populated areas, lower-gauge copper often is used. We explained that Sprint had mischaracterized the analysis of the RUS data in the NRRI Study. We noted for example, that

---

[603] *Inputs Further Notice* at para. 72; *See also Inputs Further Notice* at 77, 82-83. As noted in paragraph 88 *supra*, this study provides a methodology for estimating cable and structure costs.

[604] *Inputs Further Notice* at paras. 90, 92, 94.

[605] *Inputs Further Notice* at para. 69.

[606] *Inputs Further Notice* at para. 69.

[607] *See Inputs Further Notice* at para. 71 n. 152 *citing* Letter from Chris Frentrup, MCI Worldcom, to Magalie Roman Salas, FCC, dated Feb. 9, 1999 (MCI Feb. 9, 1999 *ex parte*).

[608] *See Inputs Further Notice* at para. 71 n. 153 *citing* Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated Jan 29, 1999 (Sprint Jan. 29, 1999 *ex parte*).

[609] *See Inputs Further Notice* at para 71 n. 154 *citing* Sprint Jan. 29, 1999 *ex parte* at 8-9.

Sprint challenged the validity of the study because some of the observations have zero values for labor or material, while failing to recognize that these values were excluded from Gabel and Kennedy's regression analysis.[610] Similarly, we found that Sprint's complaint that Gabel and Kennedy do not analyze separately the components of total cable costs, labor and material, overlooked the fact that Gabel and Kennedy's regression analysis is designed to explain the variation in total costs.[611]

104. Moreover, in reaching our tentative conclusion to use the NRRI Study and the underlying data from the two lowest density zones, i.e., rural areas, to estimate cable costs for non-rural LECs, we noted that none of the parties proposed cable cost values that vary by density zones. Nor did the models considered by the Commission have the capability of varying cable costs by density zones.[612]

b. Discussion

105. We affirm our tentative conclusion that we should use, with certain modifications as described more fully below, the estimates in the NRRI Study for the per-foot cost of aerial, underground, and buried 24-gauge copper cable and for the per-foot cost of aerial, underground, and buried fiber cable. We conclude that, on balance, these estimates, as modified in the *Inputs Further Notice*, and further adjusted herein, are the most reasonable estimates of the per-foot cost of aerial, underground, and buried 24-gauge copper cable and fiber cable on the record before us. In reaching this conclusion, we reject, for the reasons enumerated below, the arguments of those commenters who contend that we should use company-specific data to develop the inputs for the per-foot cost of cable to be used in the model.[613]

106. <u>Company-specific data</u>. As we discussed above, we have determined to use nationwide average input values for estimating outside plant costs.[614] In reaching this conclusion, we determined that the use of company-specific inputs was inappropriate because of the difficulty in verifying the reasonableness of each company's data, among other reasons. We have examined cable cost and structure cost data received from a number of non-rural LECs, as well as AT&T, in response to the structure and cable cost survey and through a series of *ex parte*

610 *Inputs Further Notice* at para. 73 n. 156 *citing* Sprint Jan. 29 *ex parte*, Attachment at 5.

611 *Inputs Further Notice* at para. 73 n. 157 *citing* Sprint Jan. 29 *ex parte*, Attachment at 7.

612 *Inputs Further Notice* at para. 73.

613 *See e.g.*, Bell Atlantic *Inputs Further Notice* comments at 18; GTE *Inputs Further Notice* comments at 48; BellSouth *Inputs Further Notice* comments, Attachment B at B-7 - B-11.

614 *See supra* paragraph 29-32 and 90-93.

filings. In addition, we have examined additional company-specific data submitted by certain parties with their comments. As discussed more fully below, we conclude that these data are not sufficiently reliable to use to estimate the nationwide input values for cable costs or structure costs to be used in the model.[615]

107. We conclude that the cable cost and structure cost data received in response to the structure and cable cost survey, in the *ex parte* filings, and in the comments are not verifiable. We find that with regard to the survey data, notwithstanding our request, most respondents did not trace the costs submitted in response to the survey from dollar amounts set forth in contracts by providing copies of these contracts and all of the interim calculations for a single project or a randomly selected central office. With regard to the *ex parte* data and data submitted with the comments, we find that, because most respondents did not document in sufficient detail the methodology, calculations, assumptions, and other data used to develop the costs they submitted, nor did they submit contracts or invoices setting forth in detail the cable and structure costs they incurred, these data cannot be substantiated.[616] Moreover, we note that the structure and cable costs reported in the survey by some parties differ significantly from those reported by the same parties in the *ex parte* filings. These differences are not explained, and render those sets of data unreliable.

108. We find this lack of back-up information particularly unsettling given the magnitude of certain of the costs reported. We agree with AT&T and MCI that the cable installation costs submitted by the incumbent LECs appear to be high.[617] We also agree with AT&T and MCI that this is because the loading factors employed in calculating these costs appear to be overstated. Because of the lack of back-up information to explain these loading costs, however, there is no evidence on the record to controvert our initial assessment. Accordingly, the level of these costs remains suspect.

109. Moreover, we find additional deficiencies beyond the critical lack of substantiating data, impugning the reliability of the LEC survey data and the *ex parte* data we have received. As discussed above, the task of the model is to calculate forward-looking costs of

[615] The following discussion reaches conclusions with regard to the use of company-specific data in the estimation of cable costs inputs. Such information was received initially, in conjunction with structure costs data, in response to our survey on cable and structure costs. Because we find that the data for cable costs and structure costs suffers from the same deficiencies, we also reach conclusions with regard to the use of such data in the estimation of structure cost inputs.

[616] In reaching this conclusion we also take note of AT&T and MCI's inability to link the incumbents LECs actual contract costs and the data they submitted to the Commission. AT&T and MCI *Inputs Further Notice* comments at 15 (Proprietary Version).

[617] AT&T and MCI *Input Further Notice* comments at 15 (Proprietary Version).

constructing a wireline local telephone network. To that end, the survey directed respondents to submit cable and structure costs for growth projects for which expenditures were at least $50,000.[618] We believed that such projects would best reflect the costs that a LEC would incur today to install cable if it were to construct a local telephone network using current technology. In contrast, absent from the data would be costs associated with maintenance or projects of smaller scale which do not represent the costs of installing cable during such construction using current technology. Thus, the data would capture the economies of scale enjoyed on large projects which, should result in lower cable costs on a per-foot basis. Notwithstanding the survey directions, several of the respondents submitted data representing projects that were not growth projects or projects for which expenditures were less than the $50,000 minimum we established.

110. Conversely, some respondents included costs that should have been excluded under the definitions employed in the survey. For example, some respondents included costs for terminating structures, such as cross-connect boxes, in the cable costs they reported. Similarly, some respondents reported underground structure costs on a "per duct foot" basis contrary to the instructions set forth in the survey directing that such costs be reported on a "per foot" basis. We find that these inconsistencies render the use of the survey data inappropriate.

111. In sum, we find that certain of the concerns we identified with regard to using company-specific data, rather than nationwide average inputs for model inputs, have been borne out in our review of the cable cost and structure cost data we have reviewed. Specifically, we find that we are unable to verify the reasonableness of such data. Accordingly, we find that we are unable to use the company-specific data we have received for the estimation of cable cost and structure cost inputs for the model.

112. In reaching this conclusion, we reject the contention that the inability to link the costs submitted in response to the cable and structure cost survey to contracts is irrelevant because the survey request was not intended to create such a trail.[619] This claim ignores the fact that the reasonableness of the survey data was placed into question by the presence of data received on the record that was inconsistent with the survey data. For this reason, as GTE attests, we attempted to create such a trail by requesting contracts and other supporting data in an effort to verify the reasonableness of the company-specific data received in response to the survey as well as in *ex parte* filings.[620]

---

[618] *Inputs Further Notice*, Appendix C, section III.C.

[619] GTE *Inputs Further Notice* reply comments at 27.

[620] As GTE explains in its comments, GTE submitted additional information as a follow-up to our original request. GTE submitted such information in response to a request from the Bureau.

113. Methodology. As we explained in the *Inputs Further Notice*, our tentative decision to rely on the NRRI Study was predicated on our inability to substantiate the default input values for cable costs and structure costs provided by the HAI and BCPM sponsors.[621] For that reason, we tentatively concluded, in the absence of more reliable evidence of cable and structure costs for non-rural LECs, to use estimates in Gabel and Kennedy's analysis of RUS data, subject to certain modifications, to estimate cable and structure costs for non-rural LECs. As we explained, Gabel and Kennedy first developed a data base of raw data from contracts for construction related to the extension of service into new areas, and reconstruction of existing exchanges, by rural-LECs financed by the RUS. Gabel and Kennedy then performed regression analyses, using data from the HAI model on line counts and rock, soil, and water conditions for the geographic region in which each company in the database operates to estimate cable and structure costs.[622] Regression analysis is a standard method used to study the dependence of one variable, the dependent variable, on one or more other variables, the explanatory variables. It is used to predict or forecast the mean value of the dependent variable on the basis of known or expected values of the explanatory variables.[623]

114. Those commenters advocating the use of company-specific data provide a litany of alleged weaknesses and flaws in the NRRI Study, and the modifications we proposed, to discredit its use to estimate the input values for cable costs and structure costs. In sum, they argue that the overall approach we proposed is unsuitable for estimating the cable and structure costs of non-rural LECs and generally leads to estimates which understate actual forward-looking costs.[624] As discussed below, we find the contentions in support of this claim unpersuasive. Significantly, we note that these commenters provide no evidence that substantiates the reasonableness of the company-specific cable costs and structure costs submitted on the record to permit their use as an alternative in the estimation of cable and structure cost inputs to be used in the model.[625]

115. For similar reasons, we reject AT&T and MCI's recommendation that we rely on

---

[621] *Inputs Further Notice* at paras. 69-74, 105. As noted above, we had received data in response to the cable and structure cost survey and, at the time of the *Inputs Further Notice*, were in the process of scrutinizing it.

[622] NRRI Study at 34-36.

[623] For a discussion of regression analysis, *See* William H. Greene, *Econometric Analysis* (1990).

[624] *See e.g.*, GTE *Inputs Further Notice* comments at 13-33; Bell Atlantic *Inputs Further Notice* comments at 15-19; BellSouth *Inputs Further Notice* comments, Attachment A at A-2 - A-5, Attachment B at B-1 - B-14; US West *Inputs Further Notice* comments, Attachment A at 2-29; Sprint *Inputs Further Notice* comments at 5-7, 17-33.

[625] As discussed in more detail below, we have relied on contract data in the estimation of input values for the costs of DLCs and *ex parte* data in the estimation of input values for the costs of SAIs. As explained in paragraphs 253-254 and 274-275, such data is the only reliable data available on the record for the determination of such costs.

the RUS data to develop cost estimates for the material cost of cable and then adopt "reasonable" values for the costs of cable placing, splicing, and engineering based on the expert opinions submitted by AT&T and MCI in this proceeding.[626] We find that the expert opinions on which AT&T and MCI's proposed methodology relies lack additional support that would permit us to substantiate those opinions. Moreover, as discussed in more detail below, we reject AT&T and MCI's contentions, often analogous to those raised by the non-rural LECs, that the approach we proposed to estimate cable and structure costs is flawed in certain respects.

116. We reject the contentions of the commenters, either express or implied, that it is inappropriate to employ the NRRI Study because the RUS data set on which it relies is not a sufficiently reliable data source for structure and cable costs. We find that the RUS data set is a reasonably reliable source of absolute cable costs and structure costs, and more reliable and verifiable than the company-specific data we have reviewed. As explained in the NRRI Study, and noted above, the RUS data reflect contract costs for construction related to the extension into new areas, and reconstruction of existing exchanges, by rural LECs financed by the RUS.[627] Thus, the RUS data reflect actual costs derived from contracts between LECs and vendors. These costs are not estimates, but actual costs. Nor do they reflect only the opinions of outside plant engineers. In sum, we conclude that these are verifiable data.

117. We also note that the RUS data reflect the costs from 171 contracts covering 57 companies operating in 27 states adjusted to 1997 dollars.[628] These companies operate in areas that have different terrain, weather, and density characteristics. This fact makes the RUS data sample suitable for econometric analysis. Moreover, we find that, because the costs are for construction that must abide by the engineering standards established by the RUS, these data are consistent. We note also that the imposition of consistent engineering requirements mitigate the impact of any inefficiencies or inferior technologies that may otherwise be reflected in the data.

118. Finally, as noted above, the RUS data reflect costs for additions to existing plant or new construction. The use of such costs is consistent with the objective of the model to identify the cost today of building an entire network using current technology.

119. In reaching our conclusion to use the NRRI Study and thus the underlying RUS data, we have considered and rejected the contentions of the commenters that the RUS data set is flawed thereby rendering use of the NRRI Study inappropriate. GTE claims that because certain high-cost observations were removed from the RUS data, the NRRI Study's results are unrepresentative of rural companies' costs, and are even less representative of non-rural

[626] AT&T and MCI *Inputs Further Notice* comments at 15-16.

[627] NRRI Study at 2.

[628] NRRI Study at 2.

companies' costs.[629] We disagree. Gabel and Kennedy omitted data reflecting certain contracts from the RUS data they used to develop cost estimates because estimates produced using the data were inconsistent with the values of such estimates suggested by *a priori* reasoning or evidence.[630] For example, they excluded certain observations from the buried copper and structure regression analysis because buried copper cable and structure estimates obtained from this analysis would otherwise be higher in low density areas than in higher density areas. Such a result is contrary to the information contained in the more than 1000 observations reflected in the data from which Gabel and Kennedy developed their buried copper cable and structure regression equation. Thus, removing the observations does not render the remaining data set less representative of rural companies' costs or, as adjusted below, the estimates of the costs of non-rural companies. Moreover, we note that the evidence supplied on the record in this proceeding demonstrates that structure costs increase as population density increases. Thus, we find that the RUS data set is not flawed as GTE contends. We conclude that the removal of certain high cost observations was reasonable.

120. We also disagree with GTE's and Bell Atlantic's assertion that the NRRI Study is flawed because the RUS company contracts do not reflect actual unit costs for work performed, but rather the total cost for a project.[631] Both commenters claim that this alleged failure results in unexplained variations in the RUS data which undermine the validity of the estimates produced. Contrary to GTE's and Bell Atlantic's contention, the contracts from which Gabel and Kennedy developed their data base for developing structure and cable costs do set forth per unit costs for materials and per unit costs for specific labor tasks.[632]

121. We also disagree with AT&T and MCI's claim that the RUS data are defective because they consist of primarily small cables.[633] AT&T and MCI claim that 74 percent of the RUS data are for cables of 50 pairs or less, and 95 percent are for cable sizes of 200 pairs or less. As a result, AT&T and MCI contend that the RUS data are inaccurate, especially for cable sizes above 200 pairs. We disagree with AT&T and MCI's analysis. We note that, for the buried copper cable and structure regression equations we proposed and adopt, approximately 39 percent of the observations are for cable sizes of 50 pairs or less, and approximately 76 percent are for 200 pairs or less. For the underground copper cable regression equation we proposed and

[629] GTE *Inputs Further Notice* comments at 15-16.

[630] NRRI Study at 37-40.

[631] GTE *Inputs Further Notice* comments at 17-19*;* Bell Atlantic *Inputs Further Notice* comments at 16, Attachment C at 9.

[632] NRRI Study at 8-9 and 67-73.

[633] AT&T and MCI *Inputs Further Notice* comments at 14.

adopt, approximately 10 percent of the observations are for cable sizes of 50 pairs or less, and approximately 33 percent are for 200 pairs or less. For the aerial copper cable regression equation we proposed and adopt, approximately 40 percent of the observations are for cable sizes of 50 pairs or less, and approximately 76 percent are for 200 pairs or less. Thus, the proportion of the observations reflected in the copper cable cost estimates we adopt are significantly greater for relatively large cables than what AT&T and MCI contend.

122. Finally, we reject the contention that it is inappropriate to use the NRRI Study because the RUS data base is not designed for the purpose of developing input values for the model.[634] In the NRRI Study, Gabel and Kennedy explain that they began developing the data base as an outgrowth of the Commission's January 1997 workshop on cost proxy models when it became apparent that costs used as inputs in such models should be able to be validated by regulatory commissions. For this reason, they prepared data that is in the public domain to provide independent estimates of structure and cable costs.[635]

123. We also find unpersuasive the contention that there are econometric flaws in the NRRI Study which render it unsuitable for developing input values.[636] We disagree with the contentions of several commenters that the structure cost and cable cost regression equations that we develop from the RUS data are flawed because they are based on a relatively small number of observations.[637] As a general rule of thumb, in order to obtain reliable estimates for the intercept and the slope coefficients in a regression equation, the number of observations on which the regression is based should be at least 10 times the number of independent variables in the regression equation.[638] Ameritech claims that the sample size used to estimate the costs of buried placement is too small because it contains only 26 observations in density zone one.[639] Ameritech's criticism ignores the fact that we use a single regression equation to estimate buried copper cable and structure costs for density zones one and two based on 1,131 observations (1,105 in zone two and 26 in zone one). There are four independent variables in the buried copper cable and structure regression equation, i.e., the variables that indicate the size of the

[634] *See e.g.*, Bell Atlantic *Input Further Notice* comments at 16, Attachment C at 9.

[635] NRRI Study at 1-2.

[636] *See e.g.*, GTE *Inputs Further Notice* comments at 19-22; Bell Atlantic *Inputs Further Notice* comments at 16-17, Attachment C at 13-14.

[637] *See e.g.*, GTE *Inputs Further Notice* comments at 15; Ameritech *Inputs Further Notice* comments at 26; AT&T and MCI *Inputs Further Notice* comments at 14.

[638] Richard W. Madsen and Melvin L. Moeschberger, *Statistical Concepts with Applications to Business and Economics*, 490 (2nd Edition 1986).

[639] Ameritech *Inputs Further Notice* comments at 16.

cable, presence of a high water table, combined rock and soil type, and density zone. This suggests that approximately 40 observations are needed to obtain reliable estimates for the parameters in this regression equation. The total number of observations used to estimate this regression equation, 1,131, readily exceeds the number suggested for estimating reliably this regression equation. The number of observations for density zone one alone, 26, provides 65 percent of the suggested number of observations. Similarly, AT&T and MCI claim that the sample size for underground cable is too small because it contains only 80 observations.[640] There is one independent variable in the adopted underground copper cable equation, i.e., the variable that indicates the size of the cable. Based on the rule of thumb noted above, 10 observations are needed to reliably estimate this regression equation. The number of observations used to estimate the adopted underground copper cable regression equation, 81, is more than eight times this suggested number.[641] Moreover, we note that Ameritech does not provide any evidence that suggest that a sample that has 26 observations in density zone 1 produces biased estimates of buried structure and cable costs for density zone one. Similarly AT&T and MCI do not provide any evidence to support their allegation that a sample size of 80 observations produces biased estimates of underground copper cable costs. Finally, we note that GTE contends that the regression results for aerial structure are undermined because the sample size for poles is based only on 19 observations.[642] While a sample of this size fails to satisfy the general rule of thumb we noted above, we find that the estimates produced are reasonable. As we pointed out in the *Inputs Further Notice*, the average material price reported in the NRRI Study for a 40-foot, class four pole is $213.94. This is close to our calculations of the unweighted average material cost for a 40-foot, class four pole, $213.97, and the weighted average material cost, by line count, $228.22, based on data submitted in response to the *1997 Data Request*. Moreover, we note that GTE does not provide any evidence that suggests that a sample size of 19 poles for developing aerial structure costs produces biased estimates as GTE seems to allege.

124. We also disagree with GTE's contention that the NRRI Study contains three methodological errors that make its results unreliable. First, GTE asserts that the most serious of these flaws is that the NRRI Study improperly averages ordinal or categorical data, i.e., qualitative values, for the costs of placing structure in different types of soil.[643] Contrary to

---

640 AT&T and MCI *Inputs Further Notice* comments at 14.

641 The *Inputs Further Notice* indicated that 80 observations were used to estimate the proposed underground copper cable costs. However, 81 observations were used to develop these proposed costs. Eighty one observations are used to estimate the adopted underground copper cable costs.

642 GTE *Inputs Further Notice* comments at 15.

643 GTE *Inputs Further Notice* comments at 19-21. *See also* Bell Atlantic *Inputs Further Notice* comments at 16-17, Attachment C at 13-14.

GTE's claim, the independent variables that indicate soil type, rock hardness, and the presence of a high water table used in the regression equations for aerial and underground structure and buried structure and cable costs in the NRRI Study and proposed in the *Inputs Further Notice* do not reflect an incorrect averaging of ordinal data. The variables for soil, rock, and water indicate the average soil, rock, and water conditions in the service areas of RUS companies. They are based on averages of data obtained from the HAI database for the Census Block Groups in which the RUS companies operate. In general, the magnitude of the t-statistics for the coefficients of the independent variables for soil, rock, and water in the structure regression equations indicate that these variables have a statistically significant impact on structure costs. The magnitude of the F-statistic indicates that the independent variables in the structure regression equations, including those that indicate water, rock, and soil type, jointly provide a statistically significant explanation of the variation in structure costs. These statistical findings justify use of these variables in the structure regression equations. We also note that HAI uses as cardinal values, i.e., quantitative, not ordinal values, the soil and rock data from which the averages reflected in the rock and soil variables in the NRRI Study are calculated. For example, HAI uses a multiplier of between 1 and 4 to calculate the increase in placement cost attributable to the soil condition. Moreover, and more importantly, we note that no commenter has demonstrated the degree of, or even the direction of, any bias in the cost estimates derived in the NRRI Study or in the regression equations proposed in the *Inputs Further Notice* as a result of the use of soil, water, and rock variables based on averages of HAI data.

125. GTE also claims that the NRRI Study is flawed because it relies on the HAI model's values relating to soil type which GTE claims were "made up."[644] GTE contends that this renders the variable relating to soil type judgmental and biased. We find GTE's concern misplaced. As explained above, the econometric analyses of the data demonstrate a statistically significant relationship between the geological variables developed from the HAI data and the structure costs. Finally, we disagree with GTE's claim that the NRRI Study is flawed because of a mismatch in the geographic coverage of the RUS data and the HAI model variables.[645] GTE does not provide any evidence showing that the alleged mismatch introduces an upward or downward bias on the cost estimates obtained from the regression equations. Moreover, and more importantly, the t-statistics for the coefficients of the variables that measure rock and soil type generally indicate that these geological variables provide a statistically significant explanation of variations in RUS companies' structure costs.

126. We also reject the claims that the derivation of the equations for 24-gauge buried copper cable, buried structure, and buried fiber cable from the NRRI Study regression equations for 24-gauge buried copper cable and structure and buried fiber cable and structure, respectively,

[644] GTE *Inputs Further Notice* comments at 21.

[645] GTE *Inputs Further Notice* comments at 22.

is inappropriate.[646] As we explained in the *Inputs Further Notice*, we modified the regression equations in the NRRI Study for 24-gauge buried copper cable and structure and buried fiber cable and structure, as modified by the Huber methodology described below, to estimate the cost of 24-gauge buried copper cable, buried structure and buried fiber cable because the regression equations for buried copper cable and structure and buried fiber cable and structure provide estimates for labor and material costs for both buried cable and structure combined.[647] In layman's terms, we split the modified 24-gauge buried copper cable and structure regression equation into two separate equations, one for 24-gauge buried copper cable and one for buried structure costs. We also split the modified buried fiber cable and structure regression equation to obtain an equation for buried fiber cable.[648] We did this because the model requires a separate input for labor and material costs for cable and a separate input for labor and material costs for structure. In contrast, the RUS data and buried cable and structure regression equations developed from these data, reflect labor and material costs for buried cable and structure combined.

127. Significantly, the criticisms of our development of the 24-gauge buried copper cable equation, buried structure equation and buried fiber cable equation in this manner ignore the fact that reliable, alternative data for buried cable costs and buried structure costs is not available on the record.[649] Given that the model requires a separate input reflecting labor and material costs for both copper and fiber cable and a separate input reflecting labor and material costs for structure, and that the only reliable data on the record does not separate such costs between cable and structure, we find it necessary to split the regression equation.

128. Contrary to the assertions of the commenters, either express or implied, the steps we took to derive these equations were not arbitrary.[650] We used a single buried structure equation to estimate the cost for buried structure without distinguishing between the equation for buried copper structure and the equation for buried fiber structure because the model does not distinguish between buried copper structure costs and buried fiber structure costs. We find that this is reasonable because the intercept and the coefficients for the variables that primarily explain the variation in structure costs, i.e., the variables that indicate density zone, the combined

---

[646] *See e.g.*, GTE *Inputs Further Notice* comments at 52-53;

[647] *Inputs Further Notice* at paras. 83, 113. *See also Inputs Further Notice*, Appendix D, sections I.C., III.C.

[648] *Inputs Further Notice* at para. 94. *See also Inputs Further Notice*, Appendix D, section II.C.

[649] Moreover, at least one LEC commenter states that it is not able to separate buried structure costs from total buried plant costs. GTE *Inputs Further Notice* comments at 53. This inability may reflect the fact that under current FCC accounting guidelines these costs are not identified separately.

[650] *See e.g.*, GTE *Inputs Further Notice* comments at 52; BellSouth *Inputs Further Notice* comments, Attachment A at A-16.

soil and rock type, and the presence of a high water table, in the combined regression equation for buried fiber cable and structure are not statistically different from the intercept and the coefficients for these variables in the combined regression equation for 24-gauge buried copper cable and structure.[651] We also find that it is reasonable to develop a separate structure equation from the regression equation for the combined cost of 24-gauge buried copper cable and structure rather than from the regression equation for the combined cost of buried fiber cable and structure because the water and soil and rock type indicator variables in the regression equation for the combined cost of 24-gauge buried copper cable and structure are statistically significant. In contrast, these variables are not statistically significant in the buried fiber cable and structure regression equation.[652] In addition, we note that the number of observations used to estimate the 24-gauge buried copper cable and structure regression equation, 1,131, exceeds the number of observations used to estimate the buried fiber cable and structure regression equation, 707 observations.

129. We note that we included in the separate buried cable equations the variable for cable size and its coefficient reflected in the combined cable and structure regression equations. We find that this is reasonable because the cable size variable and its coefficient explain the variation in cable costs. We also note that we excluded from the separate buried cable equations the independent variables in the combined cable and structure regression equations that indicate density zone, the presence of a high water table, and the soil and rock type. We find that this is reasonable because these variables and their coefficients explain primarily the variation in buried structure costs. Conversely, we excluded from the separate buried structure equation the variable for cable size and its coefficient reflected in the combined 24-gauge buried copper cable and structure regression equation because this variable and its coefficient explain the variation in cable costs.

130. We also included in the separate structure equation the variables and the coefficients for the variables that indicate density zone, the combined soil and rock type, and the presence of a high water table in the combined regression equation for 24-gauge buried copper cable and structure. Again, we find this is reasonable because these independent variables and coefficients primarily explain the variation in structure costs.

131. Finally, because the estimated intercepts in the regression equations for the cost

[651] That is, the values of the intercept and the coefficients for the variables that indicate density zone, the combined soil and rock type, and the presence of a high water table in the combined regression equation for buried fiber cable and structure lie within the 95 percent confidence interval surrounding the values of the intercept and the coefficients for the respective variables in the combined regression equation for 24-gauge buried copper cable and structure.

[652] Nevertheless, the value of the F-statistic for the regression equation for the combined cost of buried fiber cable and structure, 172.80, indicates that the regression equation is statistically significant.

of buried cable and structure reflect the fixed cost for both buried cable and structure in density zone one, we included in the separate equations for buried cable an intercept reflecting the fixed cost of cable. Similarly, we included in the equation for buried structure an intercept reflecting the fixed cost of structure in density zone one. Specifically, we allocated an estimate of the portion of the combined fixed cable and structure costs that represents the fixed copper cable costs reflected in the intercept in the 24-gauge buried copper cable and structure cost regression equation to the intercept in the equation for 24-gauge buried copper cable. Correspondingly, we allocated an estimate of the portion of fixed cable and structure cost that represents the fixed costs of buried structure reflected in the intercept in the buried 24-gauge copper cable and structure cost regression equation to the intercept in the equation for structure costs. We also allocated to the intercept in the separate buried fiber cable equation the remaining portion of the fixed costs reflected in the intercept in the combined buried fiber cable and structure regression equation after subtracting from the value of this intercept the estimate for fixed structure costs in density zone 1 in the separate buried structure equation. The sum of the particular values that we adopt for the fixed cable cost in the separate 24-gauge copper cable equation, $.46, and the fixed structure cost in density zone 1 in the separate structure equation, $.70, equals the 24 gauge buried copper cable and structure fixed costs reflected in the intercept in the combined copper cable and structure regression equation of $1.16. The sum of the particular values that we adopt for the fixed cable cost in density zone 1 in the separate fiber cable equation, $.47, and the fixed structure cost in the separate structure equation of $.70 equals the buried fiber cable and structure fixed costs reflected in the intercept in the combined fiber cable and structure regression equation, $1.17. We find that these values are reasonable. We note that $.46[653] lies between AT&T and MCI's estimate of the fixed cost for a 24-gauge buried copper cable of $.12[654] and the HAI default value for the installed cost of a 6-pair 24-gauge buried copper cable of $.63.[655] Moreover, we note that we could have used relatively higher or lower values for the fixed structure and cable costs in the separate structure and cable equations. However, we note that the sum of the fixed costs reflected in the buried structure cost estimates (excluding LEC engineering costs) developed from the separate buried structure equation and the fixed costs reflected in the buried cable cost estimates (excluding LEC engineering and splicing costs) developed from the separate buried copper or fiber cable equation is not affected by the relative

653 This estimate of the fixed cost for a 24-gauge buried copper cable excludes fixed costs for structure, LEC engineering, and splicing, but includes fixed costs for contractor engineering.

654 *See* AT&T and MCI *Inputs Further Notice* comments, Appendix A at A-7. The AT&T and MCI estimate of the fixed cost for a 24-gauge buried copper cable excludes fixed costs for structure, splicing, and contractor and LEC engineering.

655 *See* HAI Model, Release 5.0a, Model Description, Appendix B at 15. A 6-pair 24-gauge buried copper cable is the smallest buried cable for which HAI has a default value. The HAI default value for the installed cost of a 6-pair 24-gauge buried copper cable excludes fixed and variable costs for structure, but includes fixed and variable costs for material, contractor and LEC engineering, and splicing. Fixed cable costs do not vary with cable size. A large percentage of the installed cable cost for a small cable is a fixed cost.

values that we use for the fixed cost in these separate equations.[656]

132. Finally, we note that GTE contends that the proposed equations for buried cable and buried structure are questionable because the buried structure costs would not vary with the presence of water.[657] As discussed below, we have modified the regression equation for buried copper cable and structure by adding the variable that indicates the presence of a high water table. We obtain structure cost estimates used as input values by setting the coefficient for the water indicator variable equal to zero. These structure cost estimates, therefore, assume that a high water table is not present. The model adjusts these estimates to reflect the impact on these costs of a high water table. GTE also claims that the proposed equations are questionable because the costs for buried structure derived from the buried structure equation would not vary with cable size. We reject this contention. GTE has not provided any evidence that demonstrates that buried structure costs vary with cable size. To the contrary, GTE states that it cannot produce such evidence because it is not able to separate actual costs of buried structure from total costs of buried plant.

133. In sum, we find that the regression equations we proposed and tentatively adopted in the *Inputs Further Notice* are an appropriate starting point for estimating cable costs and structure costs for non-rural LECs for purposes of developing inputs for the model, particularly given the absence of more reliable cable and structure cost data from any other source.[658] We find, however, that certain commenters' criticisms of the regression equations we proposed have merit. We make the following adjustments to improve the regression equations consistent with those criticisms.[659]

---

[656] The sum of the fixed costs reflected in the buried structure cost estimates, including LEC engineering costs, developed from the separate buried structure equation and the fixed costs reflected in the buried copper or fiber cable cost estimates, including LEC engineering and splicing costs, developed from the separate buried cable equation is affected slightly by the relative values used for the fixed cost in these separate equations. The relative values used for these fixed costs affects slightly the sum of these fixed costs because a splicing loading of 9.4 or 4.7 percent is applied to the fixed cost reflected in the separate buried copper or fiber cable cost estimates (excluding LEC engineering and splicing costs), while a loading of 10 percent for LEC engineering is applied to the fixed cost reflected in the separate buried structure cost estimates (excluding LEC engineering costs).

[657] GTE *Inputs Further Notice* comments at 52.

[658] We note that the regression equations in the NRRI Study are a starting point because, as we explained in the *Inputs Further Notice,* and discuss in more detail below, we proposed to modify the regression equations used to estimate cable costs to capture the buying power of the non-rural LECs reflected in the price they pay for cable.

[659] We set forth in Appendix B the regression equations that we adopt in this Order. We also set forth in Appendix B the adjustments we make to those equations to reflect the buying power of large LECs, splicing costs, LEC engineering costs, and to separate the buried cable and structure regression equations into separate equations for buried cable and buried structure.

134. First, we remove the independent variable that indicates whether two or more cables are placed at the same location from the regression equations for 24-gauge aerial copper cable, 24-gauge buried copper cable and structure, aerial fiber cable, and buried fiber cable and structure.[660] As a result, the regression equations we adopt do not have this variable as an independent variable. We do not include this independent variable in any of the cable and structure equations because the model does not use a different cable cost if the outside plant portion of the network it builds requires more than one cable.

135. We also remove from the regression equation for 24-gauge underground copper cable the variable that is the mathematical square of the number of copper cable pairs. We remove this variable because its use results in negative values for the largest cable sizes, as some parties point out.[661] We note that none of the other proposed cable and structure regression equations had this variable as an independent variable.

136. We add the variable that indicates the presence of a high water table to the regression equations for buried copper cable and structure and underground structure costs. With this change, all of the regression equations for structure costs adopted in this Order have this variable as an independent variable.[662] We include this variable in the structure equations because the model applies a cost multiplier to all structure costs when the water table depth is less than the critical water depth. To develop structure cost inputs, we set the value of the water indicator variable equal to zero in the structure regression equations, thereby developing structure costs that assume that there is no water in the geographic area where the structure is installed. The multiplier in the model then adjusts these costs to reflect the impact on these costs of a high water table when it determines that the water table depth is less than the critical water depth.

137. We reduce the value of the intercept to \$.46 from \$.80 in the equation proposed in the *Inputs Further Notice* for calculating the labor and material costs for buried copper cable (excluding structure, LEC engineering, and splicing costs). We now estimate the buried 24-gauge copper cable and structure regression equation after removing the multi-cable variable and adding the water indicator variable. The value of the intercept in this regression equation of

---

[660] *See* Bell Atlantic *Inputs Further Notice* comments, Attachment C at 25; Ameritech *Inputs Further Notice* comments at 13-14; US West *Inputs Further Notice* comments, Attachment A at 9, 11.

[661] *See e.g.*, Ameritech *Inputs Further Notice* comments at 10-11; GTE *Inputs Further Notice* comments at 30-31; Bell Atlantic *Inputs Further Notice* comments at 25-26; US West *Inputs Further Notice* comments, Attachment A at 9.

[662] *See* Bell Atlantic *Inputs Further Notice* comments, Attachment C at 25-26; Ameritech *Inputs Further Notice* comments at 13; US West *Inputs Further Notice* comments, Attachment A at 9; GTE *Inputs Further Notice* comments at 30-31.

$1.16 is less than the intercept in the proposed regression equation of $1.51. As we did in the *Inputs Further Notice*, we derive the buried copper cable equation from the regression equation for 24-gauge buried copper cable and structure costs. The value of the intercept in the buried copper cable and structure regression equation represents the fixed cost for both buried copper cable and buried copper cable structure in density zone 1. We assume, as we did in the *Inputs Further Notice*, that $.70 is the fixed cost for buried copper cable structure in density zone 1. Accordingly, the fixed labor and material cost for buried copper cable is $1.16 minus $.70, or $.46.

138. We also reduce the value of the intercept to $.47 from $.60 in the equation proposed in the *Inputs Further Notice* for calculating the labor and material costs for buried fiber cable (excluding structure, LEC engineering, and splicing costs). We now estimate the buried fiber cable and structure regression equation after removing the multi-cable variable. The value of the intercept in this regression equation, $1.17, is greater than the value of the intercept in the proposed regression equation, $1.14. As we did in the *Inputs Further Notice*, we derive the buried fiber cable equation from the regression equation for buried fiber cable and structure costs. The value of the intercept in the buried fiber cable and structure regression equation represents the fixed cost for both buried fiber cable and buried fiber cable structure in density zone 1. We assume that $.70 is the fixed cost for buried fiber cable structure in density zone 1. Accordingly, the fixed labor and material cost for buried fiber cable in density zone 1 is $1.17 minus $.70 or $.47

139. Huber Adjustment. In the *Inputs Further Notice,* we tentatively concluded that one substantive change should be made to Gabel and Kennedy's analysis.[663] As we explained, we tentatively concluded that the regression equations in the NRRI Study should be modified using the Huber regression technique[664] to mitigate the influence of outliers in the RUS data.[665] Statistical outliers are values that are much higher or lower than other data in the data set. The Huber algorithm uses a standard statistical criterion to determine the most extreme outliers and exclude those outliers. Thereafter, the Huber algorithm iteratively performs a regression, then for each observation calculates an observation weight based on the absolute value of the observation residual. Finally, the algorithm performs a weighted least squares regression using

[663] *Inputs Further Notice* at para. 75.

[664] We used Stata Statistical Software: Release 5 (Stata) to perform the calculations needed to estimate the regression equations adopted in this Order for cable and structure costs. Stata has a robust regression methodology that uses formulas developed by P.J. Huber, R.D. Cook, A.E. Beaton and J.W. Tukey. We used this methodology to estimate the regression equations for cable and structure costs. We refer to this robust regression methodology as the Huber methodology. *See Stata Reference Manual, Release 5*, Volume 3, P-Z, Stata Press, College Station, TX, 168-173.

[665] *Inputs Further Notice* at para. 76.

the calculated weights. This process is repeated until the values of the weights effectively stop changing.[666]

140. We affirm our tentative conclusion to modify the regression equations in the NRRI Study using the Huber methodology to develop input values for cable and structure costs. The cable and structure cost inputs used in the model should reflect values that are typical for cable and structure for a number of different density and terrain conditions. If they do not reflect values that are typical, the model may substantially overestimate or underestimate the cost of building a local telephone network. As discussed below, application of the Huber methodology minimizes this risk, thereby producing estimates that are consistent with the goal of developing cable and structure cost inputs that reflect values that are typical for cable and structure for different density and terrain conditions.

141. The commenters attest to the fact that there are significant variances in the RUS structure and cable cost data.[667] We find that the presence of these outliers warrants the use of the Huber methodology. By relying on the Huber methodology to identify and to exclude or give less than full weight to these data outliers in the regressions, we decrease the likelihood that the cost estimates produced reflect measurement error or data anomalies that may represent unusual circumstances that do not reflect the typical case. We note that we are not readily able to ascertain the specific circumstances that may explain why some data points are outliers relative to more clustered data points because of the multivariate nature of the database. Such occurrences are expected when dealing with such a database. Not only are there many observations, but these observations reflect the circumstances surrounding the construction work of many different contractors done for a large number of companies on different projects over a number of years. We also note that the task of identifying structure cost outliers without using a statistical approach such as Huber is especially difficult because these costs are a function of different geological conditions and population densities. Given that it is not feasible, as a practical matter, to determine why particular data points are outliers and our objective is to develop typical cable and structure costs, we conclude that use of the Huber methodology is appropriate.[668]

---

[666] As noted in the *Inputs Further Notice*, we used the robust regression parameter estimates for cable, conduit, and buried structure. The use of robust estimation did not improve the statistical properties of the estimators for pole costs, so we tentatively concluded that the ordinary least squares technique is appropriate for pole costs. The value of the F-statistic was not statistically significant at the five percent level. *Inputs Further Notice* at para. 76 n. 161.

[667] *See e.g.*, GTE *Inputs Further Notice* comments at 23-26; Bell Atlantic *Inputs Further Notice* comments at 17, Attachment C at 29-34; US West *Inputs Further Notice* comments, Attachment A at 11-13; BellSouth *Inputs Further Notice* comments, Attachment A at A-17.

[668] For example, for one to determine why the reported structure cost for a single project is an outlier, one would have to interview the LEC engineers and contractors to verify the reported cost, identifying with precision whether unusual circumstances surrounded the project thereby leading to atypical costs.

142. We find the comments opposing application of the Huber methodology unpersuasive. In the first instance, we reject the assertions of the commenters, either express or implied, that the application of robust regression analysis is not the preferred method of dealing with outliers in a regression.[669] There is no preferred method. The use of robust regression techniques is a matter of judgement for the estimator. As we explained above, the goal of our analysis is to estimate values that are typical for cable and structure costs for different density and terrain conditions. We determined that we should mitigate the effects of outliers occurring in the data to ensure that the estimates we produce reflect typical costs. Noting that such outliers have an undue influence on ordinary least squares regression estimates because the residual associated with each outlier is squared in calculating the regression, we determined, in our expert opinion, to employ the Huber methodology to diminish the destabilizing effects of these outliers. Thus, while it can be argued that we could have produced a different estimate, the commenters have not established that application of the Huber methodology produces an unreasonable estimate.

143. Bell Atlantic and GTE assert that the probability distribution of the error term must be symmetric about its mean and have fatter tails than in the normal distribution in order to use the Huber methodology.[670] We disagree. The Huber methodology in effect fits a line or a plane to a set of data. The algebraic expression of this line or plane explains or predicts the effects on a dependent variable, e.g., 24-gauge aerial copper cable cost, of changes in independent variables, e.g., aerial copper cable size. It does this by assigning zero or less than full weight to observations that have extremely high or extremely low values. The assignment of weights to observations depends on the values of the observations. It does not depend on the probability of observing these values. The error term to which Bell Atlantic and GTE refer is the difference between the predicted or estimated values of the dependent variable and the observed values of the dependent variable. Given that the error term is the difference between the predicted and observed values of the dependent variable, and that the assignment of weights by the Huber methodology does not depend on the probability of observing particular values of this variable, this assignment of weights does not depend on the probability of observing particular values of the error term. It, therefore, does not depend on whether the probability distribution of the error term is symmetric about its mean and has fatter tails than in the normal distribution.

144. Bell Atlantic also argues that the Huber methodology should not be used unless

[669] *See e.g.*, GTE *Inputs Further Notice* comments at 23-26; Bell Atlantic *Inputs Further Notice* comments at 17, Attachment C at 29-34; US West *Inputs Further Notice* comments, Attachment A at 11-13; BellSouth *Inputs Further Notice* comments, Attachment A at A-17.

[670] *See* Bell Atlantic *Inputs Further Notice* comments at 17, Attachment C at 30, 31; *See* GTE *Inputs Further Notice* comments at 25.

there is evidence that outliers in the RUS data are erroneous.[671] We disagree. We believe that use of the Huber methodology with RUS data ensures that cost estimates reflect typical costs regardless of whether there is evidence that outliers in the RUS data are erroneous. The RUS data, as Bell Atlantic and other parties point out, have a number of high values and low values.[672] These outliers may reflect unusual circumstances that are unlikely to occur in the future. The Huber methodology dampens the effects of anomalistically high or low values that may reflect unusual circumstances. Notwithstanding the dispersion in the RUS data, we believe that there are relatively few errors in these data. As we explained, the RUS data are derived from contracts. Gabel and Kennedy determined that the values reflected in the RUS data are within one percent of the values set forth on the contracts.[673] There are likely to be few errors in the contracts themselves because these are binding agreements that involve substantial sums of money between RUS companies and contractors. These parties have an obvious interest in ensuring that these values are correctly reflected in these contracts. While we believe that errors in these contracts are likely to be infrequent, outlier observations in the RUS data may reflect large errors. The Huber methodology dampens the effects of outlier observations that may reflect large errors.

145. We find that the estimates produced by applying the Huber methodology are reasonable. As we explain more fully in Appendix B, the estimates resulting from application of the Huber methodology reflect most of the information represented in nearly all of the cable and structure cost observations in the RUS data. Approximately 80 percent of the cable and structure observations are assigned a weight of at least 80 percent in each structure and regression equation that we adopt. This large majority comprises closely clustered observations that clearly represent typical costs. Conversely, approximately 20 percent of the cable and structure observations are assigned a weight of less than .8 in each of these regression equations. This small minority comprises observations that have extremely high and extremely low values that do not represent typical costs. We also note that because the Huber methodology treats symmetrically observations that have high or low values, it excludes or assigns less than full weight to data outliers without regard to whether these are high or low cost observations.

146. <u>Buying Power Adjustment</u>. In the *Inputs Further Notice*, we tentatively concluded that we should make three adjustments to the regression equations in the NRRI Study, as modified by the Huber methodology described above, to estimate the cost of 24-gauge aerial copper cable, 24-gauge underground copper cable, and 24-gauge buried copper cable.[674] We

[671] *See* Bell Atlantic *Inputs Further Notice* comments at 17.

[672] Bell Atlantic *Inputs Further Notice* comments, Attachment C at 23, 24. *See also* GTE *Inputs Further Notice* comments at 17, 18; AT&T *Inputs Further Notice* comments at 14.

[673] NRRI Study at 34.

[674] *Inputs Further Notice* at paras. 77-81; 82; 83-84.

further tentatively concluded that these adjustments should be made in the estimation of the cost of aerial fiber cable, buried fiber cable, and underground fiber cable.[675] The first of these adjustments was to adjust the equation to reflect the superior buying power that non-rural LECs may have in comparison to the LECs represented in the RUS data. We noted that Gabel and Kennedy determined that Bell Atlantic's material costs for aerial copper cable are approximately 15.2 percent less than these costs for the RUS companies based on data entered into the record in a proceeding before the Maine Public Utilities Commission (the "Maine Commission).[676] Similarly, Gabel and Kennedy determined that Bell Atlantic's material costs for aerial fiber cable are approximately 33.8 percent less than these costs for the RUS companies.[677] We also noted that Gabel and Kennedy determined that Bell Atlantic's material costs for underground copper cable are approximately 16.3 percent less than these costs for the RUS companies and 27.8 percent less for underground fiber cable. We tentatively concluded that these figures represent reasonable estimates of the difference in the material costs that non-rural LECs pay in comparison to those that the RUS companies pay for cable.[678] Accordingly, to reflect this degree of buying power in the copper cable cost estimates that we derived for non-rural LECs, we proposed to reduce the regression coefficient for the number of copper pairs by 15.2 percent for aerial copper cable, and 16.3 percent for 24-gauge underground copper cable.

147. We also proposed to reduce the regression coefficient for the number of fiber strands by 33.8 percent for aerial fiber cable and 27.8 percent for underground fiber cable.[679] As we explained, this coefficient measures the incremental or additional cost associated with one additional copper pair or fiber strand, as applicable, and therefore, largely reflects the material cost of the cable. Because the NRRI Study did not include a recommendation for such an adjustment for buried copper cable or buried fiber, we tentatively concluded we should reduce the coefficient by 15.2 percent for buried copper cable and 27.8 percent for buried fiber cable.[680] We explained that the level of these adjustments reflect the lower of the reductions used for aerial and underground copper cable and aerial and underground fiber cable, respectively.

148. We adopt the tentative conclusion in the *Inputs Further Notice* and select buying power adjustments of 15.2 percent, 16.3 percent and 15.2 percent for 24-gauge aerial copper

---

[675] *Inputs Further Notice* at paras. 90-95.

[676] *Inputs Further Notice* at para. 79 n. 163 *citing* NRRI Study at 47.

[677] *Inputs Further Notice* at para. 91 n. 174 *citing* NRRI Study at 47.

[678] *Inputs Further Notice* at paras. 79, 82.

[679] *Inputs Further Notice* at paras. 91, 93.

[680] *Inputs Further Notice* at paras. 84, 95.

cable, 24-gauge underground copper cable, and 24-gauge buried copper cable, respectively. Correspondingly, we adopt buying power adjustments of 33.8 percent, 27.8 percent, and 27.8 percent for aerial fiber cable, underground fiber cable, and buried fiber cable, respectively. We find that, based on the record before us, the buying power adjustment is appropriate and the levels of the adjustments we proposed for the categories of copper and fiber cable we identified are reasonable.

149. As we explained in the *Inputs Further Notice*, the buying power adjustment is intended to reflect the difference in the materials prices that non-rural LECs pay in comparison to those that the RUS companies pay.[681] Because non-rural LECs pay less for cable, a downward adjustment to the estimates developed from data reflecting the costs of rural-LECs is necessary to derive estimates representative of cable costs for non-rural LECs. The commenters generally concede that such differences exist.[682] There is, however, disagreement among the commenters that an adjustment is necessary in this instance to reflect this difference.

150. Those commenters advocating the use of company-specific data oppose the buying power adjustment as unnecessary. GTE and Sprint contend that the use of a more representative data set, i.e., company-specific data, would account for any differences in buying power.[683] As we explained above, however, the RUS data are the most reliable data on the record before us for estimating cable and structure costs. Because there is a difference in the material costs that non-rural LECs pay in comparison to those that the RUS companies pay, a downward adjustment to the RUS cable estimates is necessary to obtain representative cable cost estimates for non-rural LECs.

151. We note that AT&T and MCI support the proposed adjustment for aerial and underground copper and fiber cable.[684] AT&T and MCI oppose, however, the use of the lower of the reductions adopted for aerial and underground cable categories, for the buried cable category. Although AT&T and MCI agree that an adjustment is appropriate for buried cable, they contend that the buying power adjustment should be set at the higher figures of 16.3 percent for buried copper cable and 33.8 percent for buried fiber cable, or at the very least, at the average of the higher and lower values for aerial and underground cable. We disagree. We find that AT&T and MCI offer no support to demonstrate why the higher values should be used. As explained below, the levels of the adjustments we proposed and adopt are the most conservative based on the available record evidence.

---

681 *Inputs Further Notice* at para. 79.

682 *See e.g.*, SBC *Inputs Further Notice* comments at 8; Sprint *Inputs Further Notice* comments at 22; Sprint *Inputs Further Notice* reply comments at 15; AT&T and MCI *Inputs Further Notice* comments at 21.

683 GTE *Inputs Further Notice* comments at 26-27; Sprint *Inputs Further Notice* reply comments at 14.

684 AT&T and MCI *Inputs Further Notice* comments at 21.

152. Apart from opposing the buying power adjustment on the ground that as a general matter the adjustment is unnecessary, those opposing the adjustment take issue with the adjustment on methodological grounds. GTE contends that the adjustment cannot properly convert RUS data into costs for non-rural carriers because the RUS data do not reflect the cost structure of rural carriers.[685] As we explained above, the assertion that the RUS data does not reflect the cost structure of rural carriers is without merit. GTE also contends that the application of the adjustment factors to the coefficients in the regression equations is contrary to the fundamentals of sound economic analysis.[686] The solution GTE recommends is that additional observations for non-rural companies be added to the data set. This solution echoes GTE's assertion that company-specific data should be used. Reliable observations for non-rural LECs are not available, however, as explained above.

153. GTE also identifies what it considers flaws in the development of the buying power adjustment.[687] GTE argues that because the adjustment to the RUS data was developed using only one larger company's data (Bell Atlantic's) reflecting costs for a single year, the adjustment is not proper.[688] We disagree for several reasons. First, we note that although we specifically requested comment on this adjustment and its derivation in the *Inputs Further Notice,*[689] GTE and other parties challenging the use of Bell Atlantic's data have not provided any alternative data for measuring the level of market power, despite their general agreement that such market power exists.[690] These parties failed to submit comparable verifiable data to show that the buying power adjustment we proposed was inaccurate. Under these circumstances, we cannot give credence to the unsupported claims that the Bell Atlantic data is not representative.

154. Equally important, we have reason to conclude that the adjustment we adopt is a conservative one. The buying power adjustment we proposed and adopt is based upon a submission by Bell Atlantic to the Maine Commission in a proceeding to establish permanent unbundled network element (UNE) rates.[691] In that context, it was in Bell Atlantic's interests to

[685] GTE *Inputs Further Notice* comments at 26.

[686] GTE *Inputs Further Notice* comments at 27.

[687] GTE *Inputs Further Notice* comments at 28.

[688] GTE *Inputs Further Notice* comments at 28.

[689] *Inputs Further Notice* at para. 79.

[690] Such agreement is consistent with representations by parties in merger contexts that a merger will produce costs savings.

[691] NRRI Study at 47. *See Inputs Further Notice* at para. 79.

submit the highest possible cost data in order to ensure that the UNE rates would give it ample compensation. But in the context of the adjustment we consider here for buying power, a relatively higher cost translates into a reduced adjustment because the greater the LEC costs, the less the differential between LEC and rural carrier costs. Therefore, given the source of this data, we conclude that it is likely to produce a conservative buying power adjustment, not an excessive one. Nevertheless, in the proceeding on the future of the model, we intend to seek further comment on the development of an appropriate buying power adjustment to reflect the forward-looking costs of the competitive efficient firm. In sum, we find that GTE's criticisms are not persuasive, and that the adjustment is a reasonable one, supported by the record.

155. GTE also asserts a litany of other concerns that, according to GTE, render the buying power adjustment invalid.[692] We find these concerns unpersuasive. GTE claims that the adjustment is suspect because some RUS observations used in the determination of material costs are not used in the regression.[693] We disagree. As discussed above, we apply the Huber methodology to RUS cable costs that reflect both labor and material costs.[694] The observations in the RUS database to which the Huber methodology assigns zero or less than full weight are those with the highest and the lowest values. As described more fully below, a statistical analysis demonstrates that this assignment of weights to these observations has little impact on the level of material costs reflected in the cable cost estimates derived by using this methodology. Therefore, material cost averages based on all of the RUS data are not likely to vary significantly from material cost averages based on a subset of these data.

156. Specifically, with one exception, the value of the regression coefficient for the variable representing the size of the cable in the cable cost regression equations derived by using the Huber methodology lies inside the 95 percent confidence interval surrounding the value of this coefficient in these regression equations in the NRRI Study obtained by using ordinary least squares.[695] The coefficient for the variable that represents cable size represents the additional cost for an additional pair of cable and therefore represents cable material costs. The values of the coefficient for the cable size variable obtained by using Huber and ordinary least squares are based on a sample of RUS companies' cable costs drawn from a larger population of such costs. The values of the coefficient obtained from this sample by using the Huber methodology and

---

[692] GTE *Inputs Further Notice* comments at 28-29.

[693] GTE *Inputs Further Notice* comments at 29.

[694] *See supra* paras. 139-145.

[695] We set forth in Appendix B a table that shows the value of this regression coefficient derived by using the Huber methodology and the 95 percent confidence interval surrounding the value of this coefficient obtained by using ordinary least squares. We also discuss in more detail the statistical evidence on the impact of the Huber methodology on the level of the material costs reflected in the cable cost estimates.

ordinary least squares are estimates of the true values of this coefficient theoretically obtained from the population of cable costs by using these techniques. Generally speaking, a 95 percent confidence interval associated with a coefficient estimate contains, with a probability of 95 percent, the true value of the coefficient.[696] The fact that the value of the cable size coefficient obtained by using the Huber methodology lies within an interval that contains with 95 percent certainty the true value of the ordinary least squares cable size coefficient supports the conclusion that the Huber methodology does not by its weighting methodology have a statistically significant impact on the level of the material costs reflected in the cable cost estimates derived by using this methodology.[697]

157. GTE also claims that some RUS observations appear to be from rescinded contracts or contracts excluded from the NRRI Study per-foot cable cost calculation.[698] However, GTE offers no evidence that this is the case. Finally, GTE claims that some RUS observations are for technologies that may not be appropriate for a forward-looking cost model.[699] On the contrary, loading coils were excluded from the RUS data base. Thus, we find that the RUS data do not reflect any non-forward-looking technologies.

158. GTE and Sprint each attempt to impugn the validity of the buying power adjustment, claiming that there may be an incongruity between the data submitted to the Maine Commission by Bell Atlantic and the RUS data.[700] We find this claim unpersuasive. Both GTE and Sprint assert that it is unknown whether the underlying data include such items as sales tax or shipping costs and, if so, whether the level of these items is comparable between Maine and the states included in the RUS data. Significantly, neither claim that such an incongruity exists in fact, nor do they provide viable alternatives for the calculation of the adjustment. We note

[696] As a general matter, 95 percent of the confidence intervals associated with different estimates of a given coefficient derived from a large number of samples of a given population can be expected to contain the true value of the coefficient.

[697] The one exception is that the value of the cable size coefficient obtained by using the Huber methodology for buried copper cable lies outside the 95 percent confidence interval associated with the cable size coefficient for buried copper cable obtained in the NRRI Study using ordinary least squares. This suggests that the assignment of weights by the Huber methodology does have a statistically significant impact on the level of the buried material costs reflected in the buried cable cost estimates. We find that this does not lead to an unreasonable estimate for buried cable costs. As we explained, application of the Huber methodology results in a better estimate of the expected value or tendency of the material costs for the RUS companies. Moreover, as noted above, the level of the buying power adjustment we adopt for buried copper cable is the most conservative estimate on the record before us.

[698] GTE *Inputs Further Notice* comments at 29.

[699] GTE *Inputs Further Notice* comments at 29.

[700] GTE *Inputs Further Notice* comments at 28-29; Sprint *Inputs Further Notice* comments at 22-23.

that the RUS data reflect the same categories of costs as those reflected in the Bell Atlantic data. More importantly, this data reflects the best available evidence on the record on which to base the buying power adjustment.

159. BellSouth claims that the buying power adjustment is flawed because it does not take into account the exclusion of RUS data resulting from the Huber adjustment.[701] Bell Atlantic makes a similar claim.[702] Both parties argue that because the Huber methodology excludes high cost data from the regression analysis, it is inappropriate to apply a discount which essentially has the same effect. In sum, these commenters claim that we are adjusting for high material costs twice. We disagree. This contention ignores the fact that the application of the Huber methodology and the buying power adjustment are fundamentally different adjustments. The Huber adjustment gives reduced weight to observations that are out of line with other data provided by the RUS companies. The Huber adjustment provides coefficient estimates that can be used to estimate the cost incurred by a typical RUS company. The adjustment is designed to dampen the effect of outlying observations that otherwise would exhibit a strong influence on the analysis. The large buying power adjustment, on the other hand, adjusts for the greater buying power of the non-rural companies. None of the RUS companies have the buying power of, for example, Bell Atlantic or GTE, and therefore have to pay more for material. The buying power adjustment could only duplicate the Huber adjustment if some of the RUS companies have the buying power of a company as large as Bell Atlantic. Because none of the firms in the RUS data base are close to the size of Bell Atlantic, the commenters are incorrect when they assert that, since the Huber methodology excludes high cost data from the regression analysis, it is inappropriate to apply the buying power adjustment.

160. We also reject BellSouth's argument that, to determine the size of the buying power adjustment, we should use a weighted average of the cable price differentials between Bell Atlantic and the RUS companies that is based on the miles of cable installed, not the number of observations, for each cable size.[703] In the NRRI Study, this weighted average price differential is determined by: (1) calculating the price differential between Bell Atlantic's average cable price and the RUS companies' average cable price for each cable size; (2) weighting the price differential for each cable size by the number of observations used to calculate the RUS companies' average cable price; and (3) summing these weighted price differentials.[704] The average measures the central tendency of the data. In general, the average more reliably measures this central tendency the larger the number of observations from which

[701] BellSouth *Inputs Further Notice* comments, Attachment A at A-5, A-18.

[702] Bell Atlantic *Inputs Further Notice* comments, Attachment C at 22-23, 27.

[703] BellSouth *Inputs Further Notice* comments, Attachment A at A-18.

[704] NRRI Study at 47 n. 47.

this average is calculated. In the NRRI Study, the average cable prices calculated for the RUS companies that reflect a relatively large number of observations are more reliable than those that reflect relatively few observations. Accordingly, weighting the price differentials for each cable size by the number of observations reflected in the average cable price calculated for the RUS companies provides a weighted average that reliably measures the central tendency of the price. In contrast, use of the miles of cable installed as weights to determine the average cable price differentials could result in a less reliable measure of central tendency because price differentials based on a small number of observations but reflecting a high percentage of cable miles purchased would have a greater impact on the weighted average than price differentials based on a large number of observations of cable purchase prices. Moreover, use of the number of miles of cable installed as the weights would result in a weighted average price differential that reflects RUS companies' relative use of different size cables. The RUS companies' relative use of different size cables is irrelevant for use in a model used to calculate non-rural LECs' cost of constructing a network.

161. We also reject Bell Atlantic's contention that the buying power adjustment is flawed because it should have been applied to the material costs rather than the regression coefficient of copper cable pairs or the number of fiber strands.[705] Bell Atlantic has provided no evidence that demonstrates that applying the discount to the coefficient is incorrect. It is an elementary proposition of statistics that the result of applying the discount to the regression coefficient is equal to applying the discount to the material costs.[706] Significantly, Bell Atlantic has not demonstrated that applying the discount to the regression coefficient does not produce the same result as applying the discount to the material costs.

162. Finally, we disagree with Sprint that, because buying power equates to company size, it is inappropriate to apply this adjustment uniformly to all carriers.[707] We are estimating the costs that an efficient provider would incur to provide the supported services.[708] We are not attempting to identify any particular company's cost of providing the supported services. We find, therefore, that applying the buying power adjustment as we propose is appropriate for the purpose of calculating universal service support.

163. In sum, we find unpersuasive the criticisms of the buying power adjustment we

---

[705] Bell Atlantic *Inputs Further Notice* comments, Attachment C at C-27.

[706] $E(aX) = aE(X)$ where "a" is the discount factor and X is the price of cable. *See*, *e.g.*, Gerald Keller and Brian Warrick, *Statistics for Management Economics* at 206 (Fourth Edition, Duxbury, 1997).

[707] Sprint *Inputs Further Notice* comments at 22. *See also* Cincinnati Bell *Inputs Further Notice* comments at 3-5.

[708] *See supra* at paragraph 29.

proposed. We conclude that, based on the record before us, a downward adjustment to the estimates developed from data reflecting the cable costs of rural LECs is necessary to derive estimates representative of cable costs for non-rural LECs and that the levels we have proposed for this adjustment are reasonable.

164. LEC Engineering. The second adjustment we proposed to the regression equations used to estimate cable costs was to account for LEC engineering costs, which were not included in the RUS data.[709] As we noted, the BCM2 default values include a loading of five percent for engineering.[710] In contrast, the HAI sponsors claimed that engineering constitutes approximately 15 percent of the cost of installing outside plant cables.[711] This percentage includes both contractor engineering and LEC engineering. The cost of contractor engineering already is reflected in the RUS cable cost data. In the *Inputs Further Notice*, we tentatively concluded that we should add a loading of 10 percent to the material and labor costs of cable (net of LEC engineering and splicing costs) to approximate the cost of LEC engineering.[712]

165. We affirm our tentative conclusion to add a loading of 10 percent to the material and labor for the cost of cable (net of LEC engineering and splicing costs) to approximate the cost of LEC engineering. We find that, based on the record before us, the proposed LEC engineering adjustment, as modified below, is appropriate. We also find that the level of the adjustment we proposed is reasonable. We note that there is a general consensus among the commenters that the proposed adjustment is necessary.[713] We reject, however, the contentions of those commenters that advocate that the level of the LEC adjustment be based on company-specific data. As we explained above, we find such data to be unreliable. For similar reasons, we reject the LEC engineering adjustment proposed by AT&T and MCI. As we explained, AT&T and MCI's proposal is based on expert opinions which we find to be unsupported and, therefore, unreliable.[714] Accordingly, the level of the adjustment that we proposed, which, as we

---

[709] *See Inputs Further Notice* at paras. 80, 91. It should be noted that the LEC Engineering Adjustment as well as the Splicing Adjustment discussed *infra* in paragraphs 168-176 would be required in the estimation of costs for rural LECs from the RUS data base because such costs were not reflected in the RUS data. These adjustments are part of the process in developing estimates from the data.

[710] *Inputs Further Notice* at para. 80.

[711] *Inputs Further Notice* at para. 80.

[712] *Inputs Further Notice* at paras. 80, 82, 84, 91, 93, 95.

[713] *See e.g.*, GTE *Inputs Further Notice* comments at 31-32; AT&T and MCI *Inputs Further Notice* comments at 16-18; BellSouth *Inputs Further Notice* comments, Attachment B at B-8 - B-9; BellSouth *Inputs Further Notice* reply comments at 6-7; Sprint *Inputs Further Notice* comments at 24-25; Bell Atlantic *Inputs Further Notice* reply comments, Attachment A at 1.

[714] AT&T and MCI *Inputs Further Notice* comments at 16.

explained in the *Inputs Further Notice* represents the mid-point between the HAI default loading and the BCPM default loading, is the most reasonable value on the record before us.

166. Sprint contends that we should calculate the loadings for LEC engineering on a flat dollar basis rather than on a fixed percentage of the labor and material costs of cable.[715] We find persuasive Sprint's contention that LEC engineering costs do not vary with the size of the cable and therefore do not vary with the cost of the cable. Accordingly, we find it reasonable to apply the loading for LEC engineering in the manner that Sprint recommends.

167. We also find that the commenters are correct that the loading for LEC engineering should not reflect any adjustment for buying power because the buying power differential between non-rural and rural LECs only relates to materials.[716] We adjust our calculation accordingly. Similarly, we also find it appropriate to include in the loading for LEC engineering an allowance for LEC engineering associated with splicing.[717] We find that this is appropriate because the loading for LEC engineering is based on BCPM and HAI default values for this loading that are expressed as a percentage of cable costs inclusive of engineering.[718]

168. Splicing Adjustment. The third adjustment to the regression equations that we proposed in the *Inputs Further Notice* was to account for splicing costs, which also were not included in the RUS data.[719] As we explained, Gabel and Kennedy determined that the ratio of

[715] Sprint *Inputs Further Notice* comments at 24.

[716] *See e.g.,* GTE *Inputs Further Notice* comments at 26-28; BellSouth *Inputs Further Notice* comments, Attachment B at B-9.

[717] AT&T and MCI develop equations for engineering costs that reflect engineering costs associated with splicing. *See* AT&T and MCI *Inputs Further Notice* comments, Exhibit A at A-7.

[718] We develop the flat cost-per-foot loading for LEC engineering for each type of cable by first estimating the RUS companies' total cable cost inclusive of splicing and exclusive of LEC engineering costs based on: (1) the regression equations we adopt in this Order; (2) the number of feet of cable that was placed pursuant to the contracts from which the data used to develop these regression equation are derived; and (3) the loadings that we adopt in this Order for splicing costs, 9.4 percent for copper cable and 4.7 percent for fiber cable. We then compute for each type of cable the total LEC engineering cost based on the total cable cost inclusive of LEC splicing costs and the loading that we adopt in this Order for LEC engineering, 10 percent. Finally, for each type of cable, we compute the flat cost per foot loading for LEC engineering by dividing the total LEC engineering costs by the total number of feet of cable placed pursuant to the RUS contracts.

Based on this methodology, we derive values for LEC engineering costs of $.19, $1.50, $.16, $.19, $.65, and $.14 per foot for 24-gauge aerial copper cable costs, 24-gauge underground copper cable costs, 24-gauge buried copper cable costs, aerial fiber cable costs, underground fiber cable costs, and buried fiber cable costs, respectively. We add these LEC engineering costs to the cable cost estimates derived by using the Huber methodology.

[719] *See Inputs Further Notice* at paras. 81, 91.

splicing costs to copper cable costs (excluding splicing and LEC engineering costs) is 9.4 percent for RUS companies in the NRRI Study.[720] Similarly, Gabel and Kennedy determined that the ratio of splicing costs to fiber cable costs (excluding splicing and LEC engineering costs) is 4.7 percent.[721] Thus, we tentatively concluded that we should adopt a loading of 9.4 percent for splicing costs for 24-gauge aerial copper cable, 24-gauge underground copper cable, and 24-gauge buried copper cable.[722] Correspondingly, we tentatively concluded that we should adopt a loading of 4.7 percent for splicing costs for aerial fiber cable, underground fiber cable, and buried fiber cable.[723]

169. We affirm these tentative conclusions. We find that, based on the record before us, the splicing cost adjustment is appropriate and the levels of the adjustments proposed are reasonable. In reaching this conclusion, we reject the claims of those commenters that advocate the use of company-specific data to develop the splicing loadings.[724] For the reasons enumerated above, we find such data unreliable.

170. We disagree with GTE's claim that, because the splicing factor is based on the RUS data, it is flawed.[725] This contention echoes GTE's assertion that we should use company-specific data. As we explained above, however, we conclude that such data are not reliable. We also disagree with GTE's contention that an analysis of the source contract data shows that some splicing costs are invalid.[726] GTE is mistaken. The RUS cost data from which the regression equations in the NRRI Study and in this Order are derived exclude splicing costs. Cable cost estimates obtained by using this methodology and these data are net of LEC engineering and splicing costs. We add to these cable cost estimates a loading factor for splicing that Gabel and Kennedy developed separately using the RUS data in the NRRI Study without using the regression analysis. In the NRRI Study, Gabel and Kennedy determined the ratio of splicing to cable costs by comparing the cost for splicing and the cost for cable (exclusive of splicing and LEC engineering costs) reflected in the contracts included in the RUS data base. Some of the

[720] *Inputs Further Notice* at para. 81 n. 164 *citing* NRRI Study at 29.

[721] *Inputs Further Notice* at para. 91 n. 176 *citing* NRRI Study at 29.

[722] *Inputs Further Notice* at paras. 81, 82, 84.

[723] *Inputs Further Notice* at paras. 91, 93, 95.

[724] *See e.g.*, GTE *Inputs Further Notice* comments at 32 and 50; Sprint *Inputs Further Notice* comments at 27; BellSouth *Inputs Further Notice* comments, Attachment A at A-9 - A-11, and Attachment B at B-8; BellSouth *Inputs Further Notice* reply comments at 6-7.

[725] GTE *Inputs Further Notice* comments at 49.

[726] GTE *Inputs Further Notice* comments at 49.

splicing costs reflected in this database are relatively high and some are relatively low. None of these high or low values is likely to influence significantly this ratio because it reflects a large number of observations. Accordingly, we find it reasonable to apply the splicing ratios developed in the NRRI Study to the cable cost estimates developed separately in this Order by using the Huber methodology with the RUS data.

171. We also disagree with AT&T and MCI's contention that, rather than adopting the proposed splicing loadings or the incumbent LEC's loading factors, we should adopt "reasonable values for the costs of cable placing, splicing, and engineering based on the expert opinions submitted in this proceeding."[727] As discussed above, we find that these expert opinions are unsupported, and therefore unreliable.

172. For the same reason, we also find unpersuasive AT&T and MCI's claim that the loading of 9.4 percent for splicing copper cable is excessive.[728] AT&T and MCI estimates that splicing costs vary between 3.4 and 6.9 percent of cable investment in contrast to the proposed rate of 9.4 percent. We find that these estimates, which rely on assumptions concerning the per-hour cost of labor, the number of hours required to set up and close the splice, the number of splices per hour, and the distance between splices, are unreliable. AT&T and MCI have provided no evidence other than the unsupported opinions of their experts to substantiate these data. In contrast, Bell Atlantic supports the use of the 9.4 percent loading indicating, that this level is consistent with its own data.[729]

173. While Sprint agrees that a splicing loading is required in the NRRI regression, Sprint recommends that a flat dollar "per pair per foot" cost additive should be employed rather than the adjustment we proposed.[730] We disagree. We find that Sprint's flat dollar "per pair per foot" cost additive ignores the differences in set-up costs among different cable sizes. In contrast, the percent loading for splicing costs we adopt herein implicitly recognizes such differences because these loadings are applied to cable costs estimates (exclusive of splicing and LEC engineering costs) derived from regression equations that have an intercept term that provides a measure of the fixed cost of cable. Accordingly, we conclude that the percent loading approach is more reasonable.

174. Sprint also asserts that underground splicing costs are higher due to the need to

[727] AT&T and MCI *Inputs Further Notice* comments at 16.

[728] AT&T and MCI *Inputs Further Notice* comments at 16-18.

[729] Bell Atlantic *Inputs Further Notice* reply comments, Attachment A at 1.

[730] Sprint *Inputs Further Notice* comments at 25. We note that Sprint advocates the use of company-specific data in the first instance.

work in manholes.[731] We agree. The dollar amounts associated with the fixed percentage loadings adopted in this Order for underground copper and fiber cable are generally larger than for aerial and buried copper cable and fiber cable. The dollar amounts that we adopt for splicing are generally larger for underground cable because the costs that we develop from RUS data for underground cable net of splicing and engineering costs are generally larger than the costs that we develop for aerial and buried cable net of splicing and engineering costs. As a result, when the fixed percentage is applied to these cable costs, the dollar amount for splicing is generally larger for underground cable than for aerial and buried cable.[732]

175. We disagree with those commenters who argue that the splicing costs do not vary with the cost of cable (net of splicing costs).[733] We find that cable costs increase as the size of the cable increases. Splicing costs increase as the size of the cable increases because larger cables require more splicing than small cables. Therefore, splicing costs increase as the cost of the cable increases.

176. Finally, we disagree with SBC's claim that the 14 percent splicing factor for fiber cable is more appropriate than the 4.7 percent we proposed.[734] We find that the 14 percent factor SBC proposes is unsupported. SBC asserts that this factor is based on an average cost ratio from an analysis using various lengths of underground fiber placement, including placing labor and comparing it to associated splicing costs from current cost dockets. However, SBC has not provided this analysis on the record.

177. 26-Gauge Copper Cable. In the *Inputs Further Notice*, we explained that, because the NRRI Study did not provide estimates for 26-gauge copper cable, we must either use another data source or find a method to derive these estimates from those for 24-gauge copper cable.[735] To that end, we tentatively concluded that we should derive cost estimates for 26-

[731] Sprint *Inputs Further Notice* comments at 25.

[732] There is one instance where the underground cable costs that we develop from RUS data (net of splicing and engineering costs) are not the largest for a given cable size. For the largest fiber cable size, 288 pairs, the costs that we develop for buried cable, $12.07 per foot, are greater than those for underground cable, $11.96 per foot. However, the model is unlikely to frequently place the largest fiber cable size in the network it builds in high-cost areas because most high-cost areas are in the lowest density zones where use of such a cable provides too much capacity relative to demand.

[733] *See e.g.*, Sprint *Inputs Further Notice* reply comments at 16; GTE *Inputs Further Notice* reply comments 26-27.

[734] SBC *Inputs Further Notice* comments at 9.

[735] *Inputs Further Notice* at para. 85.

gauge cable by adjusting our estimates for 24-gauge cable.[736] We proposed to estimate these ratios using data on 26-gauge and 24-gauge cable costs submitted by Aliant and Sprint and the BCPM default values for these costs.[737] We noted, that while we would prefer to develop these ratios based on data from more than these three sources, we tentatively concluded that these were the best data available on the record for this purpose.

178. We affirm our tentative conclusion to derive cost estimates for 26-gauge cable by adjusting our estimates for 24-gauge cable. As we explained in the *Inputs Further Notice*, we agree with the BCPM sponsors that the cost of copper cable should not be estimated based solely on the relative weight of the cable.[738] Instead, we proposed to use the ordinary least squares regression technique to estimate the ratio of the cost of 26-gauge to 24-gauge cable for each plant type (i.e., aerial, underground, buried). We conclude that, based on the record before us, this approach, adjusted as described more fully below, is reasonable.

179. Consistent with their position on estimating the costs of 24-gauge cable, many commenters advocate that we use company-specific data to estimate the costs of 26-gauge cable.[739] As we explained above, we have determined that such data are not sufficiently reliable to employ in the model.[740] Accordingly, we reject the use of company-specific data to estimate the costs of 26-gauge cable. We note that AT&T and MCI endorse the derivation of cost estimates for 26-gauge cable from estimates for 24-gauge cable.[741] Notwithstanding their support of the general approach we proposed, AT&T and MCI oppose estimating the ratio of costs of 26-gauge cable to 24-gauge cable using the cable costs submitted by Aliant and Sprint and the BCPM default values. Instead, AT&T and MCI advocate the use of the relative weight of copper to adjust the cost of the 24-gauge copper.[742] AT&T and MCI claim that this approach is the most logical because 26-gauge copper costs are directly proportional to the weight of the metallic copper in the cable. We reject AT&T and MCI's recommended approach. We find that, because AT&T and MCI have provided no evidence that the weight differential is approximately

[736] *Inputs Further Notice* at para. 86.

[737] We did not use the HAI default values in addition to these data to estimate these ratios because the HAI defaults do not have separate values for 26-gauge and 24-gauge cable costs for each different cable size.

[738] *Inputs Further Notice* at para. 86.

[739] *See e.g.*, BellSouth *Inputs Further Notice* comments at 6-7, Attachment B at B-8 - B-9; GTE *Inputs Further Notice* comments at 48.

[740] *See supra* paragraph 92.

[741] AT&T and MCI *Inputs Further Notice* comments at 19-20.

[742] AT&T and MCI *Inputs Further Notice* comments at 19-20.

equal to the price differential, there is insufficient evidence on the record demonstrating the reasonableness of this approach.

180. Many of those commenters advocating the use of company-specific data contend that there are flaws in the methodology adopted herein to derive cost estimates for 26-gauge cable by adjusting our estimates for 24-gauge cable. Bell Atlantic and GTE contend that our methodology results in biased estimates due to statistical error.[743] We agree and modify our proposed methodology as explained below.

181. As we explained in Appendix D of the *Inputs Further Notice*, in order to derive the 26-gauge copper cable costs, we first estimated the cost for 24-gauge copper cable for each cable size from the RUS data using the Huber methodology.[744] More specifically, we obtained an estimate of the expected or mean value of the cost for 24-gauge copper cable (for given values of the independent variables in the regression equation). We then obtained values for the ratio of 24-gauge copper cable to 26-gauge copper cable for each cable size using *ex parte* data obtained from Aliant and Sprint and BCPM default values for the costs and employing ordinary least squares regression analysis. As a result, we obtained an estimate of the expected value of the ratio of 24-gauge copper cable to 26-gauge copper cable (for given values of the independent variables in the regression equation). Finally, we multiplied the reciprocal of this ratio by the cost of 24-gauge copper cable obtained by using the Huber methodology with RUS data to obtain the proposed 26-gauge copper cable cost for each copper cable size. Bell Atlantic and GTE contend, and we agree, that this is a biased estimate of the expected value of the cost for 26-gauge copper cable because the expected value of the ratio of two random variables, e.g., 26-gauge copper cable cost and 24-gauge copper cable, does not equal the ratio of the expected value of the first random variable to the expected value of the second random variable. We note that the magnitude of the bias is larger as the difference grows between the expected value of the ratio of 26-gauge copper cable cost to 24-gauge copper cable cost and the ratio of the expected value of 26-gauge copper cable cost to the expected value of 24-gauge copper cable cost.

182. Accordingly, we modify the methodology tentatively adopted in the *Inputs Further Notice* to derive estimates of 26-gauge copper cable costs from 24-gauge copper cable costs that are not biased. As explained in more detail in Appendix B, in addition to estimating the expected value of the cost for 24-gauge copper cable for each cable size using the RUS data, we also estimate the expected value of the costs of 24-gauge and 26-gauge copper cable for each cable size using the data submitted by Aliant and Sprint and the BCPM default values, as well as data submitted by BellSouth,[745] hereinafter identified in the aggregate as "the non-rural LEC

---

[743] Bell Atlantic *Inputs Further Notice* comments, Attachment C at 26-27; GTE *Inputs Further Notice* comments at 29-30.

[744] *Inputs Further Notice*, Appendix D.

[745] BellSouth *Inputs Further Notice* reply comments, Attachment A at A-22 - A-23.

data." We divide the estimate of the expected value for 24-gauge copper cable cost derived from the non-rural LEC data into the estimate of the expected value for 26-gauge copper cable cost derived from these data for each cable size. The result is a ratio of an estimate of the expected value for 26-gauge copper cable cost to an estimate of the expected value for 24-gauge cable cost for each cable size. Finally, we multiply this ratio by the estimate of the expected value of the cost for 24-gauge copper cable derived from the RUS data to obtain an estimate of the expected value of the cost for 26-gauge copper cable for each cable size. We find that this adjustment eliminates the bias identified by the commenters. We conclude, therefore, that these estimates are reasonable and adopt them as inputs for 26-gauge copper cable costs.

183. We note that, in adopting these modifications, we find that it is reasonable to rely on the non-rural LEC data for calculating the ratio of the cost for 24-gauge copper cable to that for 26-gauge copper cable, but not for calculating the absolute cost for 24-gauge copper cable and 26-gauge copper cable. As discussed above, we find that the non-rural LEC data are not a reliable measure of absolute costs. Notwithstanding this finding, we conclude that it is reasonable to use the non-rural LEC data to determine the relative value of the cost for 24-gauge copper cable to that for 26-gauge copper cable. We find that it is reasonable to conclude that each LEC used the same methodology to develop both 24-gauge and 26-gauge copper cable costs. Accordingly, any bias in the costs for 24-gauge and 26-gauge copper cable that results from using a given methodology is likely to be in the same direction and of a similar magnitude. As a consequence, the estimate of the expected value of the cost for 26-gauge copper cable for each cable size and the estimate of the expected value of the cost for 24-gauge copper cable obtained from non-rural LEC data are likely to be biased by approximately the same factor. The ratios of the estimates of these expected values are not likely to be affected significantly because the bias in one estimate approximately cancels the bias in the other estimate when the ratio is calculated.

184. GTE also contends that the proposed methodology systematically reduces the amount of labor associated with placing cable.[746] We conclude that the adjustments made in response to GTE and Bell Atlantic's criticisms discussed above render this criticism irrelevant. We find that no systematic bias will result because the ratio of the 24-gauge cost of copper cable to the cost of 26-gauge copper cable represents the installed cost of 26-gauge copper cable including all labor and materials divided by the installed cost of 24-gauge copper cable including all labor and materials. Moreover, this ratio is applied to the installed cost of 24-gauge copper cable which includes all labor and material costs.

185. BellSouth claims that neither the data used to develop the ordinary least squares regression equation we employ in the *Inputs Further Notice* to estimate the cost of 26-gauge

[746] GTE *Inputs Further Notice* comments at 48-50.

copper cable or the computations used to derive that equation have been provided.[747] BellSouth contends that, as a result, it is not possible to confirm or contradict the discount value. We disagree. Contrary to BellSouth's assertion, the data are available. As we explained, the regression equation uses *ex parte* data submitted by Aliant and Sprint. These data are available subject to the Commission's rules regarding the treatment of confidential material. We also note that the BellSouth data we employ in the adjusted methodology we adopt herein are publicly available. Moreover, the BCPM data are publicly available.

5. Cable Fill Factors

a. Background

186. As we explained in the *Inputs Further Notice*, in determining appropriate cable sizes, network engineers include a certain amount of spare capacity to accommodate administrative functions, such as testing and repair, and some expected amount of growth.[748] The percentage of the total usable capacity of cable that is expected to be used to meet current demand is referred to as the cable fill factor.[749] If cable fill factors are set too high, the cable will have insufficient capacity to accommodate small increases in demand or service outages. In contrast, if cable fill factors are set too low, the network could have considerable excess capacity. While carriers may choose to build excess capacity for a variety of reasons, it is necessary to determine the appropriate cable fill factors for use in the federal mechanism. We also explained that, if the fill factors are too low, the resulting excess capacity would increase the model's cost estimates to levels higher than an efficient firm's costs, potentially resulting in excessive universal service support payments. Accordingly, as discussed more fully below, we tentatively selected the HAI defaults for distribution fill factors, the average of the HAI and BCPM default values for copper feeder fill factors, and fiber fill factors of 100 percent.[750]

187. <u>Variance Among Density Zones</u>. As a preliminary matter, we noted that both the HAI and BCPM sponsors provided default fill factors for copper cable that vary by density zone,

---

[747] BellSouth *Inputs Further Notice* comments, Attachment A at A-19.

[748] *Inputs Further Notice* at para. 96.

[749] We note that the actual fill factor may be lower than the fill factor used to design the network (sometimes referred to as administrative fill), because cable and fiber are available only in certain sizes. For example, assume a neighborhood with 100 households has a current demand of 120 telephones. Dividing the 120-pair demand by an 80 percent administrative fill factor establishes a need for 150 pairs. Cable is not sold, however, in 150-pair units. The company would purchase the smallest cable that is sufficient to provide 150 pairs, which is a 200 pair cable. The fill factor that occurs and is measurable, known as the effective fill, would be the number of pairs needed to meet demand, 120 pairs, divided by the number of pairs installed, 200 pairs, or 60 percent.

[750] *Inputs Further Notice* at paras. 100, 101, 102.

and that both agreed that fill factors should be lower in the lowest density zones.[751] We explained that the HAI sponsors claimed that an outside plant engineer is more interested in providing a sufficient number of spares than in the ratio of working pairs to spares, so the appropriate fill factor will vary with cable size.[752] Because smaller cables are used in lower density zones, HAI recommended that lower fill factors be used in the lowest density zones to ensure there will be enough spares available. Similarly, the BCPM sponsors claimed that less dense areas require lower fill ratios because the predominant plant type is buried and it is costly to add additional capacity after installation.[753] We tentatively agreed with the HAI and BCPM sponsors that fill factors for copper cable should be lower in the lowest density zones, and reflected this relationship in the fill factors that we proposed in the *Inputs Further Notice*.[754]

188. Distribution Fill Factors. We also noted in the *Inputs Further Notice* that the fill factors proposed by the HAI sponsors for distribution cable were somewhat lower than for copper feeder cable.[755] In contrast, the BCPM default fill factors for distribution cable are set at 100 percent for all density zones.[756] We explained that this difference is related to the differences between certain assumptions that were made in the HAI and BCPM models. The HAI proponents claimed that the level of spare capacity provided by their default values is sufficient to meet current demand plus some amount of growth.[757] This is consistent with the HAI model's approach of designing plant to meet current demand, which on average is 1.2 lines per household as defined by HAI. BCPM, on the other hand, designs outside plant with the assumption that every residential location has two lines, which is more than current demand. This reflects the practice of incumbent LECs to build enough distribution plant to meet not only current demand, but also anticipated future demand because it is costly to add distribution plant

[751] *Inputs Further Notice* at para. 97. As explained below, default values in BCPM 3.1 for distribution cable do not vary by density zone.

[752] *Inputs Further Notice* at para. 97 n. 187 *citing* HAI Dec. 11, 1997 submission, Inputs Portfolio at 39, 63.

[753] *Inputs Further Notice* at para. 97 n. 188 *citing* BCPM 3.1 May 26, 1998 (Preliminary Edition) Loop Inputs Documentation at 51.

[754] *Inputs Further Notice* at para. 97.

[755] *Inputs Further Notice* at para. 98 n. 189 *citing* HAI Dec. 11, 1997 submission, Inputs Portfolio at 39, 63. HAI 5.0 default values range from 50 percent in the lowest density zone to 75 percent in the highest density zone for distribution cable sizing fill factors, and range from 65 percent in the lowest density zone to 75 percent in the highest density zone for copper feeder cable sizing fill factors.

[756] *Inputs Further Notice* at para. 98 n. 190 *citing* BCPM Dec. 11, 1997 submission. We noted that earlier versions of BCPM, however, had lower fill factors for distribution than for feeder. *See, e.g., 1997 Further Notice* at para. 118. Default values in BCPM 3.1 range from 75 to 85 percent for feeder cable.

[757] *Inputs Further Notice* at para. 98 n. 191 *citing* HAI Dec. 11, 1997 submission, Inputs Portfolio at 39, 63.

at a later point in time.[758]

189. We also noted that, in a meeting with Commission staff, Ameritech raised the issue of whether industry practice is the appropriate guideline for determining fill factors to use in estimating the forward-looking economic cost of providing the services supported by the federal mechanism.[759] Ameritech claimed that forward-looking fill factors should reflect enough capacity to provide service for new customers for a few years until new facilities are built, and should account for the excess capacity required for maintenance and testing, defective copper pairs, and churn.[760]

190. We tentatively concluded that the fill factors selected for use in the federal mechanism generally should reflect current demand,[761] and not reflect the industry practice of building distribution plant to meet "ultimate" demand. We also tentatively selected the HAI defaults for distribution fill factors and tentatively concluded that they reflect the appropriate fill needed to meet current demand.[762]

191. Feeder Fill Factors. In the *Inputs Further Notice* we explained that, in contrast to distribution plant, feeder plant typically is designed to meet only current and short term capacity needs.[763] We noted that the BCPM copper feeder default fill factors are slightly higher than HAI's, but both the HAI and BCPM default values appear to reflect current industry practice of sizing feeder cable to meet current, rather than long term, demand.[764] We tentatively selected copper feeder fill factors that are the average of the HAI and BCPM default values because both the HAI and BCPM default values assume that copper feeder fill reflects current demand.[765]

[758] For example, in an *ex parte* meeting on March 24, 1999, Ameritech representatives said that Ameritech designs distribution plant to meet "ultimate" demand and designs feeder plant that is "growable." *See* Letter from Celia Nogales, Ameritech, to Magalie Roman Salas, FCC, dated March 25, 1999 (Ameritech March 25 *ex parte*).

[759] *Inputs Further Notice* at para. 99.

[760] *Inputs Further Notice* at para. 99 n. 194. Ameritech filed data, subject to the protective order in this proceeding, showing how these considerations are used to calculate the actual and forward-looking fill factors in Ameritech's territory. *See* Ameritech March 25 *ex parte*.

[761] We define "current demand" to include a reasonable amount of excess capacity to accommodate short term growth. *Inputs Further Notice* at para. 100 n. 195.

[762] *Inputs Further Notice* at para. 100.

[763] *Inputs Further Notice* at para. 101 *citing* Ameritech March 25 *ex parte*.

[764] *Inputs Further Notice* at para. 101.

[765] *Inputs Further Notice* at para. 101.

192. Fiber Fill Factors. We also explained in the *Inputs Further Notice* that, because of differences in technology, fiber fill factors typically are higher than copper feeder fill factors.[766] Standard fiber optic multiplexers operate on four fiber strands: primary optical transmit, primary optical receive, redundant optical transmit, and redundant optical receive. In determining appropriate fiber cable sizes, network engineers take into account this 100 percent redundancy in determining whether excess capacity is needed that would warrant application of a fill factor.[767] Both the HAI and BCPM models use the standard practice of providing 100 percent redundancy for fiber and set the default fiber fill factors at 100 percent. Accordingly, we tentatively concluded that the input value for fiber fill in the federal mechanism should be 100 percent.[768]

b. Discussion

193. We affirm our tentative conclusion that fill factors for copper cable should be lower in the lowest density zones. Significantly, those commenters addressing this issue agree that lower density zones should utilize lower copper cable fill factor inputs.[769] We also reject, at the outset, certain assertions made by GTE and others, challenging the overall approach we proposed and adopt herein for determining the appropriate cable fill factors to use in the federal mechanism and reject GTE's assertions that the model is flawed.

194. We disagree with GTE's assertion that the use of generalized fill factors are not proper inputs for a cost model that seeks to estimate the forward-looking costs of building a network. GTE claims that the use of generalized fill factors disregards how actual distribution plant is designed and that different levels of utilization are observed in different parts of the local network.[770] However, we find that GTE's concerns are misplaced. Contrary to GTE's implication, generalized fill factors are an administrative input and are not the sole determinate of the effective fill factor. As we explained in the *Inputs Further Notice*, the effective fill factor will vary with the number of customer locations and the available discrete size of cable.[771] Thus,

[766] *Inputs Further Notice* at para. 102.

[767] That is, fiber plant with a 100 percent fill factor has an actual utilization of 50 percent; whereas copper plant with a 50 percent fill factor has an actual utilization of 50 percent.

[768] *Inputs Further Notice* at para. 102.

[769] Sprint *Inputs Further Notice* comments at 29; SBC *Inputs Further Notice* comments at 9; GTE *Inputs Further Notice* comments at 54.

[770] GTE *Inputs Further Notice* comments at 53.

[771] *Inputs Further Notice* at para. 96 n. 135.

the effective fill factor will reflect how distribution plant is designed and different levels of utilization that are observed in different parts of the local network.

195. Similarly, we disagree with GTE's assertion that company-specific information should be used to determine appropriate fill factor inputs.[772] We note that the final effective fill factors are the result of the input of the administrative fill factors and company-specific customer location data. We also disagree with the contention that administrative fill factors must be company-specific.[773] The administrative fill factors are determined per engineering standards and density zone conditions. These factors are independent of an individual company's experience and measured effective fill factors. The administrative fill factors would be the same for every efficient competitive firm.

196. We reject GTE's contention that the model should be modified to accept the number of pairs per location to determine the required amount of distribution plant rather than using fill factors.[774] GTE claims that this is necessary because using fill factor inputs produces anomalous results. GTE contends that the use of fill factors causes the number of implicit lines per location to decrease as density increases, in contrast to what occurs in reality. There are, according to GTE, always more business customers in higher density zones; therefore, the number of lines that must be provisioned per location should increase as density increases.

197. We find that there is no need to modify the model to accept pairs per location rather than fill factors, as GTE contends. The number of implicit lines per location does not decrease in the model as GTE claims. On the contrary, the number of implicit lines per location increases as a function of the number of business lines. The model will build to the level of business demand. With business demand increasing as a function of density, the model generates a higher number of lines per location as density increases. In sum, the anomaly that GTE identifies does not exist. GTE's claim reflects a misunderstanding of the model's operation.

198. Finally, we disagree with GTE's assertion that there is an error in the way the model calculates density zones that prevents correct application of zone-specific inputs.[775] As GTE explains, after the model has assigned customer locations to clusters, it constructs a

---

[772] GTE *Inputs Further Notice* comments at 54. Ameritech contends that the nationwide fill factors proposed by the Commission are reasonable estimates to use if company-specific or state-specific fill factors are not used. Ameritech *Inputs Further Notice* comments at 20.

[773] *See e.g.*, GTE *Inputs Further Notice* comments at 54; BellSouth *Inputs Further Notice* comments, Attachment B at B-12

[774] GTE *Inputs Further Notice* comments at 54.

[775] GTE *Inputs Further Notice* comments at 55.

"convex hull" around all locations in the cluster. The model then calculates density as the lines in the cluster divided by the area within the convex hull. GTE claims that the calculated densities will be higher than those observed in the real world because the denominator excludes all land not contained in the convex hull. While we agree with GTE's description of how the model determines cluster density, we find GTE's claim that this methodology is erroneous to be misplaced. In sum, GTE argues that the model employs a restricted definition of area which causes the model to use excessively high utilization factors.[776] In other words, the issue is whether the model should recognize all of the area around a cluster. We conclude that it should not. If the land outside the convex hull were included in the denominator, as GTE implies it should, the denominator would recognize unoccupied areas where no customers reside. As a result, the model would select density zone fill factors that are lower than needed to service the customers in that cluster. There would be a downward bias in the model fill factors. Thus, there is not an error in the way the model calculates density zones, as GTE contends. The model generates density values that correspond to the way the population is dispersed. To do otherwise would introduce a bias and distort the forward-looking cost estimates generated by the model.

199. Distribution Fill Factors. We also affirm our tentative conclusion that the fill factors selected for use in the federal mechanism generally should reflect current demand and not reflect the industry practice of building distribution plant to meet ultimate demand. As we explained in the *Inputs Further Notice*, the fact that industry may build distribution plant sufficient to meet demand for ten or twenty years does not necessarily suggest that these costs should be supported today by the federal universal service support mechanism.[777]

200. We find unpersuasive GTE's assertion that the input values for distribution fill factors should reflect ultimate demand.[778] In concluding that the fill factors should reflect current demand, we recognized that correctly forecasting ultimate demand is a speculative exercise, especially because of rapid technological advances in telecommunications. For example, we note that ultimate demand decreases substantially when computer modem users switch from dedicated lines serving analog modems to digital subscriber lines where one pair of copper wire provides the same function as a voice line and a separate dedicated line. Given this uncertainty, we find that basing the fill factors on current demand rather than ultimate demand is more reasonable because it is less likely to result in excess capacity, which would increase the model's cost estimates to levels higher than an efficient firm's costs and could potentially result in excessive universal service support payments.

201. Significantly, we note that, contrary to GTE's inference, current demand as we

[776] We note that GTE did not assert that this bias will increase structure costs.

[777] *Inputs Further Notice* at para. 100.

[778] GTE *Inputs Further Notice* comments at 55-56.

define it includes an amount of excess capacity to accommodate short-term growth.[779] We find that GTE has not provided any evidence that demonstrates that the level of excess capacity to accommodate short-term growth is unreasonable. Rather, GTE claims that, if distribution is not built to reflect ultimate demand there will be delays in service and increased placement costs due to the need to reinforce distribution plant in established neighborhoods on a regular basis.[780] GTE also contends that telephone companies do not design distribution plant with the expectation that it will require reinforcement because that is rarely the least-cost method of placing plant.[781] GTE also claims that, in a competitive environment, facilities-based competitors would build plant to serve ultimate demand.[782] We find, however, that these unsupported claims do not demonstrate that reflecting ultimate demand in the fill factors more closely represents the behavior of an efficient firm and will not result in the modeling of excess capacity. Finally, we find that we did not misinterpret the meaning of building distribution plant to serve "ultimate demand," as GTE asserts.[783] Rather, we refused to engage in the highly speculative activity of defining "ultimate demand." Moreover, we believe that universal service support will be determined more accurately considering current demand, and not ultimate demand. Although firms may have installed excess capacity, it does not follow that the cost of this choice should be supported by the universal service support mechanism. As growth occurs, however, we anticipate that the requirement for new capacity will be reflected in updates to the model.[784]

202. Concomitantly, we adopt the proposed values for distribution fill factors. As we explained in the *Inputs Further Notice*, the model designs outside plant to meet current demand in the same manner as the HAI model.[785] Accordingly, it is appropriate to choose fill factors that are set at less than 100 percent. We conclude that, based on the record before us, the proposed values reflect the appropriate fill factors needed to meet current demand.

203. There is divergence among the commenters with regard to the adoption of the proposed values for the distribution fill factors. Sprint does not object to the use of the proposed

[779] GTE *Inputs Further Notice* comments at 55-56.

[780] GTE *Inputs Further Notice* comments at 55.

[781] GTE *Inputs Further Notice* comments at 55.

[782] GTE *Inputs Further Notice* comments at 55.

[783] GTE *Inputs Further Notice* comments at 56.

[784] We anticipate beginning a proceeding in the near future to determine how to incorporate changed circumstances such as these into the modeling process.

[785] *Inputs Further Notice* at para. 100.

values, stating that "they appear to reasonably represent realistic, forward-looking practices."[786] As noted above, Ameritech contends that the copper distribution and feeder fill factors are reasonable estimates to use if company-specific or state-specific fill factors are not used.[787] In contrast, SBC disagrees with the HAI proponents' claim that the level of spare capacity provided in the proposed values is sufficient to meet current demand plus some amount of growth.[788] SBC, however, offers no controverting evidence demonstrating that the proposed values are insufficient to meet current demand plus short-term growth. We find that the lone fact that SBC disagrees is insufficient to controvert our conclusion that the proposed values reflect the appropriate fill needed to meet current demand. BellSouth contends that the proposed values will significantly understate distribution cable requirements.[789] BellSouth submits instead projected fill factors for its distribution copper, feeder copper, and fiber cables determined by BellSouth network engineers. We find these estimates unsupported. Similarly, Bell Atlantic contends that the proposed fill factors for feeder and distribution are too high and recommends we adopt its proposed fill factors.[790] We find these recommended fill factors unsupported. We, therefore, select the proposed values for distribution fill factors.

204. We also disagree with AT&T and MCI's contention that the proposed values for the distribution fill factors are too low. AT&T and MCI claim that distribution fill factors of 1.2 lines per household are more than adequate in a forward-looking cost study.[791] We disagree. We find that 1.2 lines per household are inadequate because they simply reflect the existing provision of telephone service and are less than current demand as we define it herein.[792] Moreover, AT&T and MCI's claim is belied by their own assertions. AT&T and MCI contend that the "proposed conservative fill factors will ensure sufficient plant capacity to accommodate potentially unaccounted service needs in the PNR data."[793] AT&T and MCI also state that "[t]he fill levels used in HAI provides more than enough spare capacity for service work, churn, and

[786] Sprint *Inputs Further Notice* comments at 29.

[787] Ameritech *Inputs Further Notice* comments at 20.

[788] SBC *Inputs Further Notice* comments at 9.

[789] BellSouth *Inputs Further Notice* comments, Attachment B at B-11.

[790] Bell Atlantic *Inputs Further Notice* comments, Attachment D at 7 (Proprietary Version); Bell Atlantic *Inputs Further Notice* reply comments, Attachment A at A-1.

[791] AT&T and MCI *Inputs Further Notice* comments at 22-23.

[792] *See* FCC, Common Carrier Bureau, Industry Analysis Division, *Trends in Telephone Service* at 20-6 (rel. Sept. 1999).

[793] AT&T and MCI *Inputs Further Notice* comments at 8.

unforeseen spikes in demand.[794] In sum, AT&T and MCI attest to the reasonableness of not only use of the HAI default values for distribution plant, but also the use of the average of the HAI and BCPM default values for copper feeder.

205. We also disagree with AT&T and MCI's claim that higher factors are appropriate because the model's sizing algorithm produces effective fill factors that are lower than optimal values.[795] As we explained in the *Inputs Further Notice*, because cable and fiber are available only in certain sizes, the effective fill factor may be lower than the administrative fill factor adopted as an input.[796] We find that AT&T and MCI's claim ignores this fact.

206. Finally, we note that AT&T and MCI also claim that the factor should be higher because universal service support does not include residential second lines or multiple business lines. The Commission has never acted on the recommendation in the *First Recommended Decision* that only primary residential lines should be supported.[797] Moreover, we also note that AT&T and MCI's claim ignores the sixth criterion, which requires that:

> The Cost Study or model must estimate the cost of providing service for all businesses and households. . . Such inclusion of multi-line business services and multiple residential lines will permit the cost study or model to reflect the economies of scale associated with the provision of these services.[798]

In sum, we find AT&T and MCI's claim in this regard unpersuasive.

207. Feeder Fill Factors. We also affirm our tentative conclusion to adopt copper feeder fill factors that are the average of the HAI and BCPM default values. The divergence among the commenters noted above with regard to the use of the average of the HAI and BCPM default values for the distribution fill factors is reflected in the comments regarding the proposed feeder fill factors. Sprint finds that use of the average of the HAI and BCPM default values for feeder fill factors is reasonable.[799] Ameritech's conditional support was noted above. In

794 AT&T and MCI *Inputs Further Notice* reply comments at 20.

795 AT&T and MCI *Inputs Further Notice* comments at 22.

796 *Inputs Further Notice* at para. 96 n. 185.

797 *See First Recommended Decision*, 12 FCC Rcd at 91-92, 132-134, paras. 4, 89-92.

798 *Universal Service Order*, 12 FCC Rcd at 8915, para. 250.

799 Sprint *Inputs Further Notice* comments at 29.

contrast, BellSouth contends that the average of the HAI and BCPM default values will significantly understate copper feeder cable requirements.[800] As noted above, BellSouth advocates the use of projected fill factors for copper feeder determined by BellSouth network engineers. Similarly, Bell Atlantic contends that the feeder fill factors are too high.[801] We reject the use of these fill projections for copper feeder for the reasons enumerated above. We also reject, for the reasons enumerated above, AT&T and MCI's contention that feeder fill factors based on the average of the HAI and BCPM default values are too low.

208. Fiber Fill Factors. Finally, we affirm our tentative conclusion that the input value for fiber fill in the federal mechanism should be 100 percent. The majority of commenters addressing this specific issue agree with our tentative conclusion.[802] AT&T and MCI contend that fiber feeder fill factors of 100 percent are appropriate because the allocation of four fibers per integrated DLC site equates to an actual fill of 50 percent, since a redundant transmit and a redundant receive fiber are included in the four fibers per site.[803] AT&T and MCI explain that, because fiber capacity can easily be upgraded, 100 percent fill factors applied to four fibers per site are sufficient to meet unexpected increases in demand, to accommodate customer churn, and, to handle maintenance issues. Similarly, SBC asserts that fiber fill factors of 100 percent can be obtained because they are not currently subject to daily service order volatility and are more easily administered.[804] In contrast, BellSouth advocates that we employ projected fills estimated by BellSouth engineers.[805] As noted above, these estimates are unsupported and we reject them accordingly. In sum, we find that the record demonstrates that it is appropriate to use 100 percent as the input value for fiber fill in the federal mechanism.

6. Structure Costs

a. Background

[800] BellSouth *Inputs Further Notice* comments, Attachment B at B-11.

[801] Bell Atlantic *Inputs Further Notice* comments, Attachment D at 7 (Proprietary Version); Bell Atlantic *Inputs Further Notice* reply comments, Attachment A at A-1.

[802] *See e.g.*, AT&T and MCI *Inputs Further Notice* comments at 22; Sprint *Inputs Further Notice* comments at 30; GTE *Inputs Further Notice* comments at 56; SBC *Inputs Further Notice* comments at 9-10.

[803] We note that GTE agrees with a fill factor of 100 percent for fiber as it relates to 100 percent redundancy only if it provides fibers for redundant optical transmit and receive and does not equate to 100 percent fiber utilization. We note that a fill factor of 100 percent for fiber does not equate to 100 percent fiber utilization.

[804] SBC *Inputs Further Notice* comments at 9-10.

[805] BellSouth *Inputs Further Notice* comments, Attachment B at B-9 - B-10.

209. Outside plant structure refers to the set of facilities that support, house, guide, or otherwise protect distribution and feeder cable.[806] We explained that aerial structure consists of telephone poles and associated hardware such as anchors and guys. Buried structure consists of trenches.[807] Underground structure consists of trenches, conduit, manholes, and pullboxes. Underground cable is placed underground within conduits for added support and protection. Structure costs include the initial capital outlay for physical material associated with outside plant structure, including manholes; conduit, trenches, poles, anchors and guys, and other facilities; the capitalized cost for supplies, delivery, provisioning, right of way fees, taxes, and any other capitalized costs directly attributable to these assets; and the capitalized cost for the labor, engineering, and materials required to install these assets. For example, buried and underground structure costs include capitalized labor, engineering, and material costs for such activities as plowing or trenching, backfilling, boring cable, and cutting and restoring asphalt, concrete, or sod, or any combination of such activities. Generally, the type of structure that is placed will vary depending on the type of plant installed, i.e., the plant mix.

210. As noted above, the model uses structure cost tables that identify the per-foot cost of structure by type (aerial, buried, or underground), loop segment (distribution or feeder), and terrain conditions (normal, soft rock, or hard rock), for each of the nine density zones. For aerial structure, the cost per foot that is entered in the model is calculated by dividing the total installed cost per telephone pole by the distance between poles. We tentatively concluded that we should use, with certain modifications, the estimates in the NRRI Study for the per-foot cost of aerial, underground, and buried structure.[808] We noted that, in general, these estimates are derived from regression equations that measure the effect on these costs of density, water, soil, and rock conditions.

211. In the *Inputs Further Notice*, we rejected the HAI and BCPM sponsors' default input values for structure costs because they were based upon the opinions of their respective experts and lacked supporting data that allowed us to substantiate these values.[809] As noted above, we have received other structure cost data from a number of LECs, as well as AT&T, including data received in response to the structure and cable cost survey and data submitted in *ex parte* filings.

212. In the *Inputs Further Notice*, we tentatively decided to use the regression equation

[806] *Inputs Further Notice* at para. 104.

[807] When a plow is used to place buried cable, a separate trench is not required.

[808] *Inputs Further Notice* at para. 106.

[809] *Inputs Further Notice* at para. 105.

for aerial structure in the NRRI Study as a starting point for aerial structure input values.[810] We proposed to use this equation to develop proposed input values for the labor and material cost for a 40-foot, class-four telephone pole. We developed separate pole cost estimates for normal bedrock, soft bedrock, and hard bedrock.[811] The regression coefficients estimate the combined cost of material and supplies. The NRRI Study reports that the average material price for a 40-foot, class-four pole is $213.94.[812] We noted that this estimate is very close to results obtained from the data submitted in response to the *1997 Data Request*.

213. We also tentatively concluded that we should add to these estimates the cost of anchors, guys, and other materials that support the poles, because the RUS data from which this regression equation was derived do not include these costs.[813] As we noted, Gabel and Kennedy used the RUS data to develop the following cost estimates for anchors, guys and other pole-related items: $32.98 in rural areas; $49.96 in suburban areas; and $60.47 in urban areas.[814] We tentatively concluded that these are reasonable estimates for the cost of anchors, guys, and other pole-related items.[815]

214. We also explained, in the *Inputs Further Notice*, that in order to obtain proposed input values that can be used in the model, it is necessary to convert the estimated pole costs into per-foot costs for each of the nine density zones.[816] For purposes of this computation, we proposed to use, for density zones 1 and 2, the per-pole cost that we have estimated for rural areas, based on the NRRI Study; for density zones 3 through 7, the per-pole cost for suburban areas; and for density zones 8 and 9, the per-pole cost for urban areas. We then divided the estimated cost of a pole by the estimated distance between poles. We proposed to use the following values for the distance between poles: 250 feet for density zones 1 and 2; 200 feet for zones 3 and 4; 175 feet for zones 5 and 6; and 150 feet for zones 7, 8, and 9. For the most part, these values are consistent with both the HAI and BCPM defaults.

215. We also tentatively concluded that we should adopt a methodology to estimate the

---

[810] *Inputs Further Notice* at para. 107. This regression equation was set forth in Appendix D, section III.A of the *Inputs Further Notice*.

[811] *See Inputs Further Notice*, Appendix D, section III.A.

[812] *Inputs Further Notice* at para. 107 n. 206 *citing* NRRI Study at 51, Table 2-11.

[813] *Inputs Further Notice* at para. 108.

[814] *Inputs Further Notice* at para. 108 n. 208 *citing* NRRI Study at 55, Table 2-14.

[815] *Inputs Further Notice* at para. 108.

[816] *Inputs Further Notice* at para. 110.

cost of underground structure that is similar to the one we proposed for the cost of aerial structure.[817] We tentatively concluded that we should use the equation set forth in Appendix D of the *Inputs Further Notice* as a starting point for this estimate.[818] We proposed to use this equation to develop proposed input values for the labor and material cost for underground cable structure. We developed separate cost estimates for underground structure in normal bedrock, soft bedrock, and hard bedrock for density zones 1 and 2.[819]

216. We also tentatively concluded that we should use the modified equation for estimating the cost of 24-gauge buried copper cable and structure to estimate the cost of buried structure.[820] We determined that it is necessary to modify this equation because estimates derived from it include labor and material costs for both buried cable and structure.[821]

217. Finally, we determined that, because the RUS data are from companies that operate only in density zones 1 and 2, we were unable to develop estimates from the regression equation for density zones 3 through 9 for underground and buried structure.[822] We tentatively concluded, therefore, that we should derive cost estimates for density zones 3 through 9 by extrapolating from the estimates for density zone 2. We sought comment on alternative methods for estimating structure costs for density zones 3 through 9.

b. Discussion

218. We affirm our tentative conclusions to use the regression equation for aerial structure in the NRRI Study as a starting point for the cost estimate for aerial structure; to use the regression equation for underground structure in the *Inputs Further Notice* as a starting point for the cost estimate for underground structure for density zones 1 and 2; and to use the regression equation for the cost of 24-gauge buried copper cable and structure, as modified below, to

---

[817] *Inputs Further Notice* at para. 111.

[818] *See Inputs Further Notic*e, Appendix D, section III.B. This regression equation is based on the RUS data, but was developed after the publication of that report. The NRRI Study does not set forth a regression equation for estimating the cost of underground structure.

[819] This regression equation was developed using underground cost data for density zones 1 and 2. The variable in this equation that represents the density zone of the geographic area in which the underground costs are incurred is not statistically significant at any standard level of significance.

[820] This equation is set forth in Appendix D, section III.C of the *Inputs Further Notic*e.

[821] *See Inputs Further Notice*, Appendix D, section III.C.

[822] *Inputs Further Notice* at para. 112.

estimate the cost of buried structure for density zones 1 and 2.[823] Concomitantly, we affirm our tentative conclusion to add to the estimates for aerial structure the costs of anchors, guys, and other materials that support the poles. As we explained in the *Inputs Further Notice*, the RUS data from which this regression equation was derived do not include these costs. We also adopt the following values we proposed in the *Inputs Further Notice* for the distance between poles: 250 feet for density zones 1 and 2; 200 feet for zones 3 and 4; 175 feet for zones 5 and 6; and 150 feet for zones 7, 8, and 9.

219. As noted above, several commenters advocate that the input values we adopt for structure costs reflect company-specific data. For the reasons enumerated above, we reject the use of the company-specific data we have received to estimate the nationwide average input values for structure costs to be used in the model.

220. Notwithstanding this conclusion, we find that it is unnecessary to extrapolate cost estimates for underground and buried structure for density zones 3 through 9 as we proposed. At the time of the *Inputs Further Notice*, we believed the extrapolated data were the best data available to us at the time for density zones 3 through 9 although we noted our preference to use data specific to those density zones.[824] Upon further examination, we find that cost data, which include values for density zones 3 through 9, submitted by various state commissions for use in this proceeding are more reliable than the extrapolated data.[825] Specifically, we reviewed structure cost data from North Carolina, South Carolina, Indiana, Nebraska, New Mexico, Montana, Minnesota, and Kentucky. These data reflect structure costs designed for use in the HAI and BCPM models.[826]

221. The structure costs submitted by the state commissions have values for normal rock, soft rock, and hard rock for density zones 3 through 9. We adopt as the buried and underground structure cost input values for these density zones weighted average structure costs

[823] *See* paragraphs 126-132 for a discussion of the development of the equation for buried structure.

[824] *Inputs Further Notice* at para. 112.

[825] In the *Universal Service Order*, we determined that states could submit their own cost studies to serve as the basis for calculating federal universal service support in their states, if those studies met the criteria for forward-looking economic cost determinations. In sum, we required that such cost studies must be based on forward-looking economic cost principles and supported by publicly available data and computations. In order for the Commission to accept a state cost study for these purposes, we also required that the study be the same cost study that is used by the state to determine intrastate universal service support levels pursuant to 254(f) of the Act. *See Universal Service Order*, 12 Fcc Rcd at 8912-16, paras. 248, 250-51. The Commission subsequently adopted the Joint Board's recommendation to estimate forward-looking costs using a single national model. *See Seventh Report & Order*, 14 FCC Rcd at 8103.

[826] The RUS data underlying the NRRI Study reflect structure costs for density zones 1 and 2.

developed from these data based on the number of access lines for the companies to which the state decisions regarding the submitted structure costs apply. We find that these weighted averages represent reasonable estimates for buried and underground structure costs in normal, soft, and hard rock conditions for density zones 3 through 9.

222. Apart from the criticism of the extrapolation of structure costs for density zones 3 through 9 from the estimates for density zone 2,[827] the comments we have received regarding the values we proposed for structure costs vary as to the type of structure the commenters address and vary as to the position they take on the reasonableness of the estimates.[828] BellSouth states that the values we adopt for aerial structures are "fairly representative of BellSouth's values" but claims that, based on a comparison to its actual data, the values for underground and buried structure are too low.[829] Cincinnati Bell states that the values we adopt for underground structure never vary from Cincinnati Bell's actual costs by more than 15 percent.[830] Sprint claims that our proposed cost of poles are understated but the costs of anchor and guys appear to be reasonable.[831] SBC claims that its actual weighted cost of a 40 foot pole is inconsistent with the loaded cost from the NRRI Study. SBC asserts, however, that the NRRI-specified cost is more closely aligned with SBC's anchor and guy costs.[832] We find that, given this divergence of positions, the support in the record for some of our proposed values, and lack of back-up data to support the arguments opposing our proposals, on balance, the structure cost estimates we adopt for aerial, underground, and buried structure for density zones 1 and 2 are reasonable. Moreover, we find it is reasonable to use the values we adopt for density zones 3 through 9. As we discussed above, these values reflect cost data for density zones 3 through 9 and have been submitted to us by state commissions for use in this proceeding. These values are more reliable than those derived through the extrapolation of data reflecting density zones 1 and 2, and for the reasons discussed above, the company-specific data submitted on the record.

---

[827] *See* GTE *Inputs Further Notice* comments at 53.

[828] GTE contends that the model should rely on two sizes of poles in estimating aerial costs. GTE *Inputs Further Notice* comments at 51. GTE also recommends that the calculation of the number of poles for a given length of facility be modified. We find that there is insufficient evidence on the record at this time with regard to the type of pole used in a particular density zone to make a determination as to GTE's first recommendation. We may evaluate this, among other factors, and provide parties an opportunity to submit additional evidence on the record in the upcoming proceeding on future changes to the model. We also find that GTE's second recommendation represents a platform change which may be considered in the upcoming proceeding on future changes to the model.

[829] GTE *Inputs Further Notice* comments at 51.

[830] Cincinnati Bell *Inputs Further Notice* comments at 4.

[831] Sprint *Inputs Further Notice* comments at 30-31.

[832] SBC *Inputs Further Notice* comments at 10.

223. In reaching these conclusions, we note that AT&T and MCI advocate that we adjust the regressions used to estimate structure costs to reflect the buying power of large non-rural LECs.[833] We find that, because AT&T and MCI did not provide any data to support such a determination, the record is insufficient to determine that such an adjustment is necessary. We also reject AT&T and MCI's claim that the costs of underground structure are excessive because they fail to exclude manhole costs from the costs of underground distribution.[834] Contrary to AT&T and MCI's assertion, we find that manhole costs are necessary to allow for splicing when the length of the distribution cable exceeds minimum distance criteria adopted by the model.

224. Finally, we note, as described more fully above, that we have made adjustments to certain of the regression equations in the *Inputs Further Notice* from which we estimate structure costs in order to address certain of the criticisms reflected in the comments and improve the regression equations accordingly.[835]

225. LEC Loading Adjustment. In the *Inputs Further Notice*, we tentatively concluded that we should add a loading of ten percent to the material and labor cost (net of LEC engineering) for aerial, underground, and buried structure because the cost of LEC engineering was not reflected in the data from which Gabel and Kennedy derived their estimates.[836] We find that, based on the record before us, the LEC engineering adjustment is appropriate and the proposed level of the adjustment is reasonable. In reaching this conclusion, we reject at the outset the position of those commenters advocating that the adjustment be based on company-specific data. As we explained above, we find such data are not the most reliable data on the record.

226. As with the LEC adjustment proposed for cable costs discussed above, there is a general consensus on the record among the commenters that an adjustment is necessary. We find, therefore, that an adjustment to reflect the cost of LEC engineering is appropriate. Beyond the general claim that we should adopt company-specific data, there is divergence among the commenters regarding the appropriate level of this adjustment. GTE claims that the adjustment should be greater than 10 percent based on a comparison to its data for buried plant.[837] SBC

---

833 AT&T and MCI *Inputs Further Notice* comments at 23.

834 AT&T and MCI *Inputs Further Notice* comments at 24.

835 *See supra* at paragraphs 133-138.

836 *Inputs Further Notice* at paras. 109, 111, 114. We note that this adjustment is consistent with that made to aerial, underground, and buried cable.

837 GTE *Inputs Further Notice* comments at 53.

agrees that 10 percent is appropriate for aerial and buried structure but too low for underground structure.[838] SBC proposes a loading factor of 20 percent instead for underground structure. Based on our review of the information, it is our judgement that the 10 percent adjustment is the most reasonable value on the record before us to reflect the cost of LEC engineering.[839]

7. Plant Mix

a. Background

227. In the *Inputs Further Notice*, we explained that plant mix, i.e., the relative proportions of different types of plant in any given area, plays a significant part in determining total outside plant investment.[840] This is because the costs of cable and outside plant structure differ for aerial, buried, and underground cable and structure. The model provides three separate plant mix tables, for distribution, copper feeder, and fiber feeder, which can accept different plant mix percentages for each of the nine density zones.

228. Distribution Plant. In the *Inputs Further Notice*, we tentatively selected input values for distribution plant mix that more closely reflected the assumptions underlying BCPM's default values than HAI's default values.[841] Specifically, we tentatively proposed input values, for the lowest to the highest density zones, that range from zero percent to 90 percent for underground plant; 60 to zero percent for buried plant; and 40 to ten percent for aerial plant. We tentatively selected input values that more closely reflected the assumptions underlying the BCPM default values because the model does not design outside plant that contains either riser cable or block cable, so we did not believe it would be appropriate to assume that there is as high a percentage of aerial plant in densely populated areas as the HAI default values assume. Moreover, although our proposed plant mix values assumed somewhat less underground

---

838 SBC *Inputs Further Notice* comments at 10-11.

839 *See supra* paragraph 165.

840 *Inputs Further Notice* at para. 116.

841 In the *Inputs Further Notice*, we distinguished the BCPM default values for distribution plant from those reflected in the HAI model. *Inputs Further Notice* at para. 47. As we explained, the BCPM default values for distribution plant assume that there is no underground plant in the lowest density zone and the percentage increases with each density zone to 90 percent underground distribution plant in the highest density zone. In contrast, the HAI default values for distribution plant mix place no underground structure in the six lowest density zones and assume that only 10 percent of the structure in the highest density zone is underground. The BCPM default values assume there is no aerial plant in the highest density zone in normal and soft rock terrain, and 10 percent aerial plant in hard rock terrain. In contrast, the HAI default values assume that there is significantly more aerial cable, 85 percent, in the highest density zone, but notes that this includes riser cable within multi-story buildings and "block cable" attached to buildings, rather than to poles.

structure in the lower density zones than the BCPM default values, we disagreed with HAI's assumption that there is very little underground distribution plant and none in the six lowest density zones.

229. Feeder Plant. We tentatively selected input values for feeder plant mix that generally reflect the assumptions underlying the BCPM and HAI default plant mix percentages, with certain modifications.[842] We tentatively proposed input values, for the lowest to the highest density zones, that range from five percent to 95 percent for underground plant; 50 to zero percent for buried plant; and 45 to five percent for aerial plant. Based on our preliminary review of the structure and cable survey data,[843] the proposed values assume that there is no buried plant in the highest density zone. In contrast to the BCPM defaults, the proposed values assume there is some aerial plant in the three highest density zones. We tentatively found that it is reasonable to assume that there is some aerial feeder plant in all density zones, as HAI does, particularly in light of our assumption that there is no buried feeder in the highest density zone, where aerial placement would be the only alternative to underground plant. Although the HAI sponsors had proposed plant mix values that vary between copper feeder and fiber feeder, they offered no convincing rationale for doing so. We tentatively concluded that, like the BCPM defaults, our proposed plant mix ratios should not vary between copper feeder and fiber feeder.

230. Finally, we sought comment on alternatives to the nationwide plant mix input values we tentatively adopted. As we explained, the Commission tentatively concluded, in the *1997 Further Notice*, that plant mix ratios should vary with terrain as well as density zones.[844] Because the model does not provide separate plant mix tables for different terrain conditions, however, the nationwide plant mix values we proposed do not vary by terrain. We noted that one method of varying plant mix by terrain would be to add separate plant mix tables, as there are in BCPM, to the model. We observed that, while the BCPM model provides separate plant mix tables, the BCPM default values reflect only slightly more aerial and less buried plant in hard rock terrain than in normal and soft rock terrain. We suggested that another method of varying plant mix would be to use company-specific or state-specific input values for plant mix, as advocated by the BCPM sponsors and other LECs.

[842] As we explained in the *Inputs Further Notice*, the default plant mix percentages for feeder plant are generally similar in the BCPM and the HAI models. *Inputs Further Notice* at para. 120. Although the BCPM default values vary between normal or soft rock terrain and hard rock terrain, as noted above, and the HAI default values differ between copper and fiber feeder, the plant mix ratios across density zones are similar. For example, both the BCPM default values and the HAI default values assume that there is only five or ten percent of underground feeder plant in the lowest density zone. The HAI defaults assume there is somewhat more aerial feeder cable than the BCPM defaults, except for fiber feeder cable in the four lowest density zones. The BCPM defaults assume there is no aerial feeder plant in the three highest density zones, except in hard rock terrain. Despite these differences, the relative amounts of aerial and buried plant across density zones are generally similar.

[843] *See Inputs Further Notice*, Appendix C.

[844] *1997 Further Notice* at para. 122.

231. We also noted that, although we had generally chosen not to use study area specific input values in the federal mechanism, and we recognized that historical plant mix ratios may not reflect an efficient carrier's plant type choice today, historical plant mix might reflect terrain conditions that will not change over time. We explained that our analysis of current ARMIS data reveals a great deal of variability in plant mix ratios among the states. To that end, we recognized that US West had proposed an algorithm in certain state proceedings for adjusting plant mix to reflect its actual sheath miles as reported in ARMIS.[845] We sought comment on a modified version of this algorithm as an alternative to nationwide plant mix values.[846]

b. Discussion

232. As explained above, although we tentatively chose to adopt nationwide plant mix values, we presented and sought comment on an alternative algorithm based on sheath miles reported in ARMIS to develop plant mix values. Consistent with that alternative, GTE asserts that company-specific plant mix should be used instead of nationwide input values.[847] Similarly, Sprint contends that company-specific or state-specific plant mix values should be used.[848] US West asserts that the model should utilize study-area specific plant mix values that are available in ARMIS as a starting point for plant mix inputs in the model.[849]

233. We find, however, as discussed more fully below, because companies do not report aerial and buried route miles in ARMIS, that it is not possible to develop plant mix factors

[845] Structure distance, also known as route distance, measures the distance of the pole line or the trench. Sheath distance measures cable distance. If there is only one cable along a particular route then structure distance and sheath distance are equal. When, however, there is more than one cable along a route, sheath distance will be a multiple of the structure distance.

[846] The proposed algorithm uses ARMIS 43-08 data on buried and aerial sheath distances and trench distances to allocate model determined structure distance between aerial, buried, and underground structures. The first step is to set the underground structure distance equal to the ARMIS trench distance and to allocate that distance among the density zones on the basis of the nationwide plant mix defaults. Then an initial estimate of aerial plant is calculated as the sum of the synthesis model structure distances by density zone multiplied by the nationwide aerial plant mix defaults. A second estimate of aerial plant is calculated by multiplying structure distance less trench miles by the aerial percentage of total ARMIS sheath miles. Then an adjustment ratio is calculated by dividing the second estimate by the initial estimate. This adjustment ratio is then applied to each density zone to adjust the nationwide default so that the final synthesis model plant mix reflects the study area specific plant mix. The buried plant mix percentage is determined as a residual equal to one minus sum of the underground and aerial percentages.

[847] GTE *Inputs Further Notice* comments at 58.

[848] Sprint *Inputs Further Notice* comments at 34.

[849] US West *Inputs Further Notice* comments at 32-36.

directly from these data at this time. Moreover, we note that the record does not reflect company-specific plant mix values for all companies, nor has any commenter presented a methodology that recognizes the fact that plant mix varies across density zones and allocates it accordingly. In sum, we conclude that neither company-specific nor ARMIS-derived data represent reasonable alternatives to the use of nationwide inputs. We find, therefore, that the use of nationwide inputs is the most reasonable approach in developing plant mix values on the record before us.

234. US West claims that the plant mix algorithm we proposed places too much plant in aerial. US West traces this flaw to several alleged errors in the plant mix algorithm.[850] US West claims that the algorithm erroneously double weights the model plant mix. This is not an error as US West claims. Because the model results used in US West's analysis are based on the low aerial distribution input, we find that the double weight should result in low levels of aerial construction rather than high levels of aerial construction. US West also identifies several formulaic errors.[851] We find these errors attributable, however, to US West's lack of understanding of how the proposed algorithm works.[852] We agree, however, with US West that the high aerial results do appear to be a function of incorrectly weighting aerial plant. We find that this problem is a function of treating the aerial plant mix factor as a residual rather than directly estimating an aerial factor. Given this flaw, we conclude that we should not adopt the plant mix algorithm on which we sought comment.

235. As noted above, we sought comment on alternatives to nationwide plant mix input values.[853] US West has proposed two algorithms. As explained below, we find that each of these has its own biases and, therefore, that neither is a reasonable alternative to what we have proposed. In brief, US West's first algorithm takes the geometric mean of the national default and a structure ratio to determine the plant mix factor. It defines the structure ratio for underground plant as the ratio of ARMIS trench miles to model route miles; for buried and aerial plant the structure ratio is defined as the relative sheath miles of the structure type multiplied by the model route miles less the ARMIS trench miles. We find that the final result of this algorithm places too much underground structure because, for all but the lowest density zone, the underground plant mix factor is significantly higher than the ARMIS ratio. The second

[850] US West *Inputs Further Notice* comments, Attachment D.

[851] US West *Inputs Further Notice* comments, Attachment D.

[852] For example, the ARMIS buried ratio is not the ratio of model buried to the sum of model underground and model aerial as US West claims, but rather the ratio of model buried to the sum of model buried and model aerial. US West claims that the underground ratio is the ratio of ARMIS to model sheath miles. This is incorrect. It is the ratio of ARMIS trench miles to model route miles.

[853] *Inputs Further Notice* at para. 49.

algorithm US West proposes starts with the relative share of ARMIS sheath miles for all three structure types. It then establishes two series of fractions that sum to one. In the first series, the fractions increase as the density zone increases. This series is applied to underground structure and thus places more underground structure in the higher density zones. In the second series, the fractions decrease as the density zones increase. This series is applied to aerial structure, with the result that the percentage of aerial cable declines as density increases. For buried structure, the ARMIS ratio is used for all density zones. We find that this algorithm is flawed because it does not recognize the difference between sheath and route miles. As a consequence, the algorithm produces a biased result. Specifically, it constructs too much underground cable. We find that, until this problem is resolved, relying directly on ARMIS information leads to unreasonable results.

236. Distribution Plant. We adopt the proposed input values for distribution plant mix which are set forth in Appendix A. We conclude that these values for the lowest to the highest density zones, which range from zero percent to 90 percent for underground plant; 60 to zero percent for buried plant; and 40 to ten percent for aerial plant, are the most reasonable estimates of distribution plant mix on the record before us.

237. There is divergence among the commenters with regard to the appropriateness of the input values for the distribution plant mix proposed in the *Inputs Further Notice*. SBC supports the proposed distribution plant mix, noting that it "closely aligns with the embedded plant and future outside plant design."[854] AT&T and MCI advocate the use of the HAI default values for plant mix because, according to AT&T and MCI, they more properly reflect the use of aerial and underground cable than the proposed distribution plant mix inputs.[855] AT&T and MCI claim that the proposed inputs reflect too much underground and too little aerial cable. As we explained in the *Inputs Further Notice*, the model does not design outside plant that contains either riser cable or block cable. Accordingly, use of the HAI default values, which assume a high percentage of aerial plant in densely populated areas, would be inconsistent with the model platform. AT&T and MCI ignore this fact.

238. In the *Inputs Further Notice,* we stated that we disagreed with HAI's assumption that there is very little underground distribution plant and none in the six lowest density zones.[856] In support of the HAI values for underground distribution plant, AT&T and MCI proffer the distribution plant mix values for BellSouth, notably the only company to provide such data, showing that its underground distribution plant mix value is very low. We find that, because we are not adopting a company-specific algorithm, it is not necessary to address this issue. As noted

[854] SBC *Inputs Further Notice* comments at 11.

[855] AT&T and MCI *Inputs Further Notice* comments at 25.

[856] *Inputs Further Notice* at para. 119.

above, we will not adopt an alternative algorithm until the issue of underground structure distances has been resolved. We adhere to employing a national value because we find that, though it may not be exact for every company, it will be reasonable for all companies.

239. Feeder Plant. We also adopt the proposed input values for feeder plant mix which are set forth in Appendix A. We conclude that these values for the lowest to the highest density zones, which range from five percent to 95 percent for underground plant; 50 to zero percent for buried plant; and 45 to five percent for aerial plant, are the most reasonable estimates of distribution plant mix on the record before us. GTE's and Sprint's comments specifically address the specific issue of feeder plant mix inputs. As noted above, both carriers advocate the use of company-specific data for plant mix.[857] We reject the use of such data for feeder plant mix for the reasons we enumerate above.

240. Finally, we affirm our tentative conclusion that the plant mix ratios should not vary between copper feeder and fiber feeder. In reaching our tentative conclusion, we noted that, although the HAI sponsors proposed plant mix values that vary between copper feeder and fiber feeder, they have offered no convincing rationale for doing so. We find such support still lacking. GTE claims that a distinction is necessary because the existing plant mix indicates that the trend for more out-of-sight construction has already resulted in differing copper and fiber feeder plant mixes.[858] In contrast, SBC contends that plant mix ratios should not vary between copper feeder and fiber feeder because existing structure is used whenever available for fiber and copper placement so the mix ratio would not differ.[859] We find neither of these claims to be persuasive. Accordingly, we conclude that, given the absence of controverting evidence, it is reasonable to assume that plant mix ratios should not vary between copper feeder and fiber feeder in the model.

D. Structure Sharing

1. Background

241. Outside plant structures are generally shared by LECs, cable operators, electric utilities, and others, including competitive access providers and interexchange carriers. To the extent that several utilities place cables in common trenches, or on common poles, it is appropriate to share the costs of these structures among the various users and assign a portion of the cost of these structures to the telephone company.

---

[857] GTE *Inputs Further Notice* comments at 58; Sprint *Inputs Further Notice* comments at 34.

[858] GTE *Inputs Further Notice* comments at 59.

[859] SBC *Inputs Further Notice* comments at 11.

242. In the *Inputs Further Notice*, the Commission tentatively adopted structure sharing values for aerial, buried, and underground structure.[860] Several comments relating to these values were filed in response to the *Inputs Further Notice*. Both the BCPM and HAI models varied the percentage of costs they assume will be shared depending on the type of structure (aerial, buried, or underground) and line density.[861] Commenters differ significantly, however, on their assumptions as to the extent of sharing and, therefore, the percentage of structure costs that should be attributed to the telephone company in a forward-looking cost model.[862]

2. Discussion

243. We adopt the following structure sharing percentages that represent what we find is a reasonable share of structure costs to be incurred by the telephone company. For aerial structure, we assign 50 percent of structure cost in density zones 1-6 and 35 percent of the costs in density zones 7-9 to the telephone company.[863] For underground and buried structure, we assign 100 percent of the cost in density zones 1-2, 85 percent of the cost in density zone 3, 65 percent of the cost in density zones 4-6, and 55 percent of the cost in density zones 7-9 to the telephone company.[864] In doing so, we adopt the sharing percentages we proposed in the *Inputs Further Notice*, except for buried and underground structure sharing in density zones 1 and 2, as explained below.

244. Commenters continue to diverge sharply in their assessment of structure sharing.[865] As noted by US West, "[s]ince forward-looking sharing percentages for replacement of an entire network are not readily observable, there is room for reasonable analysts to differ on

[860] *Inputs Further Notice* at para. 129.

[861] *See* HAI Dec. 11, 1997 submission, Appendix B at 57; BCPM Jan. 31, 1997 submission, Attachment 9. The BCPM sponsors assume that an efficient telephone company will benefit only marginally from sharing. The HAI sponsors assume that utilities will engage in substantial sharing with telephone companies, and generally assigns between 25% and 50% of the cost of shared facilities to the LEC.

[862] *See, e.g.*, AT&T/MCI *Inputs Further Notice* comments at 28-31; Bell Atlantic *Inputs Further Notice* comments at 18; GTE *Inputs Further Notice* comments at 57; SBC *Inputs Further Notice* comments at 11.

[863] The model uses nine density zones, ranging from the lowest density zone (1) to the highest density zone (9). The nine density zones (measured in terms of the number of lines per square mile) are as follows: (1) zero - 4.99; (2) 5 - 99.99; (3) 100 - 199.99; (4) 200 - 649.99; (5) 650 - 849.99; (6) 850 - 2549.99; (7) 2550 - 4999.99; (8) 5000 - 9,999.99; (9) 10,000+.

[864] *See* Appendix A for a complete list of the input values that we adopt in this Order.

[865] *See, e.g.*, AT&T/MCI *Inputs Further Notice* comments at 28-31; Bell Atlantic *Inputs Further Notice* comments at 18; GTE *Inputs Further Notice* comments at 57; SBC *Inputs Further Notice* comments at 11.

the precise values for those inputs."[866] While commenters engage in lengthy discourse on topics such as whether the model should assume a "scorched node" approach in developing structure sharing values, little substantive evidence that can be verified has been added to the debate.[867] AT&T and MCI contend that the structure sharing percentages proposed in the *Inputs Further Notice* assign too much of the cost to the incumbent LEC and fail to reflect the greater potential for sharing in a forward-looking cost model.[868] In contrast, several commenters contend that the proposed values assign too little cost to the incumbent LEC and reflect unrealistic opportunities for sharing.[869] In support of this contention, some LEC commenters propose alternative values that purport to reflect their existing structure sharing percentages, but fail to substantiate those values. SBC, however, claims that the structure sharing percentages we propose reflect its current practice and concurs with the structure sharing values that we adopt in this Order.[870]

245. More than with other input values, our determination of structure sharing percentages requires a degree of predictive judgement. Even if we had accurate and verifiable data with respect to the incumbent LECs' existing structure sharing percentages, we would still need to decide whether or not those existing percentages were appropriate starting points for determining the input values for the forward-looking cost model.[871] AT&T and MCI argue that past structure sharing percentages should be disregarded in predicting future structure sharing

[866] US West *Inputs Further Notice* comments at 28.

[867] In general, the "scorched node or utilities" debate concerns whether the model should assume that all utilities are non-existent in developing structure sharing percentages. Commenters contend that if the model assumes that everything is in place except for the telecommunications network, then the sharing percentages used in the model should reflect fewer opportunities for sharing because it would not be possible to coordinate sharing with other utilities in the development of a new network. In particular, opportunities for sharing of underground and buried structure would be limited. *See* BellSouth *Inputs Further Notice* comments at 8-9; GTE *Inputs Further Notice* comments at 18-21; US West *Inputs Further Notice* comments at 28-29. While this may provide an interesting topic for academic debate, we do not believe it to be particularly useful or relevant in determining the structure sharing values in this proceeding. We note that, as part of the logical argument that the entire telephone network is to be rebuilt, it is also necessary to assume that the telephone industry will have at least the same opportunity to share the cost of building plant that existed when the plant was first built. We also note that cable and electric utilities continue to deploy service to new customers and replace existing technologies which provides an opportunity for carriers to share structure.

[868] AT&T/MCI *Inputs Further Notice* comments at 28.

[869] *See, e.g.*, BellSouth *Inputs Further Notice* comments, Attachment B at B-13; Sprint *Inputs Further Notice* comments at 36-39; US West *Inputs Further Notice* comments at 29-32.

[870] SBC *Inputs Further Notice* comments at 11.

[871] In contrast, when developing inputs for tangible components of the network, we generally begin our analysis with an estimation of the cost of today's technology at today's prices.

opportunities. Incumbent LEC commenters argue that sharing in the future will be no more, and may be less, than current practice.

246. In the *Inputs Further Notice*, we relied in part on the deliberations of a state commission faced with making similar predictive judgment relating to structure sharing.[872] The Washington Utilities and Transportation Commission, conducted an examination of these issues and adopted sharing percentages similar to those we proposed.[873]

247. In developing the structure sharing percentages adopted in this Order, we find the sharing percentages proposed by the incumbent LECs to be, in some instances, overly conservative. While we do not necessarily agree with AT&T and MCI as to the extent of available structure sharing, we do agree that a forward-looking mechanism must estimate the structure sharing opportunities available to a carrier operating in the most-efficient manner. As discussed in more detail in this Order, the forward-looking practice of a carrier does not necessarily equate to the historical practice of the carrier.[874] Given the divergence of opinion on this issue, and of AT&T and MCI's contention that further sharing opportunities will exist in the future, we have made a reasonable predictive judgment, and also anticipate that this issue will be revisited as part of the Commission's process to update the model in a future proceeding.

248. In the 1997 *Further Notice*, the Commission tentatively concluded that 100 percent of the cost of cable buried with a plow should be assigned to the telephone company.[875] In the *Inputs Further Notice*, we sought comment on the possibility that some opportunities for sharing existed for buried and underground structure in the least dense areas and proposed assignment of 90 percent of the cost in density zones 1-2 to the telephone company.[876] Several commenters contend that there are minimal opportunities for sharing of buried and underground structure, particularly in lower density areas.[877] In addition, several commenters contend that, to

[872] *Inputs Further Notice* at para. 130.

[873] *See* Washington USF Proceeding, Tenth Supplemental Order, Docket No. UT-980311(a) at para. 108. *See also* Washington Utilities and Transportation Commission, Eighth Supplemental Order, Docket No. UT-960369 at paras. 73-76 (1998).

[874] *See* Washington Utilities and Transportation Commission, Eighth Supplemental Order, Docket No. UT-960369 (1998) at para. 73 (proposing a range of sharing values "which reflects the balance between maximum achievable structure sharing and the amount of structure sharing achieved historically.").

[875] *1997 Further Notice*, 12 FCC Rcd at 18547, para. 80.

[876] *Inputs Further Notice* at paras. 129-132.

[877] *See, e.g.*, Bell Atlantic *Inputs Further Notice* comments at 19; BellSouth *Inputs Further Notice*, Attachment B at B-14; GTE *Inputs Further Notice* comments at 56-57.

the extent sharing is included in the RUS data, it is inappropriate to count that sharing again in the calculation of structure cost.[878] While we agree that structure sharing should not be double counted, we note that the RUS data includes little or no sharing of underground or buried structure in density zones 1-2.[879] This does, however, support the contention of commenters that there is, at most, minimal sharing of buried and underground structure in these density zones.[880] We therefore modify our proposed input value in this instance and assign 100 percent of the cost of buried and underground structure to the telephone company in density zones 1-2.

249. We believe that the structure sharing percentages that we adopt reflect a reasonable percentage of the structure costs that should be assigned to the LEC. We note that our conclusion reflects the general consensus among commenters that structure sharing varies by structure type and density. While disagreeing on the extent of sharing, the majority of commenters agree that sharing occurs most frequently with aerial structure and in higher density zones.[881] The sharing values that we adopt reflect these assumptions. SBC also concurs with our proposed structure sharing values.[882] In addition, as noted above, the Washington Utilities and Transportation Commission has adopted structure sharing values that are similar to those that we adopt.[883] We also note that the sharing values that we adopt fall within the range of default values originally proposed by the HAI and BCPM sponsors.

E. Serving Area Interfaces

1. Background

250. A serving area interface (SAI) is a centrally located piece of network equipment that acts as a physical interface between a feeder cable connecting a wire center and neighborhood distribution copper cables.[884] The model includes appropriate investment for SAIs

[878] Ameritech *Inputs Further Notice* comments at 12; Sprint *Inputs Further Notice* at 38; US West *Inputs Further Notice* comments, Attachment A at 8.

[879] NRRI Study at 30-31.

[880] *See* GTE *Inputs Further Notice* comments at 57; Sprint *Inputs Further Notice* comments at 39 (noting that the RUS data demonstrates that there are few sharing opportunities in rural areas).

[881] *See, e.g.*, HAI Dec. 11, 1997 submission, Appendix B at 57; BCPM Jan. 31, 1997 submission, Attachment 9; Montana State Cost Study at 46-47.

[882] SBC *Inputs Further Notice* comments at 11.

[883] *See* Washington USF Proceeding, Docket No. UT-980311(a), Appendix D.

[884] Generally, when a neighborhood is located near a wire center, copper feeder cable, using analog transmission, is deployed to connect the wire center to the SAI. From the SAI, copper cables of varying gauge

in all serving areas, whether served by copper or fiber feeder cable.

251. As we explained in the *Inputs Further Notice*, both the sponsors of BCPM and HAI submitted default input values for indoor and outdoor SAI costs.[885] In addition, Sprint submitted cost estimates for a 7200 pair indoor SAI.[886] Because the cost of an SAI depends on the cost of its components, we tentatively concluded that, in the absence of contract data between the LECs and suppliers, it was necessary to evaluate the cost of these components.[887] We posted preliminary ranges of SAI input values on the Commission's Web site to elicit comment and empirical data from interested parties on the cost of SAIs.[888] The Bureau also conducted a workshop on December 11, 1998, to discuss the posted preliminary inputs.[889] Accordingly, our analysis began with a review of the data and justifications submitted by the HAI sponsors and Sprint regarding the cost of the components that comprise a 7200 pair indoor SAI.[890] Specifically, we reviewed the cost of the following SAI components for a 7200 pair indoor SAI: building entrance splicing and distribution splicing; protectors; tie cables; placement of feeder blocks; placement of cross-connect jumpers/punch down; and placement of distribution blocks. Of these, we tentatively concluded that protector and splicing costs are the main drivers of SAI costs, and cross-connect costs and feeder block and distribution block installation costs greatly contribute to the difference in Sprint's and the HAI proponents' indoor SAI costs.[891]

extend to all of the customer premises in the neighborhood.

[885] *Inputs Further Notice* at para. 134.

[886] *Inputs Further Notice* at para. 134 n. 242 *citing Indoor SAI Cost Analysis,* submitted by Sprint - Local Telecommunications Division, July 30, 1998.

[887] *Inputs Further Notice* at para. 134.

[888] *Workshop Public Notice* at 2. We used BCPM default inputs as the low end of the ranges for both indoor and outdoor SAIs, and Sprint's cost estimates as the high end of the range for indoor SAIs. The high end of the range for outdoor SAIs represented our analysis of state-approved SAI parameters. Our preliminary ranges for SAI costs did not include HAI inputs because staff concluded that HAI had not included all of the materials and splicing required to install this equipment.

[889] *See Common Carrier Bureau Releases Preliminary Common Input Values to Facilitate Selection of Final Input Values for the Forward-Looking Cost Model for Universal Service*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 99-295 (rel. Feb. 5, 1999) (*Preliminary Input Values Public Notice*); *Workshop Public Notice*. S*ee also* Preliminary Input Values Handouts, dated December 11, 1998.

[890] We noted that the BCPM defaults do not specify estimates for the cost of SAI components. *Inputs Further Notice* at para. 134 n. 243.

[891] *Inputs Further Notice* at para. 136. *See Inputs Further Notice,* Appendix D, section IV for a breakdown of costs for each component calculated to derive the proposed cost of a 7200 pair DLC.

252. In the *Inputs Further Notice*, we also proposed to determine the costs of the other SAI sizes by extrapolating from the cost of the 7200 pair indoor SAI because we did not have similar component-by-component data for other SAI sizes.[892] We found that this appeared to be a reasonable approach because of the linear relationship between splicing and protection costs, which are the main drivers of cost, and the number of pairs in the SAI.[893]

2. Discussion

253. We affirm our approach to derive the cost of an SAI on the basis of the cost of its components and adopt a total cost of $21,708 for the 7200 pair indoor SAI. We find that there remains an absence of contract data between the LECs and suppliers with regard to SAIs on the record before us.[894] Accordingly, we affirm, as discussed in more detail below, our tentative conclusions with respect to the following issues: (1) the cost per pair for protector material; (2) the appropriate splicing rate and corresponding labor rate; (3) the methodology employed in cross-connecting in a SAI; and (4) the appropriate feederblock and distribution installation rate.

254. Based on the record before us, we conclude that $4 per pair is a reasonable estimate of the cost for protected material. As we explained in the *Inputs Further Notice*, this estimate is based on an analysis of *ex parte* submissions, which is the only evidence we have available to evaluate the cost of SAI components.[895] We also noted that Sprint has agreed that $4 is a reasonable estimate of the cost.[896] SBC and AT&T and MCI concur with our tentative conclusion to adopt the $4 per pair cost.[897] In sum, the record fully supports our conclusion that

[892] *Inputs Further Notic*e at para. 141.

[893] As we explained in the *Inputs Further Notice*, we relied on HAI data to determine the relationship in cost among the various sizes of SAI. Specifically, we developed a ratio of our proposed cost for a 7200 pair indoor SAI to the cost proposed by HAI. We then proposed to apply this ratio, 2.25, to the values submitted by the HAI sponsors for other sizes of indoor and outdoor SAIs. Applying this factor, we tentatively adopted the cost estimates for indoor and outdoor SAIs. We proposed to use the HAI, rather than BCPM data, in this manner because BCPM had not submitted estimates for all of the SAI sizes used in the model. We noted that using the BCPM data in this way would result in roughly the same cost estimates for indoor and outdoor SAIs. *Inputs Further Notice* at para. 141.

[894] BellSouth and Bell Atlantic submitted SAI costs in their comments. However, neither party provided any support for these values which reflect total SAI costs. *See* BellSouth *Inputs Further Notice* comments at Exhibit 1; Bell Atlantic *Inputs Further Notice* comments, Attachment D at 7.

[895] *Inputs Further Notice* at para. 134-135.

[896] *See* Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated February 4, 1999 (Sprint Feb. 4, 1999 *ex parte)*.

[897] SBC *Inputs Further Notice* comments at 12. AT&T and MCI support the SAI costs tentatively adopted.

$4 per pair is a reasonable estimate of the cost for protector material.

255. We also conclude that the record demonstrates that a splicing rate of 250 pairs is reasonable, and adopt it accordingly. As we explained in the *Inputs Further Notice*, the HAI sponsors proposed a splicing rate of 300 pairs per hour, while Sprint argued for a splicing rate of 100 pairs per hour.[898] We believed that HAI's proposed rate was a reasonable splicing rate under optimal conditions, and therefore, we tentatively concluded that Sprint's proposed rate was too low.[899] We noted that the HAI sponsors submitted a letter from AMP Corporation, a leading manufacturer of wire connectors, in support of the HAI rate.[900] We recognized, however, that splicing under average conditions does not always offer the same achievable level of productivity as suggested by the HAI sponsors. For example, splicing is not typically accomplished under controlled lighting or on a worktable. Having accounted for such variables, we proposed a splicing rate of 250 pairs per hour.

256. AT&T and MCI, the proponents of the 300 pairs per hour rate, support our tentative conclusion.[901] Sprint takes issue with the splicing rate we proposed.[902] Sprint impugns the evidence, appearing in the form of a letter from AMP Corporation on which we relied in part, to determine a reasonable splicing rate.[903] In sum, Sprint contends the letter represents an "unsupported claim of someone trying to sell equipment."[904] While Sprint is correct that the proponent is an equipment manufacturer, neither Sprint nor any other commenter provided evidence from any other equipment manufacturer to refute AMP.

AT&T and MCI *Inputs Further Notice* reply comments at 28.

[898] *Inputs Further Notice* at para. 138 n. 250 *citing* Letter from Chris Frentrup, MCI WorldCom, to Magalie Roman Salas, FCC, dated January 21, 1999; Letter from Kenneth T. Cartmell, U S West, dated February 8, 1999, to Magalie Roman Salas, FCC; Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC dated February 4, 1999. On January 20, 1999, the sponsors of HAI provided a demonstration of splicing, in support of their splicing rate.

[899] *Inputs Further Notice* at para. 138.

[900] *Inputs Further Notice* at para. 138 n. 251 *citing* attachment to letter from Chris Frentrup, MCI WorldCom, to Magalie Roman Salas, FCC, dated January 21, 1999.

[901] AT&T and MCI *Inputs Further Notice* reply comments at 29.

[902] In its February 9 *ex parte* noted above, US West proposed a splicing rate of 150 pairs per hour, slightly higher than Sprint's proposed rate.

[903] Sprint *Inputs Further Notice* comments at 40. The letter from AMP Corporation was submitted by the HAI sponsors. *See Inputs Further Notice* at para. 138 n. 251.

[904] Sprint *Inputs Further Notice* comments at 40.

257. Sprint also questions the fact that we did not utilize the data available from the NRRI Study to determine the splicing rate.[905] Sprint maintains that an analysis of that data results in a splicing rate of 58.8 pairs per hour, substantially less than the 300 pairs per hour we recognized as a ceiling in our analysis. We based our proposed splicing rate on an analysis of such rates as they relate specifically to the installation of a complete and functional SAI. In contrast, although the data to which Sprint refers is for modular splicing, it is not clear, nor does Sprint claim, that such data specifically relates to the installation of SAIs. In sum, the validity of this data as a measure in the derivation of splicing rates for SAI installation is not established on the record. Sprint's critique ignores this fact. Accordingly, we reject the use of the data available from the NRRI Study to determine the splicing rate.

258. We also conclude that the $60 per hour labor rate we proposed for splicing is reasonable and adopt it accordingly. Those commenters addressing this specific issue agree.[906] As we explained in the *Inputs Further Notice*, this rate, which equates with the prevalent labor rate for mechanical apprentices, is well within the range of filings on the record.[907]

259. We also conclude that the model should assume that a "jumper" method will be used half the time and a "punch down" method will be used the remainder of the time to cross-connect an SAI. A cross-connect is the physical wire in the SAI that connects the feeder and distribution cable.

260. In the *Inputs Further Notice*, we tentatively concluded that neither the jumper method nor the punch down method is used exclusively in SAIs.[908] We reached this tentative conclusion based on the conflicting assertions of Sprint and the HAI sponsors. We noted that, Sprint asserted that the "jumper" method generally will be employed to cross-connect in a SAI.[909] In contrast, the HAI sponsors claimed that the "punch down" method is generally used to cross-connect.[910] We also noted that, in buildings with high churn rates, such as commercial buildings, carriers may be more likely to use the jumper method. On the other hand, in residential buildings, where changes in service are less likely, carriers may be more likely to use the less expensive punch down method. Thus, we tentatively concluded that it appeared that

[905] Sprint *Inputs Further Notice* comments at 40.

[906] *See e.g.*, SBC *Inputs Further Notice* comments at 12; AT&T and MCI *Inputs Further Notice* reply comments at 28.

[907] *Inputs Further Notice* at para. 138.

[908] *Inputs Further Notice* at para. 139.

[909] *Inputs Further Notice* at para. 139.

[910] *Inputs Further Notice* at para. 139.

both methods are commonly used, and that neither is used substantially more than the other.[911]

261. Based on the record before us, we affirm our tentative conclusion to assume that the "jumper" method and the "punch down" method will be used an equal portion of the time.[912] SBC challenges this conclusion, pointing out that it uses the "jumper" method in applications involving hard lug or insulation displacement contact and that it is currently replacing existing "punch down" interfaces.[913] We conclude that SBC's sole claim is not sufficient to demonstrate that the "jumper" method is used substantially more than the "punch down" method. We note also that Sprint contends that the cross-connect proposed by AT&T and MCI is not an SAI, but a building entrance terminal.[914] We disagree. The design meets the SAI definition of providing an interface between distribution and feeder facilities. In sum, we find that the record demonstrates that it is reasonable for the model to assume that a "jumper" method will be used half the time and a "punch down" method will be used the remainder of the time to cross-connect an SAI.

262. We also adopt a feeder block and distribution installation rate of 200 pairs per hour. As we explained in the *Inputs Further Notice*, we derived this installation factor based on a comparison of Sprint's proposed installation rate of 60 pairs per hour with HAI's proposed 400 pair per hour rate.[915] We concluded that, because neither feeder block installation nor distribution block installation is a complicated procedure, Sprint's rate of 60 pairs per hour is too low. We also recognized that installation conditions are not always ideal. As we explained, feeder block and distribution block installations are not typically accomplished under controlled lighting or on a worktable. We proposed a rate of 200 pairs per hour to recognize these variables.[916]

263. We note that our proposed feeder block and distribution block rates are unchallenged. Significantly, SBC attests that this installation rate aligns with time-in-motion studies performed in cross-connect building applications.[917] We conclude, therefore, that our proposed rate is reasonable, and adopt input values based upon it accordingly.

911 *Inputs Further Notice* at para. 139.

912 *See Inputs Further Notice*, Appendix D, section IV to see how this conclusion is used to determine proposed costs for a 7200 pair SAI.

913 SBC *Inputs Further Notice* comments at 12.

914 Sprint *Inputs Further Notice* comments at 40-41.

915 *Inputs Further Notice* at para. 140.

916 *See Inputs Further Notice*, Appendix D, section IV to see how this value is used in the calculation of a 7200 pair SAI.

917 SBC *Inputs Further Notice* comments at 12.

264. We also adopt the cost estimates for other size indoor and outdoor SAIs tentatively adopted in the *Inputs Further Notice*.[918] We conclude that, based on the record before us, the derivation of the costs of the other SAI sizes from the cost of the 7200 pair indoor SAI is reasonable.

265. GTE takes issue with the derivation of the costs of the other SAIs from the cost of the 7200 pair indoor SAI.[919] First, GTE contends that there is no need to extrapolate the costs of other SAIs because the costs of individual SAI sizes and associated labor are readily available.[920] We disagree. We concluded that it was necessary to extrapolate the costs of other SAI sizes from the cost of a 7200 pair SAI because of the lack of component-by-component data for other SAI sizes on the record. As noted above, we find the record still lacks such data. We also disagree with GTE's contention that SAI costs are not subject to a linear relationship across all sizes as we determined.[921] We find GTE's contention, which relies on GTE's SAI estimates, unpersuasive given the lack of substantiating data supporting these estimates.[922] In sum, the record demonstrates that the derivation of the costs of the other SAIs from the cost of the 7200 pair indoor SAI is reasonable.

266. US West contends that the costs of a SAI should be determined by the actual cable sizes for the cables entering and leaving the SAI rather than the number of cable pairs entering and leaving the interface.[923] We agree. The model has been revised to calculate the costs of an SAI on the basis of actual cable sizes for the cables entering and leaving the SAI.

267. US West raises an additional issue concerning the sizing of SAIs. US West notes that some clusters created by the clustering module exceed the default line limit of 1800 lines and gives as an example a specific cluster containing 7,900 lines.[924] The largest SAI can

---

[918] *Inputs Further Notice* at para. 141. These cost estimates are contained in Appendix A of the *Inputs Further Notice*.

[919] GTE *Inputs Further Notice* comments at 61.

[920] GTE *Inputs Further Notice* comments at 61.

[921] GTE *Inputs Further Notice* comments at 61.

[922] We note that in contrast to GTE's claim, the SAI costs reflected in BellSouth's comments reflect linearity.

[923] US West *Inputs Further Notice* comments at 15-16.

[924] US West *Inputs Further Notice* comments at 14; US West *Inputs Further Notice* comments at 16; Letter from Kenneth T. Cartmell, US West, to Magalie Roman Salas, FCC, dated September 24, 1999 (US West September 24 *ex parte*) at 12.

accommodate only 7200 lines, counting both feeder side and distribution side lines. Therefore, US West contends that, in situations such as this, insufficient SAI plant is deployed by the model. We agree with this analysis. There is no way to guarantee that the line limit of 1800 lines will not be exceeded for some clusters, even though modifications have been made to the cluster algorithm to mitigate this possibility to the greatest possible extent. Therefore, in the current version of the model, we modify the input table for SAI costs so as to allow for serving areas (clusters) in which the capacity of feeder cable plus distribution cable meeting at the interface may exceed 7200. We do this by allowing for line increments of 1800 up to a total line capacity of 28,800. The values in the input table assume that, whenever more than 7200 lines are required in an SAI, two or more standard SAIs are built, one with full capacity of 7200 and the others with capacities equal to 1800, 3600, 5400 or 7200. The input values for each of the multiply-placed SAIs are then summed.

268. A related issue is raised by US West with respect to drop terminal capacity in the model.[925] In previous versions of the model, drop terminals were sized for residential housing units and small business locations, with a maximum line capacity per drop location equal to 25 lines. For medium size and larger business locations with line demand greater than 25 lines, no specific provision for additional drop terminal capacity was provided, except in situations in which a single business accounted for all of the lines in a single cluster. Again, we agree with the US West analysis of this issue. Accordingly, we have modified the input table for drop terminal costs by adding additional line sizes equal to 50, 100, 200, 400, 600, 900, 1200, 1800, 2400, 3600, 5400, and 7200. At any location requiring a drop terminal with capacity exceeding 25 lines, the model will assume that the location will be served by an indoor SAI, and the cost of the corresponding interface is equal to the corresponding value from the table for SAI costs.

F. Digital Loop Carriers

1. Background

269. A digital loop carrier (DLC) is a piece of network equipment that converts an optical digital signal carried on optical fiber cable to an analog, electrical signal that is carried on copper cable and is compatible with customers' telephones.[926] Because of the high cost of DLCs, a single DLC is shared among a number of customers where possible. The model uses fiber

[925] US West September 24 *ex parte* at 12.

[926] Optical fiber cable carries a digital signal that is incompatible with most customers' telephone equipment, but the quality of the signal degrades less with distance compared to a signal carried on copper wire. Generally, when a neighborhood is located too far from the wire center to be served by copper cables alone, an optical fiber cable will be deployed to a point within the neighborhood, where a DLC will be placed to convert incoming digital signals to analog signals and outgoing analog signals to digital. From the DLC, copper cables of varying gauge extend to all of the customer premises in the neighborhood.

cable and DLCs whenever it calculates that this configuration is cheaper than using copper cable or when the distance between the customer and the wire center exceeds the maximum copper loop length. When using DLCs, the model determines the size and number of DLCs that should be installed at a location, based on cost minimization and engineering constraints. In designing outside plant, the model uses five different sizes of DLCs.[927] In order to run the model, a user must input the fixed and per-line cost for each of these DLC sizes. The total cost of a particular DLC is determined by multiplying the number of lines connected to the DLC times the per-line cost of the DLCs, and then adding the fixed cost of the DLC.

270. In the *Inputs Further Notice*, we tentatively concluded that we should estimate the costs for DLCs based on an average of the contract data submitted on the record, adjusted for cost changes over time.[928] These contract data included data submitted to the Commission in response to the *1997 Data Request*,[929] and in *ex parte* submissions following the December 11, 1998 workshop we sponsored, to estimate the costs of DLCs in the model.[930] We found these data to be the most reliable proffered at that time.[931] We rejected use of the BCPM and HAI default values because these values are based on the opinions of experts without data to enable us to substantiate those opinions.[932] Additionally, we rejected data submitted by the HAI sponsors following the workshop.[933] We found the data submitted by the HAI sponsors to be significantly lower than the contract data on the record, and concluded that it would be inappropriate to use the data submitted by the HAI sponsors, especially as no support was provided to justify use of the data.[934]

[927] The current version of the model supports a fifth DLC size in addition to those already supported. DLC capacities currently supported are 2016, 1344, 672, 96, and 24 line facilities.

[928] *Inputs Further Notice* at para. 144.

[929] In response to the *1997 Data Request*, Ameritech, Bell Atlantic (including NYNEX), BellSouth, SBC, US West, GTE, Sprint, ATU, and PRTC originally submitted data to the Commission on DLC costs in 1997. Bell South, US West and ATU resubmitted their data on the record of this proceeding subject to the *Protective Order*. *See* Letter from William W. Jordan, BellSouth, to Magalie Roman Salas, FCC, dated March 15, 1999; Letter from Robert B. McKenna, US West, to Magalie Roman Salas, FCC, dated March 8, 1999; Letter from Alane C. Weixel, counsel for ATU, to Magalie Roman Salas, FCC, dated May 6, 1999 (ATU May 6, 1999 *ex parte*).

[930] Letter from W. Scott Randolph, GTE, to Magalie Roman Salas, FCC, dated February 11, 1998; Letter from Robert A. Mazer and Albert Shuldiner, Counsel for Aliant, to Magalie Roman Salas, FCC, dated February 8, 1998.

[931] *Inputs Further Notice* at para. 143.

[932] *Inputs Further Notice* at para. 143.

[933] *Inputs Further Notice* at para. 144.

[934] *Inputs Further Notice* at para. 144.

271. In reaching our tentative conclusion to use the contract data, we noted that, although we would have preferred to have a larger sampling of data, the contract data represent the costs incurred by several of the largest non-rural carriers, as well as two of the smallest non-rural carriers.[935] We noted that, throughout this proceeding, the Commission had repeatedly requested cost data on DLCs, largely to no avail.[936] Finally, we stated our belief that the data on which we relied was the best data available on the record to determine the cost of DLCs.[937]

272. In the *Inputs Further Notice*, we also recognized that the cost of purchasing and installing a DLC changes over time.[938] We explained that such changes occur because of improvements in the methods and components used to produce DLCs, changes in both capital and labor costs, and changes in the functionality requirements of DLCs. Accordingly, we tentatively concluded that it is appropriate to adjust the contract data, which represents the years 1995-1998, to reflect 1999 prices.[939] We proposed a 2.6 percent annual reduction in both fixed DLC cost and per-line DLC cost in order to capture changes in the cost of purchasing and installing DLCs over time.[940] We based this rate on the change in cost calculated for electronic digital switches over a four year period. We noted our belief that the change in the cost of these switches over time is a reasonable proxy for changes in DLC cost, because they are both types of digital telecommunications equipment. We also noted that the 2.6 percent figure is a conservative estimate, based on the change in cost of remote switches. Our analysis suggested that the change in cost of host switches over the past four years is much higher. Finally, we noted that use of the current consumer price index results in a similar figure over four years.[941] The indexed amount is based on the effective date of the contracts.

---

[935] *Inputs Further Notice* at para. 144.

[936] *Inputs Further Notice* at para. 144. In addition to the data submitted in response to the *1997 Data Request*, and following the December 11, 1998, workshop, the Bureau requested further data on DLC costs in the *1997 Further Notice* and in the *Inputs Public Notice*. *See also Preliminary Input Values Public Notice*.

[937] *Inputs Further Notice* at para. 144. Only US West, BellSouth, and ATU presented their contract data from the *1997 Data Request* in a useable format Some of the data and comments that were submitted in response to the *1997 Data Request*, but not re-filed on the record under the *Protective Order*, could not be used because the data were either inadequate or presented in a format from which we could not extract relevant information. *Inputs Further Notice* at para. 144 n. 262.

[938] *Inputs Further Notice* at para. 145.

[939] *Inputs Further Notice* at para. 146.

[940] *Inputs Further Notice* at para. 146.

[941] *Inputs Further Notice* at para. 146.

273. Finally, we also sought comment on the extent, if any, to which we should increase our proposed estimates for DLCs to reflect material handling and shipping costs.[942] We did this in response to comments submitted by ATU. It was unclear whether the DLC data submitted by other parties included these costs. ATU suggested that these costs could represent up to 10 percent of the material cost of a DLC.[943]

2. Discussion

274. We adopt an average of the contract data submitted on the record, adjusted for cost changes over time, as the cost estimates for DLCs. This decision is predicated on two conclusions. The first is our determination that the contract data submitted to the Commission in response to the *1997 Data Request*, and in *ex parte* submissions following the December 11, 1998, workshop, remains the most reliable data on the record. Significantly, no additional information has been proffered nor has any alternative method been proposed, on which to base our estimate of DLC costs. The second is that we conclude that it is reasonable to reduce both the fixed DLC cost and per-line DLC cost reflected in this data by a factor of 2.6 percent per year in order to capture changes in the cost of purchasing and installing DLCs over time.

275. As we explained in the *Inputs Further Notice*, the contract data submitted to the Commission in response to the *1997 Data Request*, and in *ex parte* submissions following the December 11, 1998, workshop, is the most reliable data because, not only is it the only data on the record, but it reflects the actual costs incurred in purchasing DLCs.[944] Moreover, although we would have preferred a larger sample, the contract data is sufficiently representative of non-rural carriers because it reflects the costs incurred by several of the largest non-rural carriers, as well as two of the smallest non-rural carriers.

276. GTE, Bell Atlantic and Sprint support the use of the contract data in estimating the cost of DLCs.[945] Only AT&T and MCI and SBC challenge the use of these data.[946] SBC

[942] *Inputs Further Notice* at para. 145.

[943] ATU May 6, 1999 *ex parte*. ATU also suggested that costs for placement, installation, and testing should be added to the DLC material costs it submitted. We note that these site preparation costs are already separately accounted for in the model.

[944] *Inputs Further Notice* at para. 143.

[945] GTE *Inputs Further Notice* comments at 62; Bell Atlantic *Inputs Further Notice* comments, Attachment D at 8-9, Chart 12. Sprint attests to the reasonableness of the proposed inputs based on the contract data. Sprint *Inputs Further Notice* comments at 41. Sprint explains that it demonstrated in a June 24, 1999 *ex parte* that the proposed inputs are in line with Sprint's actual costs including material and handling.

[946] AT&T and MCI *Inputs Further Notice* comments at 32-35 (Proprietary Version); SBC *Inputs Further Notice* comments at 13.

contends that the contract data is not the most reliable data on DLC costs because labor costs associated with testing, turn-up, and delivery of derived facilities are not factored into the input values.[947] We disagree. The data we identify as "contract data" include these costs. As we explained in the *Inputs Further Notice* and noted above, we sponsored a workshop on December 11, 1998, to further develop the record on DLC costs in this proceeding. During the workshop, we presented a template of the components of a typical DLC to the attendees. The template provided the respondents the opportunity to identify their contract costs with regard to each of the components. In addition, we requested that the respondents identify, and thereby include, other costs associated with DLC acquisition, including labor costs associated with testing, turn-up, and delivery of the DLC. Using this opportunity to submit DLC cost data, GTE and Aliant included such costs in their submissions. Sprint submitted similar data in a September 9, 1998 *ex parte* filing. These costs were identified and added to the analysis of US West's and BellSouth's contract data. We derived these costs from *ex parte* filings made by these carriers in this proceeding.

277. AT&T and MCI allege that the contract data overstates the actual costs of DLC equipment and therefore, should not be adopted.[948] AT&T and MCI instead advocate use of the HAI default values.[949] AT&T and MCI argue that the contract costs are not only unsupported by any verifiable evidence but, more importantly, are refuted by the contract information from which they were derived. In support, AT&T and MCI submit an analysis of the DLC cost submissions of Bell Atlantic, BellSouth, and Sprint. In each instance, AT&T and MCI assert that these data demonstrate DLC costs that are far below those proposed by the incumbent LECs and the Commission and that are fully consistent with the HAI default values.

278. We disagree with AT&T and MCI's analysis. For example, AT&T and MCI claim that information provided by Bell Atlantic shows that total DLC common equipment costs for DLC systems capable of serving 672, 1344, and 2016 lines are similar to, and uniformly less than, the corresponding HAI values.[950] In reaching this conclusion, however, AT&T and MCI omit the costs for line equipment. As Bell Atlantic points out, the cost of digital line carrier equipment should include these costs, and we agree.[951]

279. Similarly, AT&T and MCI assert that certain of Sprint's costs are significantly

---

947 SBC *Inputs Further Notice* comments at 13.

948 AT&T and MCI *Inputs Further Notice* comments at 32-35 (Proprietary Version)

949 AT&T and MCI *Inputs Further Notice* comments at 34.

950 AT&T and MCI *Inputs Further Notice* comments at 33-34 (Proprietary Version).

951 Bell Atlantic *Inputs Further Notice* reply comments 6-7.

inflated and, once adjusted, are similar to and uniformly less than the corresponding HAI values.[952] We find, however, these adjustments to be unsupported. AT&T and MCI reduce the supply expenses associated with Sprint's DLC costs, more than 66 percent, based on the experience of AT&T and MCI's engineering team members.[953] AT&T and MCI offer no evidence, however, other than the opinions of their experts to substantiate this proposed adjustment.

280. AT&T and MCI also contend that Sprint applies excessive mark-ups for sales tax.[954] AT&T and MCI argue that, because Sprint operates its own logistics company, there is no reason to apply sales tax to both supply expense and materials. We find that AT&T and MCI offer no support to demonstrate that this results in an excessive mark-up for sales tax. We reach the same conclusion with regard to AT&T and MCI's proposed reduction to Sprint's labor costs. AT&T and MCI contend that Sprint's labor costs are inflated and propose reductions in such costs through a reduction in the number of labor hours associated with DLC installation.[955] AT&T and MCI provide no support for such a reduction and, therefore, we decline to reduce Sprint's labor costs.[956]

281. Significantly, AT&T and MCI offer no evidence to controvert our tentative conclusion that the HAI values they employ as a comparative benchmark, and advocate that we adopt, are not more reliable than the contract data. We rejected the use of the HAI and the BCPM default values because they are based on the opinions of experts without substantiating data.[957] Similarly, we rejected data submitted by the HAI sponsors following the December 11, 1998, workshop. We found that data to be significantly lower than the contract data on the record, and concluded that it would be inappropriate to use because it also lacked support.[958] AT&T and MCI have not provided any additional evidence to substantiate the HAI data.

---

[952] AT&T and MCI *Inputs Further Notice* comments at 34.

[953] AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version)

[954] AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version).

[955] AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version).

[956] AT&T and MCI also claim that Sprint fails to make use of forward-looking technology such as GR303-capable hardware. AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version). Contrary to AT&T and MCI's assertion, the data supplied by Sprint and reflected in the contract data adopted herein reflects the cost of GR303-capable hardware. *See* Sprint Sept. 9, 1998 *ex parte*.

[957] *Inputs Further Notice* at para. 143.

[958] *Inputs Further Notice* at para. 144.

282. We also affirm our tentative conclusion that it is reasonable to reduce both the fixed DLC costs and per-line DLC costs reflected in the contract data in order to capture changes in the cost of purchasing and installing DLCs. As we explained in the *Inputs Further Notice*, this reduction recognizes the fact that the cost of purchasing and installing a DLC diminishes over time because of improvements in the methods and components used to produce DLCs, changes in both capital and labor costs, and changes in the functionality requirements of DLCs.[959] The premise that overall DLC costs move downward over time is not disputed on the record.

283. We also conclude that the 2.6 percent reduction we proposed in both the fixed DLC costs and per-line DLC costs is appropriate. As we explained in the *Inputs Further Notice*, this is a conservative estimate, based on the change in cost of remote switches, which is a reasonable proxy for changes in DLC cost.[960] More importantly, a comparison of data submitted on the record by Sprint for the years 1997, 1998, and 1999 demonstrates that an overall reduction of 2.6 percent is considerably less than Sprint's actual experience. An analysis undertaken by staff produces an average reduction in DLC costs for Sprint of 9.2 percent per year. We note that this estimate reflects both material and labor costs.

284. Only SBC and GTE specifically address the 2.6 percent reduction.[961] SBC supports the 2.6 percent reduction in fixed and per-line DLC costs as it applies to material costs only. In contrast, GTE opposes the adjustment.[962] GTE suggests that, as the inputs are adjusted over time, the cost of current technology will be reflected in the revised data.[963] GTE is correct that the current cost of technology would be reflected in revised data. The adjustment we proposed and adopt updates cost to current cost. Implicit in SBC's comment is the premise that labor costs will not decrease over time. Although this may be a reasonable assumption, the 2.6 percent reduction we adopt is applied to the overall cost of a DLC. As we explained above, the 2.6 percent reduction is a conservative estimate compared to the actual reductions we have observed in the Sprint data. As a result, we conclude that increases in labor will be offset by reductions in other factors in the cost of DLCs.

285. Finally, as noted above, we sought comment on the extent, if any, to which we should increase our proposed estimates for DLCs to reflect material handling and shipping costs

---

[959] *Inputs Further Notice* at para. 146.

[960] None of the commenters challenge the use of this proxy for estimating the change in DLC costs.

[961] SBC *Inputs Further Notice* comments at 13; GTE *Inputs Further Notic*e comments at 61-62.

[962] GTE *Inputs Further Notice* comments at 61-62.

[963] GTE *Inputs Further Notice* comments at 62.

because it was unclear whether the DLC data submitted by other parties include these costs. On further analysis, we note that material handling and shipping costs are reflected in the proposed DLC estimates we adopt herein. Moreover, we conclude that it is appropriate to include these costs in the cost estimates for DLCs. We note that no comments were filed opposing the inclusion of such costs.

VI. SWITCHING AND INTEROFFICE FACILITIES

A. Introduction

286. The central office switch provides the connection between a subscriber's local loop and the outside world. Modern digital switches connect telephones, fax machines, and computers to other subscribers on the public switched network.[964] In order to accomplish this, a telephone network must connect customer premises equipment to a switching facility, ensure that adequate capacity exists in that switching facility to process calls, and interconnect the switching facility with other switching facilities to route calls to their destination. A wire center is the location of the switching facility and the wire center boundaries define the area in which all customers are connected to a given wire center. The infrastructure to interconnect the wire centers is known as the "interoffice" network, and the carriage of traffic between wire centers is known as "transport."

287. In the *Universal Service Order*, the Commission stated that "[a]ny network function or element, such as . . . switching, transport or signaling, necessary to provide supported services must have an associated cost."[965] In the *1997 Further Notice*, the Commission sought comment on issues that affect the input values relating to the forward-looking economic cost of switching and interoffice transport.[966] The *Switching and Transport Public Notice* established several guidelines relating to switching, the design of the interoffice network, and interoffice cost attributable to providing supported services.[967] In the *Platform Order*, the Commission

[964] The functions performed by the switch for local service include: line termination; line monitoring; usage call processing, routing, and completion; interconnection to other carriers; billing and maintenance; and vertical services and features. We note that not all of these functions are supported by universal service.

[965] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion two).

[966] *1997 Further Notice*, 12 FCC Rcd at 18560-66, paras. 121-38.

[967] *Switching and Transport Public Notice* at 2-6. The Bureau guidelines established that: (1) the models permit individual switches to be identified as host, remote, or stand-alone; (2) switching investment costs should be separately estimated for host, remote, and stand-alone switches; (3) models should include switch capacity constraints; (4) all of the line-side port costs and a percentage of usage costs should be assigned to the cost of providing the supported service; and (5) models should accommodate an interoffice network that is capable of connecting switches designated as hosts and remotes in a way that is compatible with capabilities of equipment and technology that are available today and current engineering practices. *Id.*

concluded that the federal mechanism should incorporate, with certain modifications, the HAI 5.0a switching and interoffice facilities module.[968]

288. Both HAI and BCPM sponsors have provided default input values for estimating the forward-looking economic cost of switching and interoffice network.[969] On December 1, 1998, the Bureau held a public workshop designed to elicit comment on the switching inputs values to be used in the federal mechanism.[970]

[968] *Platform Order*, 13 FCC Rcd at 21354, para. 75.

[969] *See* Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, FCC, dated February 3, 1998 (HAI Feb. 3 submission) App. B; BCPM April 30, 1998 submission, Switch Model Inputs.

[970] *See Workshop Public Notice*. The December 1, 1998 workshop addressed issues relating to switching and expenses.

289. In the *Inputs Further Notice*, we tentatively adopted input values associated with switching and interoffice facilities, including values associated with the installation and purchase of new switches.[971] In addition, we tentatively adopted the Local Exchange Routing Guide (LERG) database to identify host-remote switch relationships.[972]

B. Switch Costs

1. Background

290. In the *Inputs Further Notice*, we tentatively concluded that we should use publicly available data on the cost of purchasing and installing switches that was compiled by the Commission, in conjunction with the work of Gabel and Kennedy,[973] and the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce.[974] This information was gathered from depreciation reports filed by LECs at the Commission. In order to better estimate the costs of small switches, we tentatively concluded in the *Inputs Further Notice* to augment the depreciation data with data compiled by the Commission, in conjunction with Gabel and Kennedy and the U.S. Department of Agriculture Rural Utility Service (RUS).[975] This information was gathered from reports made to RUS by LECs.

291. In order to make the RUS data comparable with the depreciation data, we proposed a series of adjustments to the RUS data. The cost figures reported in the depreciation information reflect the costs of purchasing and installing new switches. While the RUS cost data also contain information on purchasing and installing new switches, they do not include: (1) the cost associated with purchasing and installing the main distribution frame (MDF); (2) the cost associated with purchasing and installing power equipment; (3) the cost of connecting each remote switch to its respective host switch; and (4) LEC engineering costs.[976] In order to make the depreciation and RUS information comparable, we proposed in the *Inputs Further Notice* to

---

[971] *See Inputs Further Notice* at paras. 147-91, App. A.

[972] *Inputs Further Notice* at paras. 174-78.

[973] *See* NRRI Study, *supra* note 214.

[974] *Inputs Further Notice* at para. 152.

[975] *Inputs Further Notice* at para. 162.

[976] Letter from W. Scott Randolph, GTE, to Magalie Roman Salas, FCC dated December 18, 1998 (GTE Dec. 18 *ex parte*) at 5 and 6; NRRI Study at 97 and 102; Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated December 22, 1998 (Sprint Dec. 22 *ex parte*) at 13-21; Letter from Richard Clarke, AT&T, to Magalie Roman Salas, FCC, dated January 7, 1999 (AT&T Jan. 7 *ex parte*) at 1.

add estimates of these four components to the switch costs reported in the RUS information.[977]

292. In order to account for the cost of MDF omitted from the RUS information, we tentatively concluded that $12 per line was a reasonable cost for purchasing and installing MDF equipment.[978] In order to account for the cost of power equipment omitted from the RUS information, we tentatively concluded that the cost of purchasing and installing switches with 0-999 lines should be increased by $12,000, the cost of purchasing and installing switches with 1,000-4,999 lines should be increased $40,000, and the cost of purchasing and installing switches with 5,000-25,000 lines should be increased by $74,500.[979] We tentatively concluded that $27,598 should be added to the cost of each RUS remote switch in order to account for cost of connecting the remote switch to the host switch, a cost omitted from the RUS information.[980] We further proposed in the *Inputs Further Notice* that, in order to account for the LEC engineering costs omitted in the RUS information, we should add, after making the above adjustments for power, MDF, and remote connection costs, eight percent to the total cost of each RUS switch.

293. In order to determine the reasonable forward-looking cost of switches, based on the selected data set, we tentatively concluded in the *Inputs Further Notice* that we should employ regression analysis.[981] We tentatively concluded that the cost of a switch should be estimated as a linear function of the number of lines connected to the switch and the type of switch installed (i.e., host or remote).[982]

294. In order to capture changes in the cost of purchasing and installing switching equipment over time, we tentatively concluded in the *Inputs Further Notice* that we should modify the data to adjust for the effects of inflation, and explicitly incorporate variables in the regression analysis that capture cost changes unique to the purchase and installation of digital switches.[983]

---

[977] *Inputs Further Notice* at paras. 157-161.

[978] *Inputs Further Notice* at para. 158.

[979] *Inputs Further Notice* at para. 159.

[980] *Inputs Further Notice* at para. 160.

[981] *Inputs Further Notice* at para. 163.

[982] *Inputs Further Notice* at para. 164. In order to estimate the forward-looking cost of purchasing and installing a switch, switch costs also are estimated as a function of the date of installation. By including information on installation dates, the model produces forward-looking estimates that account for historical pricing trends.

[983] *Inputs Further Notice* at para. 166.

295. In the *Inputs Further Notice*, we tentatively concluded that in order to capture the costs associated with the purchase and installation of new switches, and to exclude the costs associated with upgrading switches, we should exclude switch cost data that contained costs reported more than three years after installation. We tentatively concluded that this restriction eliminates switch cost data that contain a significant amount of upgrade costs and, therefore, do not solely represent the purchase and installation costs of new switches.[984]

2. Discussion

296. Switch Cost Estimates. We adopt the fixed cost (in 1999 dollars) of a remote switch as $161,800 and the fixed cost (in 1999 dollars) of both host and stand-alone switches as $486,700. We adopt the additional cost per line (in 1999 dollars) for remote, host, and stand-alone switches as $87.[985]

297. For the reasons set forth below, we affirm our tentative conclusion to use the publicly available data from LEC depreciation filings, and to supplement the depreciation data with data from LEC reports to the RUS. We also affirm our tentative conclusion that we should not rely on the BCPM and HAI default values, because these values are largely based on non-public information or opinions of their experts, without data that enable us adequately to substantiate those opinions.

298. Switch Cost Data. The depreciation data contains for each switch reported: the model designation of the switch; the year the switch was first installed; and the lines of capacity and book-value cost of purchasing and installing each switch at the time the depreciation report was filed with the Commission.[986] The RUS data contains, for each switch reported: the switch type (i.e., host or remote); the number of equipped lines; cost at installation; and year of installation.[987]

299. The sample that we use to estimate switch costs includes 1,085 observations. The

[984] *Inputs Further Notice* at para. 170.

[985] *See* Appendix C for regression results, and an explanation of how cost estimates are derived from these results.

[986] Until 1996, large incumbent LECs were required to file depreciation rate reports with the Commission pursuant to 47 C.F.R. § 43.43. Prior to filing these reports, companies generally would submit depreciation rate studies that included data for each digital switch in operation. *See* Appendix C for a further description of the data set.

[987] Many small telephone companies receive financial assistance from RUS, which requires these companies to report the payments made for new switches. *See* Appendix C for a further description of the RUS data.

sample contains 946 observations selected from the depreciation data, which provide information on the costs of purchasing and installing switches gathered from 20 states. All observations in the depreciation data set are for switches with 1,000 lines or more. In order to better estimate the cost of small switches, we augmented the depreciation data set by adding data from RUS. The RUS sample contains 139 observations which provide information from across the nation on the costs of small switches purchased and installed by rural carriers. Over 80 percent of the observations of switch costs in the RUS data set measure the costs for switches with 1,000 lines of capacity or less. The combined sample represents purchases of both host and remote switches, with information on 490 host switches and 595 remote switches, and covers switches installed between 1989 and 1996. This set of data represents the most complete public information available to the Commission on the costs of purchasing and installing new switches.

300. The depreciation data set proposed in the *Inputs Further Notice* excluded 26 observations that had been deemed to be outliers by the Bureau of Economic Analysis. Bell Atlantic criticizes the Commission for excluding these outliers.[988] The excluded observations were not available in electronic form prior to the release of the *Inputs Further Notice*. Subsequently, the Bureau obtained these outlying observations from the Bureau of Economic Analysis and reinserted them into the data set used to derive the input values we adopt herein. In addition, several commenters recommend that the depreciation data set also should include switches with fewer than 1,000 lines of capacity. This information, however, is not available in electronic format and, therefore, would be unduly burdensome to include.[989]

301. In response to the *1997 Data Request*, the Commission received a second set of information pertaining to 1,486 switches. Upon analysis, however, we have identified one or more problems with most of the data submitted: missing switch costs; zero or negative installation costs; zero or blank line counts; unidentifiable switches; or missing or inconsistent Common Language Local Identification (CLLI) codes. After excluding these corrupted observations, 302 observations remained. The remaining observations represented switches purchased by only four companies. We affirm our tentative conclusion that the data set we use is superior to the data set obtained from the data request, both in terms of the number of usable observations and the number of companies represented in the data set.

302. Following the December 1, 1998, workshop, three companies voluntarily submitted further data regarding the cost of purchasing and installing switches: BellSouth provided data on switch investments for its entire operating region; Sprint provided similar data for its operations in Nevada, Missouri, and Kansas; and GTE provided switch investment

[988] Bell Atlantic *Inputs Further Notice* comments at 10 and 11.

[989] The Bureau of Economic Analysis, in creating the electronic data set from depreciation filings, did not include observations for switches with fewer than 1,000 lines.

information for California.[990] When consolidated, this information forms a data set of approximately 300 observations representing the costs of new switches.[991] As AT&T has noted, however, the information submitted contains some inconsistencies.[992] Considering these inconsistencies, the limited number of companies represented, and the size of this voluntarily submitted data set, we conclude that the data set we use is preferable.

303. BellSouth suggests that we merge either the information received in response to the *1997 Data Request,* the information from the voluntary submissions, or both, with the data set we use.[993] We reject this suggestion because there are significant inconsistencies between the different data sets. For example, in its voluntary submission, GTE provides the amount of total investment for each of its California switches at the time these switches were installed, but reports associated line counts only for October 1998. This information is not consistent with the data set used by the Commission, which contains aggregate investment and line counts measured at the same point in time. Second, our analysis of the information provided in both the voluntary submissions and the data request reveals, based on simple linear regression, inconsistencies between these two data sets and the data set employed by the Commission.[994] Our analysis reveals that both alternative data sets contain information that is inconsistent with the comments in this proceeding.[995]

[990] BellSouth January 29, 1999 *ex parte*; Sprint February 5, 1999 *ex parte*; and GTE February 22, 1999 *ex parte*.

[991] Some of the switch cost values provided in the voluntary submissions include the costs associated with upgrading switching equipment. The voluntary information does not, however, contain information that would allow us to identify the upgrade components associated with these additional costs. For example, post-installation investments are not identified as investments in additional line capacity, additional software, and so forth. After removing the information where new switch costs and the costs associated with post installation upgrades are inextricably linked, using the process outlined in Appendix C, fewer than 300 observations remain.

[992] AT&T points out that the data submitted by Sprint contains records that are either missing or inconsistent with other records, records that are old or do not reflect equipment used exclusively to provide end office switching, and records that contain ambiguous information. *See* AT&T Mar. 10, 1999 *ex parte*.

[993] BellSouth *Inputs Further Notice* comments at B-14 and B-15.

[994] A year-by-year analysis of the deprecation data and the RUS data reveals that the fixed cost of a host switch is significantly more than the fixed cost of a remote switch. Our analysis examining the deprecation data reveals that the difference is statistically significant and positive in four of the seven years covered by the Commission data set. In 1995, there are only nine observations including only one host switch, and therefore, there is insufficient data to draw any conclusion for 1995. In the other two remaining years, 1993 and 1994, the difference has a large positive magnitude but is not statistically significant (the "t-statistics" for these years are 0.68 and 0.99). In contrast, the fixed cost of host switches in the data from the *1997 Data Request* do not differ statistically from the fixed costs of remote switches, nor is there a large difference in the magnitudes of the estimated costs. Similarly, year-by-year analysis of the voluntary data provided by the carriers does not reveal any systematic difference between host fixed costs and remote fixed costs.

[995] As noted in the previous footnote, the fixed cost of host switches exceeds the fixed cost of remote switches in

304. Adjustments to the Data. As discussed above, in the *Inputs Further Notice*, we proposed certain adjustments to the RUS data to account for the cost of MDF and power equipment, which were omitted from the RUS information.[996] Specifically, we proposed increasing the cost of purchasing and installing switches by $12 per line for MDF and $12,000, $40,000, or $74,500, depending upon switch size, for power costs. Commenters who address this issue agree that the RUS data must be modified to account for the costs of MDF and power to make the RUS data consistent with the depreciation data, which include these costs.[997] Some commenters who address these adjustments claim that we should use different values for MDF and power costs, but provide little or no information we can use to verify their suggested values.[998] Sprint, for example, claims our power costs are too low and provides a breakdown of power costs, but does not supply any data to support their higher proposed values for power costs.[999] AT&T and MCI claim our proposed power costs should be reduced because they are substantially higher than those proposed by their experts.[1000]

305. We find that we need not attempt to resolve disagreement over the reasonableness of our proposed values, in the absence of any additional information, because we adopt an alternative methodology for estimating MDF and power costs. We find that we should adjust the RUS data for MDF and power equipment costs in a way that is more consistent with the way in which these costs are estimated in the depreciation data set. In the depreciation data, MDF and power equipment costs are estimated as a percentage of the total cost of the switch, as are all other components of the switch. Based on the estimates of Technology Futures, Inc., we find

---

the data set we have chosen. This is consistent with comments from this proceeding. *See* BellSouth *Inputs Further Notice* comments at B-15; Sprint *Inputs Further Notice* comments at 46; and Letter from Richard Clarke, AT&T, to Magalie Roman Salas, FCC, dated January 7, 1999 (AT&T Jan. 7 *ex parte*) at 1.

996 *See supra* para. 291.

997 *See, e.g.,* AT&T/MCI *Inputs Further Notice* comments at 38; Sprint *Inputs Further Notice* comments at 44; *but cf.* GTE *Inputs Further Notice* comments at 65. GTE appears to be confused about our use of the power adjustment to make the RUS data comparable to the depreciation data and incorrectly assumes we only use the depreciation data for switches with more than 25,000 lines.

998 SBC claims that our proposed $12 per line for MDF is too low and argues a more reasonable estimate is $30 per line. SBC *Inputs Further Notice* comments at 13. Sprint, AT&T and MCI, on the other hand, agree that $12 cost per line for MDF is reasonable. AT&T/MCI *Inputs Further Notice* comments at 38; Sprint *Inputs Further Notice* comments at 44.

999 Sprint *Inputs Further Notice* comments at 44, attachment 7. GTE also claims its power investment is higher than our proposed values, but offers no data to support this claim. GTE *Inputs Further Notice* comments at 66.

1000 AT&T/MCI *Inputs Further Notice* comments at 38.

that these costs were eight percent of total cost.[1001] Because we are adjusting the RUS data so that they are comparable with the depreciation data, we find it is appropriate to use a comparable method to estimate the portion of total costs attributable to MDF and power equipment. Accordingly, in order to account for the cost of MDF and power equipment omitted from the RUS information, we conclude that the cost of switches reported in the RUS data should be increased by eight percent.

306. In the *Inputs Further Notice*, we tentatively concluded, based on an estimate provided by Gabel and Kennedy, that $27,598 should be added to the cost of each remote switch reported in the RUS data.[1002] SBC recommends that remote termination costs should be added to remote switch costs on a per-line basis, but provides no estimates of the per-line cost of remote termination.[1003] Sprint provides remote termination estimates of $22,636 for termination of remote switches with less than 641 lines and $46,332 for termination of remote switches with between 641 and 6,391 lines.[1004] Using Sprint's methodology, the average cost of terminating a RUS remote switch on a RUS host switch is $29,840.[1005] Sprint's estimate is consistent in magnitude with Gabel and Kennedy's estimate. Therefore, because Sprint's tiered estimates captures differences between remote termination costs associated with remote switch size, we adopt Sprint's estimates.

307. Based upon Gabel and Kennedy recommendations, derived from data analysis undertaken by RUS, we conclude that the cost of switches reported in the RUS data should be increased by eight percent in order to account for the cost of LEC engineering.[1006] We conclude, however, that this adjustment should not be added to the cost of power and MDF, because these estimates already include the costs of LEC engineering.

[1001] Lawrence K. Vanston, Ray L. Hodges, Adrian J. Poitras, Technology Futures, Inc., *Transforming the Local Exchange Network: Analyses and Forecast of Technology Change* 149 (2d ed. 1997) (TFI Study). The terminology used in the TFI study differs somewhat. What TFI calls "shell" is "the common equipment, such as cabling and power equipment, that is not modular and lasts the life of the switch entity." TFI Study at 136. This includes MDF and power investment.

[1002] *Inputs Further Notice* at para. 160 (citing NRRI Study at 102-104).

[1003] SBC *Inputs Further Notice* comments at 13.

[1004] *See* Sprint *Inputs Further Notice* comments at 45. Sprint also provided an estimate of the cost of terminating remote switches with over 6,390 lines. We note, however, that there are no remote switches in the RUS data with over 6,390 lines.

[1005] Sprint estimates the average cost of terminating its own remotes on its own host switches as $61,700. Its tiered cost estimates indicate, however, that for remotes in the RUS data set, which do not include any remote switches with over 6,390 lines, the average cost is $29,840. *See* Sprint *Inputs Further Notice* comments at 45.

[1006] *Id*.

308. Methodology. Consistent with our tentative conclusions in the *Inputs Further Notice,* we employ regression analysis. In this Order, we also adopt our tentative conclusion to use a linear function based on examination of the data and statistical evidence.

309. Sprint recommends using a non-linear function, such as the log-log function, to take into account the declining marginal cost of a switch as the number of lines connected to it increases.[1007] We affirm our tentative conclusion that the linear function we adopt provides a better fit with the data than the log-log function. A discussion of the effect of time and type of switch on switch cost is presented below.

310. Based upon an analysis of the data and the record, we conclude that the fixed cost (i.e., the base getting started cost of a switch, excluding costs associated with connecting lines to the switch) of host switches and remote switches differ, but that the per-line variable cost (i.e., the costs associated with connecting additional lines to the switch) of host and remote switches are approximately the same. This is consistent with statistical evidence[1008] and the comments of Sprint, BellSouth, and the HAI sponsors.[1009]

[1007] Sprint Dec. 22 *ex parte* at 12. Sprint criticized the Commission's preliminary switch regression presented in the December 1998 workshop based on the "R-squared" statistical goodness of fit criterion. After adjusting for data transformations associated with moving to a log-log specification, however, the R-squared of a log-log regression (0.56) suggested by Sprint is lower than the R-squared in the linear regression (0.73). Specifically, we note that the R-squared measure resulting from a regression employing a log-log functional form is not directly comparable to the R-squared measure from a linear regression. In order for the two measures to be comparable, the R-squared measure computed from the log-log regression must be computed using observed and predicted cost measures, not the logs of these measures. We also note that the log-log regression we employed is of the form:

$$Ln(Cost) = a_1 + a_2*Ln(Lines) + a_3*Host + a_4*Ln(Time) + a_5*Ln(Lines)*Ln(Time) + a_6*Host*Ln(Time) + e$$

where Ln(x) denotes the natural log of x. Because Sprint did not make these necessary adjustments, we believe that its criticism of the use of a linear function is misplaced. For a discussion of the "R-squared" statistical goodness of fit criterion and a discussion of log-log specifications, see William H. Greene, *Econometric Analysis*, 192-193 and 251 (1990).

[1008] *See* General Wald Test for omitted variables in Ramu Ramanathan, *Introductory Econometrics with Applications* 170 (1989).

[1009] *See* Sprint *Inputs Further Notice* comments at 46. *See also* Letter from Richard Clarke, AT&T, to Magalie Roman Salas, FCC, dated January 7, 1999 (AT&T Jan. 7 *ex parte*) at 1.

> The primary difference between a host switch and remote switch is in the extent and complexity of the `getting started equipment,' associated with each type of switch (e.g., switch central processor functions, SS7 non-scaleable equipment, maintenance and testing, call recording for billing purposes, etc.). Because most of these functions for lines terminating a remote switch are performed at that switch's host, very little of this type of `getting started' equipment is required at the remote. In contrast, the scaleable equipment used to terminate lines and trunks and to perform

311. Accounting for Changes in Cost Over Time. We recognize that the cost of purchasing and installing switching equipment changes over time. Such changes result, for example, from improvements in the methods used to produce switching equipment, changes in both capital and labor costs, and changes in the functional requirements that switches must meet for basic dial tone service. In order to capture changes in the cost of purchasing and installing switching equipment over time, we affirm our tentative conclusion in the *Inputs Further Notice* to modify the data to adjust for the effects of inflation, and explicitly incorporate variables in the regression analysis that capture cost changes unique to the purchase and installation of digital switches.

312. To the extent that the general level of prices in the economy changes over time, the purchasing power of a dollar, in terms of the volume of goods and services it can purchase, will change. In order to account for such economy-wide inflationary effects, we multiply the cost of purchasing and installing each switch in the data set by the gross-domestic-product chain-type price index[1010] for 1997 and then divide by the gross-domestic-product chain-type price index for the year in which the switch was installed, thereby converting all costs to 1997 values.[1011]

313. In order to account for cost changes unique to switching equipment, we enter time terms directly into the regression equation.[1012] US West agrees that the costs of the equipment, such as switches and multiplexers, used to provide telecommunications services are declining,

> basic call processing is essentially the same at the host and remote. In fact, the line units used by Lucent 5E Remote Switching Modules are identical to those used by 5E host or stand-alone switches. Similarly, the line cards used in Nortel DMS 100 host or stand-alone switches are the same as those used in DMS 100 remotes, or in DMS 10 host or remote switches.

Id. BellSouth notes in its *Inputs Further Notice* comments that "BellSouth finds that the per line costs are slightly different because hosts' lines also bear the costs of some umbilical trunking and control that is not provided at the remotes. Still it is a reasonable simplification to allow host and remote per line costs to be the same." BellSouth *Inputs Further Notice* comments at B-15.

1010 The gross-domestic-product chain-type price index, which tracks economy-wide inflation, is published monthly by the Bureau of Economic Analysis of the U.S. Department of Commerce in the *Survey of Current Business*.

1011 Switch costs are adjusted after estimation for both realized and expected inflation between 1997 and 1999. *See* Appendix C for an explanation of these adjustments.

1012 Time was added to the regression in reciprocal form as an independent variable to measure fixed cost changes unique to remote switches. Then, a time term was added in conjunction with the host identifier variable to measure the fixed cost changes unique to host switches. A time term was also added in conjunction with the line variable, in order to measure cost changes unique to line additions on switches.

and that the per-unit cost of providing more services on average is declining.[1013] Bell Atlantic and GTE, however, contend that the cost of switches is not currently declining and therefore pricing declines should not be expected to continue into the future.[1014] As evidence, they cite their own fixed-cost contracts. As AT&T notes, however, "[i]f Bell Atlantic in fact agreed to switching contracts that 'effectively froze prices on switching equipment,' those prices would reflect its idiosyncratic business judgement . . ."[1015] GTE expresses concern that, under certain specifications of time, the regression equation produces investments for remote switch "getting started" costs that are negative and that such specifications overstate the decline in switch costs.[1016] As noted in the *Inputs Further Notice*, the HAI sponsors also caution that the large percentage price declines in switch prices seen in recent years may not continue.[1017] We affirm our tentative conclusion that the reciprocal form of time in the regression equation satisfies these concerns by yielding projections of switch purchase and installation costs that are positive yet declining over time.[1018]

314. Ameritech and GTE advocate the use of the Turner Price Index to convert the embedded cost information contained in the depreciation data to costs measured in current dollars.[1019] We note, however, that this index and the data underlying it are not on the public record. We prefer to rely on public data when available. Moreover, we affirm our tentative conclusion that it is not necessary to rely on this index to convert switch costs to current dollars. Rather, as described in the preceding paragraph, we will account for cost changes over time explicitly in the estimation process, rather than adopting a surrogate such as the Turner Price Index.

315. Treatment of Switch Upgrades. The book-value costs recorded in the depreciation

---

1013 US West *Inputs Further Notice* comments at 64-65.

1014 *See* Bell Atlantic *Inputs Further Notice* comments at 20, 21; GTE *Inputs Further Notice Reply* comments at 32.

1015 AT&T/MCI *Inputs Further Notice Reply* comments at 35, n.54.

1016 GTE Dec. 18 *ex parte* at 4.

1017 *See Inputs Further Notice* at para. 168. *See also* AT&T Jan. 7 *ex parte* at 4.

1018 Although the log specification of time proposed in the December 1, 1998, workshop yields similar results, it produces investments for host switch "getting started" costs that become negative in 2000 and consequently overstates pricing declines.

1019 *See* Ameritech Dec. 16, 1998 comments at 5; GTE Dec. 18, 1998 *ex parte* at 4. The Turner Price Index is an index designed to measure the changing cost of telecommunications plant published semi-annually by AUS consultants.

data include both the cost of purchasing and installing new equipment and the cost associated with installing and purchasing subsequent upgrades to the equipment over time. Upgrades costs will be a larger fraction of reported book-value costs in instances where the book-value costs of purchasing and installing switching equipment are reported well after the initial installation date of the switch. We affirm our tentative conclusion that, in order to estimate the costs associated with the purchase and installation of new switches, and to exclude the costs associated with upgrading switches, we should remove from the data set those switches installed more than three years prior to the reporting of their associated book-value costs.[1020] We believe that this restriction will eliminate switches whose book values contain a significant amount of upgrade costs, and recognizes that, when ordering new switches, carriers typically order equipment designed to meet short-run demand.

316. Bell Atlantic criticizes the Commission for excluding a large percentage of the observations from the initial depreciation data set.[1021] As noted in the preceding paragraph, however, the observations that have been excluded do not accurately represent the price of a new switch.

317. We reject the suggestions of Ameritech, Bell Atlantic, BellSouth, GTE, and Sprint that the costs associated with purchasing and installing switching equipment upgrades should be included in our cost estimates.[1022] The model platform we adopted is intended to use the most cost-effective, forward-looking technology available at a particular period in time. The installation costs of switches estimated above reflect the most cost-effective forward-looking technology for meeting industry performance requirements. Switches, augmented by upgrades, may provide carriers the ability to provide supported services, but do so at greater costs. Therefore, such augmented switches do not constitute cost-effective forward-looking technology. In addition, as industry performance requirements change over time, so will the costs of purchasing and installing new switches. The historical cost data employed in this analysis reflect such changes over time, as do the time-trended cost estimates.

318. Additional Variables. Several parties contend that additional independent variables should be included in our regression equation. Some of the recommended variables include minutes of use, calls, digital line connections, vertical features, and regional, state, and

---

[1020] *Inputs Further Notice* at para. 170.

[1021] Bell Atlantic *Inputs Further Notice* comments at 12.

[1022] Ameritech Dec. 16, 1998 comments at 4-5; GTE Dec. 18, 1998 *ex parte* at 4-5; Sprint Dec. 22, 1998 *ex parte* at 5-7; GTE *Inputs Further Notice* comments at 68; Bell Atlantic *Inputs Further Notice* comments, Affidavit of Harold Ware and Christian Michael Dippon at 9-13; Bell Atlantic *Inputs Further Notice* comments at 8-13; BellSouth *Inputs Further Notice* comments at B-15 and B-16; Sprint *Inputs Further Notice* comments at 47 and 48.

vendor-specific identifiers.[1023] For the purposes of this analysis, our model specification is limited to include information that is in both the RUS and depreciation data sets. Neither data set includes information on minutes of use, calls, digital line connections, vertical features, or differences between host and stand-alone switches. State and regional identifiers are not included in the regression because we only have depreciation data on switches from 20 states. Thus, we could not accurately estimate region-wide or state-wide differences in the cost of switching. Our model specification also does not include vendor-specific variables, because the model platform does not distinguish between different vendors' switches.[1024]

319. Switch Cost Estimates. A number of commenters criticize the switch cost estimates contained in the *Inputs Further Notice* and suggest that they should be dismissed or substantially revised. For example, Sprint suggests that we dismiss the results because the data are collinear and the model is mis-specified.[1025] Bell Atlantic and BellSouth suggest that the Commission underestimates the cost of switches, while AT&T and MCI suggest that the Commission overestimates the cost of switches.[1026] The Commission's estimates, however, are based upon the most complete, publicly-available information on the costs of purchasing and installing new switches and therefore represent the Commission's best estimates of the cost of host and remote switches. In the preceding paragraphs and in Appendix C, we have addressed the specific objections that have been raised by parties with regard to the methodology, data set, or other aspects of the approach we adopt to derive switch cost estimates, and for the reasons given there, we reject those objections. We conclude that the remaining evidence provided as grounds for dismissing or substantially revising these estimates is largely anecdotal or unconfirmed and undocumented and does not lead us to believe that our estimates should be altered. We conclude, therefore, that the switch cost estimates we adopt are the best estimates of forward-looking cost.

C. Use of the Local Exchange Routing Guide (LERG)

320. In the *Inputs Further Notice*, we tentatively concluded that the Local Exchange

[1023] GTE Dec. 18, 1998 *ex parte* at 5; Sprint Dec. 22, 1998 *ex parte* at 13; Ameritech Dec. 16, 1998 comments at 6; Bell Atlantic *Inputs Further Notice* comments, Affidavit of Harold Ware and Christian Michael Dippon at 17 and 18.

[1024] Moreover, even if the model platform were changed, we do not believe that it would be appropriate to use vendor-specific input values for switch costs. The model is intended to estimate the least-cost, most-efficient technology being deployed, not the technology available from a particular vendor.

[1025] In Appendix C, we discuss the issues of multicollinearity and mis-specification identified by Sprint in its comments.

[1026] AT&T/MCI *Inputs Further Notice* comments at 36; Bell Atlantic *Inputs Further Notice* comments at 10-11; Sprint *Inputs Further Notice* comments at 46; BellSouth *Inputs Further Notice* comments at B-15.

Routing Guide (LERG) database should be used to determine host-remote switch relationships in the federal high-cost universal service support mechanism.[1027] We now affirm that conclusion. In the *1997 Further Notice*, the Commission requested "engineering and cost data to demonstrate the most cost-effective deployment of switches in general and host-remote switching arrangements in particular."[1028] In the *Switching and Transport Public Notice*, the Bureau concluded that the model should permit individual switches to be identified as host, remote, or stand-alone switches.[1029] The Bureau noted that, although stand-alone switches are a standard component of networks in many areas, current deployment patterns suggest that host-remote arrangements are more cost-effective than stand-alone switches in certain cases.[1030] No party has placed on the record in this proceeding an algorithm that will determine whether a wire center should house a stand-alone, host, or remote switch.[1031] We therefore affirm our conclusion to use the LERG to determine host-remote switch relationships.

321. In the *Platform Order*, we concluded that the federal mechanism should incorporate, with certain modifications, the HAI 5.0a switching and interoffice facilities module.[1032] In its default mode, HAI assumes a blended configuration of switch technologies, incorporating both hosts and remotes, to develop switching cost curves.[1033] HAI also allows the user the option of designating, in an input table, specific wire center locations that house host, remote, and stand-alone switches. When the host-remote option is selected, switching curves that correspond to host, remote, and stand-alone switches are used to determine the appropriate switching investment. The LERG database could be used as a source to identify the host-remote switch relationships. In the *Platform Order*, we stated that "[i]n the inputs stage of this proceeding we will weigh the benefits and costs of using the LERG database to determine switch

[1027] *Inputs Further Notice* at para. 174. The LERG is a database of switching information maintained by Telecordia Technologies (formerly Bellcore) that includes the existing host-remote relationships. The HAI proponents have placed on the record the portion of the LERG that identifies the host-remote relationships. Letter from Chris Frentrup, MCI Worldcom, to Magalie Roman Salas, FCC, dated September 14, 1998 (MCI Sept. 14 *ex parte*).

[1028] *1997 Further Notice*, 12 FCC Rcd at 18560-61, para. 122.

[1029] *Switching and Transport Public Notice* at 2. Switches can be designated as host, remote, or stand-alone switches. Both a host and a stand-alone switch can provide a full complement of switching services without relying on another switch. A remote switch relies on a host switch to supply a complete array of switching functions and to interconnect with other switches.

[1030] *Switching and Transport Public Notice* at 2-3.

[1031] *Platform Order*, 13 FCC Rcd at 21355, para. 76.

[1032] *Platform Order*, 13 FCC Rcd at 21354-55, para. 75.

[1033] HAI Feb. 3, 1998 submission, Model Description at 58.

type and will consider alternative approaches by which the selected model can incorporate the efficiencies gained through the deployment of host-remote configurations."[1034]

322. The majority of commenters throughout this proceeding have supported the use of the LERG database as a means of determining the deployment of host and remote switches.[1035] These commenters contend that the use of the LERG to determine host-remote relationships will incorporate the accumulated knowledge and efficiencies of many LECs and engineering experts in deploying the existing switch configurations.[1036] Sprint contends that there are many intangible variables that can not be easily replicated in determining host-remote relationships.[1037] Commenters also contend that an algorithm that realistically predicts this deployment pattern is not feasible using publicly available data and would be unnecessarily "massive and complex."[1038] AT&T and MCI argue, however, that use of the LERG to identify host-remote relationships may reflect the use of embedded technology, pricing, and engineering practices.[1039]

323. We conclude that the LERG database is the best source set forth in this proceeding to determine host-remote switch relationships in the federal high-cost universal service support mechanism. As noted above, no algorithm has been placed on the record to determine whether a wire center should house a stand-alone, host, or remote switch. In addition, many commenters contend that development of such an algorithm independently would be difficult using publicly available data.[1040] While GTE suggests that the best source of host-remote relationships would be a file generated by each company, we note that no such

[1034] *Platform Order*, 13 FCC Rcd at 21355, para. 76.

[1035] *See, e.g.*, BellSouth *Inputs Further Notice* reply comments at 17; Sprint *Inputs Further Notice* comments at 48. *See also* Aliant *Switching and Transport Public Notice* comments at 2; Bell Atlantic *Switching and Transport Public Notice* reply comments at 2.

[1036] Bell Atlantic *Switching and Transport Public Notice* reply comments, Attachment 1 at 2; BellSouth et al. *Switching and Transport Public Notice* reply comments, Attachment 1 at 2-3.

[1037] Sprint *Inputs Further Notice* comments at 48.

[1038] *See, e.g.*, AT&T/MCI *Switching and Transport Public Notice* comments at 6; BellSouth et al. *Switching and Transport Public Notice* reply comments, Attachment 1 at 2.

[1039] AT&T/MCI *Inputs Further Notice* comments at 44-45. Although AT&T and MCI oppose the use of the LERG, they have taken steps to ensure that the LERG database is compatible with use in the switching module of the synthesis model. *See* MCI Sept. 14 *ex parte*; Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, FCC, dated September 16, 1998 (AT&T Sept. 16 *ex parte*).

[1040] *See, e.g.*, Ameritech *Switching and Transport Public Notice* comments at 3; AT&T/MCI *Switching and Transport Public Notice* comments at 6; BellSouth et al. *Switching and Transport Public Notice* comments Attachment 1 at 1-2; GTE *Switching and Transport Public Notice* at 11-12.

information has been submitted in this proceeding.[1041] In addition, GTE's proposal would impose administrative burdens on carriers. We conclude that the use of the LERG to identify the host-remote switch relationships is superior to HAI's averaging methodology which may not, for example, accurately reflect the fact that remote switches are more likely to be located in rural rather than urban areas. We therefore conclude that use of the LERG is the most feasible alternative currently available to incorporate the efficiencies of host-remote relationships in the federal high-cost universal service support mechanism.

D. Other Switching and Interoffice Transport Inputs

324. General. In the *Inputs Further Notice*, we proposed several minor modifications to the switching inputs to reflect the fact that the studies on which the Commission relied to develop switch costs include all investments necessary to make a switch operational.[1042] These investments include telephone company engineering and installation, the main distribution frame (MDF), the protector frame (often included in the MDF), and power costs.[1043] To avoid double counting these investments, both as part of the switch and as separate input values, the commenters agree that the MDF/Protector investment per line and power input values should be set at zero.[1044] In addition, commenters agree that the Switch Installation Multiplier should be set at 1.0.[1045] We agree that including these investments both as part of the switch cost and as separate investments would lead to double counting of these costs. We therefore adopt these values.

325. Analog Line Offset. In the *Inputs Further Notice*, we tentatively concluded that the "Analog Line Circuit Offset for Digital Lines" input should be set at zero.[1046] We now affirm that conclusion. AT&T and MCI contend that the switch investment in the model should be adjusted downward to reflect the cost savings associated with terminating digital, rather than analog, lines.[1047] AT&T and MCI assert that this cost savings is due primarily to the elimination

[1041] GTE *Inputs Further Notice* comments at 69.

[1042] *Inputs Further Notice* at para. 178.

[1043] AT&T Jan. 7 *ex parte*; Sprint Dec. 22 *ex parte* at 9.

[1044] AT&T *Inputs Further Notice* comments at 40; GTE Dec. 18 *ex parte* at 5-6; Sprint *Inputs Further Notice* comments at 49.

[1045] *See, e.g.*, AT&T *Inputs Further Notice* comments at 40; GTE Dec. 18 *ex parte* at 6; Sprint *Inputs Further Notice* comments at 49.

[1046] *Inputs Further Notice* at para. 179.

[1047] AT&T/MCI *Inputs Further Notice* comments at 41-42. AT&T/MCI contend that the cost of terminating digital lines is significantly less expensive than terminating analog lines.

of a MDF and protector frame termination. AT&T and MCI further contend that the model produces, on average, 40 percent digital lines, while the data used to determine switch costs reflect the use of only approximately 18 percent digital lines.[1048] In contrast, GTE contends that the model may calculate more analog lines than carriers have historically placed due to the use of an 18,000 feet maximum copper loop length.[1049]

326. AT&T and MCI suggest that the analog line offset input should reflect a $12 MDF and $18 switch port termination savings per line in switch investment for terminating digital lines in the model.[1050] Several commenters disagree and recommend setting the analog line offset to zero.[1051] Sprint contends that the analog line offset is inherent in the switching curve in the model, thus making this input unnecessary and, therefore, justified only if the switch cost curve is based on 100 percent of analog line cost.[1052] Sprint argues that an unknown mixture of analog and digital lines are taken into consideration in developing the switch curve.[1053]

327. The record contains no basis on which to quantify savings beyond those taken into consideration in developing the switch cost. We also note that the depreciation data used to determine the switch costs reflect the use of digital lines. The switch investment value will therefore reflect savings associated with digital lines. AT&T and MCI's proposed analog line offset per line is based on assumptions that are neither supported by the record nor easily verified. For example, it is not possible to determine from the depreciation data the percentage of lines that are served by digital connections. It is therefore not possible to verify AT&T and MCI's estimate of the digital line usage in the "historical" data. In the absence of more explicit support of AT&T and MCI's position, we conclude that the Analog Line Circuit Offset for Digital Lines should be set at zero.

328. Switch Capacity Constraints. In the *Inputs Further Notice*, we proposed to adopt the HAI default switch capacity constraint inputs as proposed in the HAI 5.0a model documentation.[1054] We now adopt that proposal. The forward-looking cost mechanism contains

[1048] AT&T/MCI *Inputs Further Notice* comments at 41.

[1049] GTE *Inputs Further Notice* comments at 66.

[1050] AT&T/MCI *Inputs Further Notice* comments at 42.

[1051] BellSouth *Inputs Further Notice* comments at 16; GTE *Inputs Further Notice* comments at 66-67; Sprint *Inputs Further Notice* comments at 49.

[1052] Sprint *Inputs Further Notice* comments at 49.

[1053] Sprint Dec. 22 *ex parte* at 12.

[1054] HAI Feb. 3, 1998 submission, App. B at 38-39.

switch capacity constraints based on the maximum line and traffic capabilities of the switch. In their most recent filings on this issue, AT&T and MCI recommend increasing the switch line and traffic capacity constraints above the HAI input default values for those inputs.[1055] AT&T and MCI contend that the default input values no longer reflect the use of the most current technology.[1056] For example, AT&T and MCI recommend that the maximum equipped line size per switch should be increased from 80,000 to 100,000 lines.[1057]

329. We conclude that the original HAI switch capacity constraint default values are reasonable for use in the federal mechanism. We note that Sprint, the only commenter to respond to this issue, supports this conclusion.[1058] We also note that the HAI model documentation indicates that the 80,000 line assumption was based on a conservative estimate "recognizing that planners will not typically assume the full capacity of the switch can be used."[1059] AT&T and MCI therefore originally supported the 80,000 line limitation as the maximum equipped line size value with the knowledge that the full capacity of the switch may be higher.[1060]

330. Switch Port Administrative Fill. In the *Inputs Further Notice*, we proposed a switch port administrative fill factor of 94 percent.[1061] We now adopt that proposed value. The HAI model documentation defines the switch port administrative fill as "the percent of lines in a switch that are assigned to subscribers compared to the total equipped lines in a switch."[1062] HAI assigns a switch port administrative fill factor of 98 percent in its default input values.[1063] The

[1055] AT&T Jan. 7 *ex parte*. The HAI proponents included the updated switch capacity constraints in a table attached to the Jan. 7 *ex parte*.

[1056] AT&T Jan. 7 *ex parte*.

[1057] AT&T Jan. 7 *ex parte*.

[1058] Sprint *Inputs Further Notice* comments at 49.

[1059] *See* HAI Dec. 11 submission, Model Inputs at 80.

[1060] In addition, we note that a decision to adopt the revised HAI values for maximum equipped lines per switch would have only a minimal impact on the overall forward-looking cost estimation because fewer than 2 percent of wire centers have more than 80,000 lines. A review of the data indicates that, of the 12,506 wire centers served by non-rural LECs, only 189 (1.5 percent) have more than 80,000 lines and 57 (0.5 percent) have more than 100,000 lines. *See* HAI Feb. 3, 1998 model submission.

[1061] *Inputs Further Notice* at para. 184.

[1062] HAI Dec. 11, 1997 submission, Inputs Portfolio at 80.

[1063] HAI Dec. 11, 1997 submission, Inputs Portfolio at 80.

BCPM default value for the switch percent line fill is 88 percent.[1064]

331. Bell Atlantic contends that switches have significant unassigned capacity due to the fact that equipment is installed at intervals to handle growth.[1065] Sprint recommends an average fill factor of 80 percent.[1066] US West contends that its actual average fill factor is 78 percent.[1067] AT&T and MCI contend that the switching module currently applies the fill factor input against the entire switch when it should be applied only to the line port portion of the switch.[1068] AT&T and MCI therefore contend that, either the formula should be modified, or the input needs to be adjusted upward so that the overall switching investment increase attributable to line fill will be the same as if the formula were corrected.[1069]

332. We note that the switch port administrative fill factor of 94 percent has been adopted in several state universal service proceedings and is supported by the Georgetown Consulting Group, a consultant of BellSouth.[1070] We also note that this value falls within the range established by the HAI and BCPM default input values. The BCPM model documentation established a switch line fill default value of 88 percent that included "allowances for growth over an engineering time horizon of several years."[1071] Sprint has provided no substantiated evidence to support its revised value of 80 percent. US West's average fill factor of 78 percent is based on data that include switches with unreasonably low fill factors.[1072] Regarding AT&T and

[1064] BCPM April 30, 1998 submission, Switch Model Inputs at 20-21. BCPM defines Switch Percent Line Fill as the ratio between the number of working lines on the switch and the total number of lines for which the switch is engineered.

[1065] Bell Atlantic *Inputs Further Notice* comments at 8-9.

[1066] Sprint *Inputs Further Notice* comments at 50.

[1067] *See* Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated Jan. 8, 1999 (attachment includes US West switch data) (Sprint Jan. 8 *ex parte*).

[1068] AT&T/MCI *Inputs Further Notice* comments at 43.

[1069] AT&T/MCI *Inputs Further Notice* comments at 43.

[1070] BellSouth *Inputs Public Notice* reply comments at Exhibit 2-13; Commonwealth of Kentucky, *An Inquiry Into Universal Service and Funding Fees*, Administrative Case No. 360, App. F at 13; Louisiana Public Service Commission, *State Forward-Looking Cost Studies for Federal Universal Service Support* (May 19, 1998) (Louisiana Cost Study).

[1071] BCPM April 30, 1998 submission, Switch Model Inputs at 20-21.

[1072] For example, switches with installed lines of 65,001, 48,818, 11,520, 12,288, 74,039, 12,800, and 36,897 were listed as having, 1,1, 2, 10, 10, 21, and 26 working lines, respectively, or collectively, an average fill factor of .027 percent. *See* Sprint Jan. 8 *ex parte*. Our analysis of the US West data indicated that, after eliminating the

MCI's contention that the switching module currently applies the fill factor input against the entire switch rather than the line port portion of the switch, we note that this occurs only when the host-remote option is not utilized in the switch module. As noted above, we are using the host-remote option and therefore no adjustment to the switch fill factor is required. We therefore adopt a switch port administrative fill factor of 94 percent.

333. Trunking. In the *Inputs Further Notice*, we tentatively concluded that the switch module should be modified to disable the computation that reduces the end office investment by the difference in the interoffice trunks and the 6:1 line to trunk ratio. In addition, we tentatively adopted the proposed input value of $100.00 for the trunk port investment.[1073] We now affirm these tentative conclusions and adopt this approach.

334. The HAI switching and interoffice module developed switching cost curves using the Northern Business Information (NBI) publication, "U.S. Central Office Equipment Market: 1995 Database."[1074] These investment figures were then reduced per line to remove trunk port investment based on NBI's implicit line to trunk ratio of 6:1.[1075] The actual number of trunks per wire center is calculated in the transport calculation, and port investment for these trunks is then added back into the switching investments.

335. Sprint notes that, under the HAI trunk investment approach, raising the per-trunk investment leads to a decrease in the switch investment per line, "despite a reasonable and expected increase" in the investment per line.[1076] GTE also notes that the selection of the trunk port input value creates a dilemma in that it is used to reduce the end office investment, as noted above, and to develop a tandem switch investment.[1077] GTE and Sprint recommend that the switch module be modified by disabling the computation that reduces the end office investment by the difference in the computed interoffice trunks and the 6:1 line to trunk ratio.[1078] MCI agrees that the trunk port calculation should be deactivated in the switching module.[1079]

---

observations with unreasonably low fill factors, the majority of US West switches had fill factors ranging from 88 percent to 98 percent.

[1073] *Inputs Further Notice* at para. 187.

[1074] HAI Dec. 11, 1997 submission, Model Description at 52.

[1075] HAI Dec. 11, 1997 submission, Model Description at 53.

[1076] Sprint Dec. 22 *ex parte* at 10.

[1077] GTE Dec. 18 *ex parte* at 6.

[1078] GTE Dec. 18 *ex parte* at 6; Sprint *Inputs Further Notice* comments at 50.

[1079] Letter from Chris Frentrup, MCI Worldcom, to Magalie Roman Salas, FCC, dated Feb. 9, 1999 (MCI

336. In the *Inputs Further Notice*, we agreed with commenters that the trunk port input creates inconsistencies in reducing the end office investment.[1080] Consistent with the suggestions made by GTE and MCI, we conclude that the switch module should be modified to disable the computation that reduces the end office investment by the difference in the computed interoffice trunks and the 6:1 line to trunk ratio. Sprint, the only commenter to address this issue in response to the *Inputs Further Notice*, agrees with our conclusion.[1081]

337. Because the trunk port input value is also used to determine the tandem switch investment, we must determine the trunk port investment.[1082] In the *Inputs Further Notice*, we proposed an input value for trunk port investment per end of $100.00.[1083] SBC and Sprint contend that this value should be higher -- ranging from $150.00 to $200.00.[1084] BellSouth has filed information on the record that supports our proposed trunk port investment value.[1085] BellSouth notes that the four states that have issued orders addressing the cost of the trunk port for universal service[1086] have chosen estimates of the cost of the trunk port that range from $62.73 to $110.77.[1087] We conclude that the record supports the adoption of a trunk port investment per end of $100.00, as supported by the HAI default values. As noted above, this value is consistent with the findings of several states and BellSouth. In addition, we note that SBC and Sprint provide no data to support their higher proposed trunk port investment value. We therefore adopt the HAI suggested input value of $100.00 for the trunk port investment, per end.

VII. EXPENSES

Worldcom Feb. 9 *ex parte*) at 24.

[1080] *Inputs Further Notice* at para. 190.

[1081] Sprint *Inputs Further Notice* comments at 50.

[1082] HAI defines this input as the "per trunk equivalent investment in switch trunk port at each end of a trunk." HAI Dec. 11, 1997 submission, Appendix B (HM 5.0 Inputs, Assumptions, and Default Values) at 46.

[1083] *Inputs Further Notice* at para. 191.

[1084] SBC *Inputs Further Notice* comments at 14; Sprint *Inputs Further Notice* comments at 50.

[1085] Letter from William W. Jordan, BellSouth, to Magalie Roman Salas, FCC, dated August 7, 1998, Attachment to Question 1 at 5, 9, 13, 17 (dated July 15, 1998) (BellSouth Aug. 7 *ex parte*).

[1086] BellSouth Aug. 7 *ex parte*, Attachment to Question 1 at 5, 9, 13, 17. The four states are Kentucky, Louisiana, North Carolina, and South Carolina.

[1087] BellSouth Aug. 7 *ex parte*, Attachment to Question 1 at 5, 9, 13, 17.

A. Introduction

338. In this section, we consider the inputs to the model related to expenses and general support facilities (GSF) investment. Consistent with the *Universal Service Order's* seventh criterion, we select input values that result in a reasonable allocation of joint and common costs for non-network-related costs, such as GSF, plant non-specific expenses, corporate operations expenses, and customer services expenses. The Commission's methodology for estimating these types of expenses is designed to "ensure that the forward-looking economic cost [calculated by the model] does not include an unreasonable share of the joint and common costs for non-supported services."[1088] Consistent with the *Universal Service Order's* first and third criteria, we also select input values for plant-specific operations expenses that reflect the cost of maintaining a forward-looking network.[1089]

339. GSF costs include the investment and expenses related to vehicles, land, buildings, and general purpose computers. Other expenses include: plant-specific operations expenses,[1090] plant non-specific expenses,[1091] corporate operations expenses,[1092] and customer services expenses.[1093] For purposes of this Order, costs associated with common support services (often called overhead expenses) refer to plant non-specific expenses, corporate operations expenses, and customer services expenses.

340. In the *Platform Order*, the Commission adopted HAI's algorithm for calculating expenses and GSF costs, as modified to provide some additional flexibility in calculating expenses offered by the BCPM sponsors.[1094] With this added flexibility, the model allows the user to estimate expenses as either a per-line amount or as a percentage of investment. We noted that many of the questions regarding how best to calculate expenses would be resolved in the

[1088] *Universal Service Order*, 12 FCC Rcd at 8915, para. 250, criterion 7; *see also* 47 U.S.C. § 254 (k).

[1089] *See Universal Service Order*, 12 FCC Rcd at 8913, para. 250, criteria 1, 3; *see also infra* para. 351.

[1090] Plant specific operations expenses (that are not associated with GSF) include the cost of maintaining telecommunications plant and equipment. These network related expenses are not considered to be "joint and common costs." In ARMIS accounts, plant-specific operations expenses include GSF expenses.

[1091] Plant non-specific expenses include the costs of engineering, network operations, and power expenses.

[1092] Corporate operations expenses include the costs of administration, human resources, legal, and accounting expenses.

[1093] Customer services expenses include the costs of marketing, billing, and directory listing expenses.

[1094] *Platform Order*, 13 FCC Rcd at 21357, para. 81.

input selection phase of this proceeding.[1095] In the *Inputs Further Notice*, we tentatively concluded that the input values for plant-specific operations expenses should be calculated as a percentage of investment,[1096] and that the input values for common support services expenses should be estimated on a per-line basis.[1097] In addition, we tentatively concluded that we should adopt input values that reflect the average expenses that will be incurred by non-rural carriers, rather than company-specific expense estimates.[1098] As described below, we proposed methodologies for calculating these expenses. In addition, we proposed a methodology for estimating the GSF investment that should be allocated to the supported services.[1099]

B. Plant-Specific Operations Expenses

1. Background

341. Plant-specific operations expenses are the expense costs related to the maintenance of specific kinds of telecommunications plant.[1100] In the *Inputs Further Notice,* we

[1095] *Platform Order*, 13 FCC Rcd at 21360, para. 87.

[1096] *Inputs Further Notice* at para. 204.

[1097] *Inputs Further Notice* at para. 213.

[1098] *Inputs Further Notice* at paras. 198, 214.

[1099] *Inputs Further Notice* at paras. 210-11.

[1100] Plant-specific operations expenses correspond to the following ARMIS 43-03 report accounts:

6110 - Network Support Expense
6120 - General Support Expense
6210 - COE Switch
    6212 - COE Digital Electronic Switch only
6220 - Operator Systems
6230 - COE Transmission
    6231 - Radio Systems
    6232 - COE Circuit - DDS
    6232 - COE Circuit - Other than DDS
6310 - Information Origination/Termination
    6311 - Station Apparatus (only)
6341 - Large PBX
6351 - Public Telephone
6362 - Other Terminal Equipment
6411 - Poles
6421.1 - Aerial Cable - Metallic (Copper)
6421.2 - Aerial Cable - Fiber
6422.1 - Underground Cable - Metallic (Copper)

proposed a methodology for estimating expense-to-investment ratios consisting of four steps.[1101] First, we obtained account-specific current cost to book cost (current-to-book) ratios for the related investment accounts, for the years ending 1995 and 1996, from Ameritech, Bell Atlantic, BellSouth, GTE, and SBC.[1102] Second, we calculated two sets of composite current-to-book ratios (year end 1995 and 1996) for each account based on composite current-to-book ratios for each of the five companies.[1103] Third, we applied these composite current-to-book ratios to the year-end 1995 and 1996 investment account balances from the ARMIS 43-03 reports for all ARMIS-filing companies and averaged the 1995 and 1996 adjusted balances for each account.[1104] Fourth, we calculated expense-to-investment ratios for each plant-specific operations expense account by dividing the total 1996 account balance for all ARMIS-filing companies by the current average investment calculated previously.[1105] We tentatively

---

6422.2 - Underground Cable - Fiber
6423.1 - Buried Cable - Metallic (Copper)
6423.2 - Buried Cable - Fiber
6441 - Conduit Systems

[1101] *Inputs Further Notice* at paras. 205-208.

[1102] *Inputs Further Notice* at para. 205. For each account or sub-account, a current-to-book ratio is developed by first revaluing each type of equipment at its current replacement cost. The sum of these current costs is then divided by the total, embedded cost account balance. The resulting current-to-book ratio will be greater than one if current costs are rising relative to the historic costs and less than one if current costs are declining. The current-to-book ratios submitted by Ameritech, Bell Atlantic, BellSouth, GTE, and SBC are proprietary information subject to provisions in the *Protective Order* and therefore are not reproduced here. Although we would prefer to have data from more companies, the other ARMIS-filing carriers informed us that they either no longer maintain this type of information, or never used current-to-book ratios for accounting purposes.

[1103] *Inputs Further Notice* at para. 206. For each study area of the five holding companies that provided current-to-book ratios, we obtained year-end 1995 and 1996 investment balances from ARMIS for the plant accounts consistent with the aforementioned plant-specific expense accounts. Study area-specific current-to-book ratios for the two periods were multiplied by the 1995 and 1996 ARMIS investments in each account to derive the forward-looking, "current," year-end 1995 and 1996 investment levels by account and by study area. The ARMIS and current investments were then summed separately, by year and by account, for all study areas of the five holding companies. The resulting total current investment (by year and by account for the sum of all study areas) was then divided by the total ARMIS investment (by year and by account for the sum of all study areas) producing two sets of composite current-to-book ratios (year end 1995 and 1996).

[1104] *Inputs Further Notice* at para. 207. To calculate the expense-to-investment ratios for the plant-specific operations expense accounts, we obtained total, year-end 1995 and 1996 investment account balances from the ARMIS 43-03 reports for all ARMIS-filing companies. To make these embedded account balances forward-looking, we next multiplied each investment account balance for each year by the current-to-book ratios for the same year developed earlier. The resulting year-end 1995 and year-end 1996 "current" account balances were then averaged by adding the two years together and dividing by two.

[1105] *Inputs Further Notice* at para. 208. From the 1996 ARMIS 43-03 report, we obtained the 1996 balances for each plant-specific operations expense account for all ARMIS-filing companies. The expense account balances concluded that these expense-to-investment ratios should be applied to the model-derived investment balances to obtain forward-looking plant-specific operations expense estimates.

342. In the *Inputs Further Notice*, we proposed adopting input values that reflect the average expenses that will be incurred by non-rural carriers, rather than a set of company-specific maintenance expense estimates, for several reasons.[1106] We stated that using nationwide expense-to-investment ratios is consistent with the views of the states as reflected in the state Joint Board staff recommendations.[1107] In addition, our proposed methodology requires some method of converting booked cost investment to current investment in order to estimate forward-looking plant specific operations expenses based on present day replacement cost, rather than historic, financial account balances. We noted that we have not been able to obtain current-cost-to-book-cost ratios for each non-rural ARMIS reporting firm, which would be necessary to calculate company or study area specific expense-to-investment ratios.[1108] We tentatively concluded that averages are more consistent with the forward-looking nature of the high-cost model because less efficient firms are not rewarded if they have higher than average costs. In seeking comment on these proposals and tentative conclusions, we requested that parties advocating the use of company-specific values or other alternatives to nationwide or regional estimates identify the method and data readily available that could be used to estimate plant-specific expenses and indicate how their proposal is consistent with the goal of estimating forward-looking costs.[1109]

343. In reaching our tentative conclusions, we recognized that parties have argued that maintenance expenses vary widely by geographic area and type of plant, while others have argued that plant-specific expenses are highly dependent on regional wage differences.[1110] We explained that the synthesis model takes into account the variance in maintenance cost by type of plant installed because, as investment in a particular type of plant varies, the associated expense cost also varies.[1111] We noted that we had been unable to verify significant regional differences among study areas or companies based solely on labor rate variations using the publicly available ARMIS expense account data for plant-specific maintenance costs. Nonetheless, we

were divided by their respective average "current" investment to obtain expense-to-investment ratios.

1106 *Inputs Further Notice* at para. 198.

1107 *See* State Members' Report on the Use of Cost Proxy Models, March 26, 1997, at 22.

1108 *Inputs Further Notice* at para. 198.

1109 *Inputs Further Notice* at para. 198.

1110 *Inputs Further Notice* at para. 199.

1111 *Inputs Further Notice* at para. 199.

sought comment on the degree to which regional wage rate differentials exist and are significant, and asked parties to suggest independent data sources on variations of wage rates between regions and a methodology that permits such distinctions without resorting to self-reported information from companies.[1112] In addition, we sought specific comment on a possible method of estimating regional wage differences by using indexes calculated by the President's Pay Agent.[1113]

344. We also tentatively concluded that we should not adopt different expense estimates for small, medium, and large non-rural companies on a per-line basis.[1114] We explained that we had tested whether significant differences in maintenance expenses per line could be discerned from segmenting companies into carriers serving less than 500,000 access lines, carriers serving between 500,000 and 5,000,000 access lines, and carriers serving over 5,000,000 access lines.[1115] Because we found no significant differences in the expense factor per-line or per-investment estimates based on these criteria, we determined that economies of scale should not be a factor in estimating plant-specific expenses.[1116]

345. Finally, we noted that we used data from 1995 and 1996 in the proposed methodology and tentatively concluded that it is appropriate to adjust these data to account for inflation and changes in productivity by obtaining revised 1997 current-to-book ratios from those companies providing data.[1117] In addition, we tentatively concluded that we should use the most current ARMIS data available for the maintenance factor methodology. We sought comment on using the most current data available in the final computation of expense estimates.[1118]

2. Discussion

346. Consistent with our tentative conclusions, we adopt input values that reflect the average expenses that will be incurred by non-rural carriers, rather than a set of company-

---

[1112] *Inputs Further Notice* at para. 199.

[1113] *Inputs Further Notice* at para. 200. These indexes are used to calculate locality pay differentials for federal employees. *See Report on Locality-based Comparability Payments for the General Schedule,* Annual Report of the President's Pay Agent, Appendix II, 1995.

[1114] *Inputs Further Notice* at para. 201.

[1115] *Inputs Further Notice* at para. 201.

[1116] *Inputs Further Notice* at para. 201.

[1117] *Inputs Further Notice* at para. 209.

[1118] *Inputs Further Notice* at para. 209.

specific maintenance expense estimates. We adopt our proposed four-step methodology for estimating expense-to-investment ratios using revised current-to-book ratios and 1997 and 1998 ARMIS data. We clarify that the ARMIS investment and expense balances used to calculate the expense-to-investment ratios in steps three and four should be based on the accounts for all *non-rural* ARMIS-filing companies. Although some rural companies file ARMIS reports, the mechanism we adopt today will be used, beginning January 1, 2000, to determine high-cost support only for non-rural carriers. We find, therefore, that it is appropriate to include only data from the non-rural ARMIS-filing companies in calculating these expense-to-investment ratios.[1119]

347. Current Data. Parties commenting on whether we should update our methodology using more current ARMIS data agree that we should use the most currently available data.[1120] We obtained account-specific current-to-book ratios for the related plant investment accounts, for the years ending 1997 and 1998, from Ameritech, Bell Atlantic, BellSouth, GTE, and SBC.[1121] Accordingly, we adopt input values using these updated current-to-book ratios and 1997 and 1998 ARMIS data to calculate the expense-to-investment ratios that we use to obtain plant-specific operations expense estimates for use in the federal mechanism. These input values and the non-proprietary data used to calculate the expense-to-investment ratios are set forth in Appendix D.[1122]

348. Nationwide Estimates. As discussed in this section, we adopt nationwide average values for estimating plant-specific operations expenses rather than company-specific values for several reasons. We reject the explicit or implicit assumption of most LEC commenters that the cost of maintaining incumbent LEC embedded plant is the best predictor of the forward-looking cost of maintaining the network investment predicted by the model. We find that, consistent with the *Universal Service Order's* criteria, forward-looking expenses should reflect the cost of maintaining the least-cost, most-efficient, and reasonable technology being deployed today, not the cost of maintaining the LECs' historic, embedded plant. We recognize that variability in

[1119] Our proposed expense-to-investment ratios were based on ARMIS data for 91 study areas. The input values we adopt herein are based on ARMIS data for 80 non-rural study areas. We note that there generally is little or no difference between the expense ratios calculated using total ARMIS expense and investment accounts and non-rural ARMIS expense and investment. Where there are differences, the ratios based on non-rural data are higher for all categories except network support and general support.

[1120] *See, e.g.,* GTE *Inputs Further Notice* comments at 76; Sprint *Inputs Further Notice* comments at 59.

[1121] Due to the manner in which SBC develops current-to-book ratios for each year (average beginning and end-of-year current investment divided by average beginning and end-of-year embedded investment) year-end 1998 current-to-book ratios are not available for SBC. Therefore, we applied year-end 1997 current-to-book ratios to both SBC's year-end 1997 and year-end 1998 investment in developing 1998 expense-to-investment ratios.

[1122] *See* Appendix D at D-4.

historic expenses among companies is due to a variety of factors and does not simply reflect how efficient or inefficient a firm is in providing the supported services. We reject arguments of the LECs, however, that we should capture this variability by using company-specific data in the model. We find that using company-specific data for federal universal service support purposes would be administratively unmanageable and inappropriate. Moreover, we find that averages, rather than company-specific data, are better predictors of the forward-looking costs that should be supported by the federal high-cost mechanism. In addition, we find that using nationwide averages will reward efficient companies and provide the proper incentives to inefficient companies to become more efficient over time, and that this reward system will drive the national average toward the cost that the competitive firm could achieve. Accordingly, we affirm our tentative conclusion that we should adopt nationwide average input values for plant-specific operations expenses.

349. AT&T and MCI agree with our tentative conclusion that we should adopt input values that reflect the average expenses incurred by non-rural carriers, rather than company-specific expenses. They argue that the universal service support mechanism should be based on the costs that an efficient carrier *could* achieve, not on what any individual carriers *has* achieved.[1123] In contrast, incumbent LEC commenters argue that we should use company-specific values.[1124]

350. BellSouth, for example, contends that the approach suggested by AT&T and MCI conflicts with the third criterion for a cost proxy model, which states that "[t]he study or model, however, must be based upon an examination of the current cost of purchasing facilities and equipment . . .."[1125] BellSouth argues that the "only logical starting point for estimating forward-looking expenses is the current actual expenses of the ILECs."[1126] We agree that we should start with current actual expenses, as we do, in estimating forward-looking maintenance expenses. We do not agree with the inferences made by the incumbent LEC commenters, however, that our input values should more closely match their current maintenance expenses.

351. BellSouth's reliance on criterion three fails to quote the first part of that criterion, which states:

[1123] AT&T/MCI *Inputs Further Notice* comments at 45.

[1124] *See, e.g.,* Bell Atlantic *Inputs Further Notice* comments at 20-21; BellSouth *Inputs Further Notice* comments at B-16, B-18; GTE *Inputs Further Notice* comments at 75-76.

[1125] *See* BellSouth *Inputs Further Notice* reply comments at 17 (citing *Universal Service Order*, 12 FCC Rcd at 8913, para. 250, criterion three).

[1126] BellSouth *Inputs Further Notice* reply comments at 17-18.

> Only long-run forward-looking economic cost may be included. The long-run period must be a period long enough that all costs may be treated as variable and avoidable. The costs must not be the embedded cost of facilities, functions, or elements.[1127]

Thus, the model's forward-looking expense estimates should not reflect the cost of maintaining the incumbent LEC's embedded plant. The *Universal Service Order's* first criterion specifies that "[t]he technology assumed in the cost study or model must be the least-cost, most efficient, and reasonable technology for providing the supported services that is currently being deployed."[1128] As we explained in the *Inputs Further Notice*, while the synthesis model uses existing incumbent LEC wire center locations in designing outside plant, it does not necessarily reflect existing incumbent LEC loop plant.[1129] Indeed, as the Commission stated in the *Platform Order*, "[e]xisting incumbent LEC plant is not likely to reflect forward-looking technology or design choices."[1130] Thus, for example, the model may design outside plant with more fiber and DLCs and less copper cable than has been deployed historically in an incumbent LEC's network. We find that the forward-looking maintenance expenses also should reflect changes in technology.

352. GTE argues that expense-to-investment ratios should not be developed as national averages, because no national average can reflect the composition of each company's market demographics and plant.[1131] GTE argues further that costs vary by geographic area and that this variability reflects operating difficulties due to terrain, remoteness, cost of labor, and other relevant factors.[1132] GTE contends that "[u]sing national average operating expenses will either understate or overstate the forward-looking costs of providing universal service for each carrier, depending on the variability of each company to the average."[1133] GTE claims that the use of the national average penalizes efficient companies that operate in high-cost areas.[1134]

[1127] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion three).

[1128] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

[1129] *Inputs Further Notice* at para. 50.

[1130] *Platform Order*, 12 FCC Rcd at 21350, para. 66. "Instead, incumbent LECs' existing plant will tend to reflect choices made at a time when different technology options existed or when the relative cost of equipment to labor may have been different than it is today." *Id.*

[1131] GTE *Inputs Further Notice* comments at 76.

[1132] GTE *Inputs Further Notice* comments at 73.

[1133] GTE *Inputs Further Notice* comments at 72.

[1134] GTE *Inputs Further Notice* comments at 73.

353. Similarly, Sprint contends that the use of nationwide estimated data does not accurately depict the realities of operating in Sprint's service territories.[1135] Sprint claims that the national averages are far below Sprint's actual costs, because the Commission's methodology for estimating plant-specific expense inputs is heavily weighted toward the Bell companies' urban operating territories.[1136] According to Sprint, the Bell companies have a much higher access line density than Sprint, and the expense data from such companies with a higher density of customers will result in expense levels that are much lower than the expense levels experienced by smaller carriers.[1137] AT&T and MCI respond by showing that a particular small carrier, serving a lower density area than Sprint, has plant-specific expenses that, on a per-line basis, are less than half of Sprint's expenses.[1138] AT&T and MCI claim that "the most significant driver of cost differences between carriers in the ARMIS study area data is *efficiency*."[1139] Like other LECs, SBC argues that the costs for LECs vary dramatically, based on various factors including size, operating territories, vendor contracts, relationships with other utility providers and the willingness to accept risk.[1140] SBC asserts that "[t]hese differences are not in all instances attributable to inefficient operations."[1141]

354. We agree with SBC that not all variations in costs among carriers are due to inefficiency. Although we believe that some cost differences are attributable to efficiency, we are not convinced by AT&T and MCI's example that Sprint is less efficient than the small carrier they identify. Sprint could have higher maintenance costs because it provides higher quality service. But we also are not convinced by Sprint's argument that maintenance expenses necessarily are inversely proportional to density. Sprint provides no evidence linking higher maintenance costs with lower density zones, and we can imagine situations where there are maintenance costs in densely populated urban areas that are not faced by carriers in low density areas. For example, busy streets may need to be closed and traffic re-routed, or work may need to be performed at night and workers compensated with overtime pay.

355. We cannot determine from the ARMIS data how much of the differences among

[1135] Sprint *Inputs Further Notice* comments at 51.

[1136] Sprint *Inputs Further Notice* comments at 51.

[1137] Sprint *Inputs Further Notice* comments at 51-52.

[1138] AT&T/MCI *Inputs Further Notice* reply comments at 38 n.58.

[1139] AT&T/MCI *Inputs Further Notice* reply comments at 38 n.58.

[1140] SBC *Inputs Further Notice* comments at 4.

[1141] SBC *Inputs Further Notice* comments at 4.

companies are attributable to inefficiency and how much can be explained by regional differences or other factors. BellSouth's consultant concedes that there is nothing in the ARMIS expense account data that would enable the Commission to identify significant regional differences.[1142] GTE concedes that it may be difficult to analyze some data because companies have not been required to maintain a sufficient level of detail in their publicly available financial records.[1143] GTE's proposed solution for reflecting variations among states is simply to use company-specific data.[1144] Indeed, none of the LECs propose a specific alternative to using self-reported information from companies.[1145] For example, SBC argues we should use company-specific expenses provided pursuant to the *Protective Order* to develop company-specific costs, because these are the costs that will be incurred by the providers of universal service.[1146]

356. While reliance on company-specific data may be appropriate in other contexts, we find that, for federal universal service support purposes, it would be administratively unmanageable and inappropriate. The incumbent LECs argue that virtually all model inputs should be company-specific and reflect their individual costs, typically by state or by study area.[1147] As parties in this proceeding have noted, selecting inputs for use in the high-cost model is a complex process.[1148] Selecting different values for each input for each of the fifty states, the District of Columbia, and Puerto Rico, or for each of the 94 non-rural study areas, would increase the Commission's administrative burden significantly.[1149] Unless we simply accept the data the companies provide us at face value, we would have to engage in a lengthy process of verifying the reasonableness of each company's data. For example, in a typical tariff

---

1142 BellSouth *Inputs Further Notice* comments, Attachment A at A-13. (comments of Georgetown Consulting Group, Inc.).

1143 GTE *Inputs Further Notice* comments at 73.

1144 GTE *Inputs Further Notice* comments at 73.

1145 In its reply comments, Sprint argues that inputs should vary by company size and region, but does not provide a specific methodology for doing so. *See* Sprint *Inputs Further Notice* reply comments at 3-4.

1146 SBC *Inputs Further Notice* comments at 14-15.

1147 *See, e.g.,* Bell Atlantic *Inputs Further Notice* comments at 20-21; BellSouth *Inputs Further Notice* comments, Attachment B at B-16, B-18; GTE *Inputs Further Notice* comments at 75-76.

1148 *See, e.g.,* AT&T/MCI *Inputs Further Notice* reply comments at 3-7.

1149 There are 94 non-rural study areas. As noted above, the expense-to-investment ratios were calculated using ARMIS data for 80 non-rural study areas. There are more non-rural study areas than there are non-rural study areas for which we have ARMIS data because some non-rural companies do not file ARMIS data (Roseville, North State, and Contel of Minnesota) and some ARMIS-filing companies file consolidated data for combined study areas (Puerto Rico, some GTE companies). *See supra* note 756.

investigation or state rate case, regulators examine company data for one-time high or low costs, pro forma adjustments, and other exceptions and direct carriers to adjust their rates accordingly. Scrutinizing company-specific data to identify such anomalies and to make the appropriate adjustments to the company-proposed input values would be exceedingly time consuming and complicated given the number of inputs to the model.[1150] We recognize that such anomalies invariably exist in the ARMIS data, but we find that, by using averages, high and low values will cancel each other out.

357. Where possible, we have tried to account for variations in cost by objective means. As we stated in the *Inputs Further Notice*, we believe that expenses vary by the type of plant installed.[1151] The model takes this variance into account because, as investment in a particular type of plant varies, the associated expense cost also varies. The model reflects differences in structure costs by using different values for the type of plant, the density zone, and soil conditions.

358. As discussed above, we cannot determine from the ARMIS data how much of the differences among companies are attributable to inefficiency and how much can be explained by regional differences or other factors. To the extent that some cost differences are attributable to inefficiency, using nationwide averages will reward efficient companies and provide the proper incentives to inefficient companies to become more efficient over time. We find that it is reasonable to use nationwide input values for maintenance expenses because they provide an objective measure of forward-looking expenses. In addition, we find that using nationwide averages in consistent with our forward-looking economic cost methodology, which is designed to send the correct signals for entry, investment, and innovation.

359. Bell Atlantic contends that using nationwide averages for plant specific expenses, rather than ARMIS data disaggregated to the study area level, defeats the purpose of a proxy model because it averages high-cost states with low-cost states.[1152] Bell Atlantic argues that we should use the most specific data inputs that are available, whether region-wide, company specific, or study-area specific.[1153] Conceding that data are not always available at fine levels of disaggregation, Bell Atlantic contends there is no reason to throw out data that more accurately

[1150] As discussed below, when the Commission has had the opportunity to scrutinize carriers' company-specific costs, as with the local number portability tariffs, we use company-specific input values in the model. *See infra* at para. 408.

[1151] *Inputs Further Notice* at para. 199.

[1152] Bell Atlantic *Inputs Further Notice* comments at 20.

[1153] Bell Atlantic *Inputs Further Notice* comments at 20.

identify the costs in each area.[1154] Bell Atlantic argues that, even if the Commission does not have current-to-book ratios for all of the ARMIS study areas, it could use average current-to-book ratios and apply them to company-specific ARMIS data.[1155]

360. Contrary to Bell Atlantic's contention, we do not find that using nationwide average input values in the federal high-cost mechanism is inconsistent with the purpose of using a cost model. In addition to the administrative difficulties outlined above, we find that nationwide values are generally more appropriate than company-specific input values for use in the federal high-cost model. In using the high-cost model to estimate costs, we are trying to establish a national benchmark for purposes of determining support amounts. The model assumes, for example, that all customers will receive a certain quality of service whether or not carriers actually are providing that quality of service.[1156] Because differences in service quality can cause different maintenance expense levels, by assuming a consistent nationwide quality of service, we control for variations in company-specific maintenance expenses due to variations in quality of service. Clearly, we are not attempting to identify any particular company's cost of providing the supported services. We are, as AT&T and MCI suggest,[1157] estimating the costs an efficient provider would incur in providing the supported services. We are not attempting to replicate past expenses, but to predict what support amounts will be sufficient in the future. Because high-cost support is portable, a competitive eligible telecommunications carrier, rather than the incumbent LEC, may be the recipient of the support. We find that using nationwide averages is a better predictor of the forward-looking costs that should be supported by the federal high-cost mechanism than any particular company's costs.[1158]

361. Estimating regional wage differences. We do not adjust our nationwide input values for plant-specific operations expenses to reflect regional wage differences. Most LEC commenters advocate the use of company-specific data to reflect variations in wage rates.[1159] GTE, for example, claims that regional wage rate differentials are reflected in the company-

[1154] Bell Atlantic *Inputs Further Notice* comments at 20.

[1155] Bell Atlantic *Inputs Further Notice* comments at 20.

[1156] In contrast, if we were determining the rates a carrier could charge for a particular service, the quality of service the carrier actually was providing could be a relevant factor.

[1157] *See supra* para. 349; AT&T/MCI *Inputs Further Notice* comments at 45.

[1158] As noted above, the Commission has not considered what type of input values, company-specific or nationwide, nor what specific input values, would be appropriate for any other purposes and caution parties from making any claims in other proceedings based upon the input values we adopt in this Order. *See supra* para. 32.

[1159] *See, e.g.,* Bell Atlantic *Inputs Further Notice* comments at 20; GTE *Inputs Further Notice* comments at 74-75; Sprint *Inputs Further Notice* comments at 54.

specific data available from ARMIS.[1160] GTE complains that our proposed input values suggest there is no difference in labor and benefits costs between a company operating in Los Angeles and one operating in Iowa.[1161] As discussed above, the publicly available ARMIS expense account data for plant-specific maintenance expenses do not provide enough detail to permit us to verify significant regional differences among study areas or companies based solely on labor rate variations.[1162] For the reasons discussed above, we find that we should not use company-specific ARMIS data to estimate these expenses, but instead use input values that reflect nationwide averages.[1163]

362. Although they would prefer that we use company-specific data, some LEC commenters suggest that the wage differential indexes used by the President's Pay Agent, on which we sought comment, would be an appropriate method of disaggregating wage-related ARMIS expense data.[1164] GTE, on the other hand, contends that these indexes are not relevant to the telecommunications industry, because they are designed for a specific labor sector, that is, federal employees.[1165] GTE claims that there are numerous publicly available sources of labor statistics and that, if we adopt an index factor, it should be specific to the telecommunications industry.[1166]

363. We agree with GTE that, if we were to use an index to adjust our input values for regional wage differences, it would be preferable to use an index specific to the telecommunications industry. We looked at other publicly available sources of labor statistics, however, and were unable to find a data source that could be adapted easily for making meaningful adjustments to the model input values for regional wage differences. Specifically, we looked at U.S. Department of Labor, Bureau of Labor Statistics (BLS) information on wage rate differentials for communications workers comparing different regions of the country.[1167]

[1160] GTE *Inputs Further Notice* comments at 74-75.

[1161] GTE *Inputs Further Notice* comments at 74-75.

[1162] *See supra* para. 355.

[1163] *See supra* para. 356.

[1164] Bell Atlantic *Inputs Further Notice* comments at 21; Sprint *Inputs Further Notice* comments at 54.

[1165] GTE *Inputs Further Notice* comments at 75.

[1166] GTE *Inputs Further Notice* comments at 75.

[1167] *See* Bureau of Labor Statistics, Employment Cost Trends, Employment Cost Index, June 1999, at http://www.bls.gov/news.releases/eci.toc.htm. In particular, we looked at the following tables: Table 4, Compensation (not seasonally adjusted), Employment Cost Index for total compensation, private industry workers, by bargaining status, region and area; Table 5, Wages and Salaries (not seasonally adjusted), Employment Cost

The Employment Cost Indexes calculated by BLS identify changes in compensation costs for communications workers as compared to other industry and occupational groups. In a number of the indexes, communications is not broken out separately, but is included with other service-producing industries: transportation, communication, and public utilities; wholesale and retail trade; insurance, and real estate; and service industries. In making regional comparisons, the Employment Cost Indexes divide the nation into four regions: northeast, south, midwest, and west. There also are separate indexes comparing metropolitan areas to other areas.

364. We find that the regions used in the BLS data are too large to make any significant improvement over our use of nationwide average numbers. For example, Wyoming is in the same region as California, but we have no reason to believe that wages in those two states are more comparable than wages rates in California and Iowa. That is, there is no simple way to use the BLS data to make the type of regional wage adjustments suggested by GTE. We note that no party has suggested a specific data source or methodology that would be useful in making such adjustments. Accordingly, we decline to adopt a method for adjusting our nationwide input values for plant-specific operations expenses to reflect regional wage differences.

365. Methodology. As discussed in this section, we adopt our proposed methodology for calculating expense-to-investment ratios to estimate plant-specific operations expenses. We reject arguments of some LEC commenters that this methodology inappropriately reduces these expense estimates.

366. Several LEC commenters generally support our methodology for calculating expense-to-investment ratios to estimate plant-specific operations expenses, although, as discussed above, only if we use company-specific input values. For example, GTE agrees with our tentative conclusion that input values for each plant-specific operations expense account can be calculated as the ratio of booked expense to current investment, but only if this calculation is performed on a company-specific basis.[1168] BellSouth states that "[t]he methodology proposed by the Commission for plant-specific expenses is very similar to the methodology employed by BellSouth."[1169]

367. Other LEC commenters object to our use of current-to-book ratios to convert historic account values to current cost. Although their arguments differ somewhat, they

Index for wages and salaries only, civilian, and state and local government workers, by industry and occupational group; and Table 7, Wages and Salaries (not seasonally adjusted) Employment Cost Index for wages and salaries only, private industry workers, by bargaining status, regional and area.

[1168] GTE *Inputs Further Notice* comments at 72, 75-76.

[1169] BellSouth *Inputs Further Notice* comments, Attachment B at B-16.

essentially claim that the effect of our methodology is to reduce forward-looking maintenance expenses and that this is inappropriate because the input values are lower than their current maintenance expenses.[1170] AT&T and MCI counter that, if there is any problem with our maintenance expense ratios, it is that they reflect the servicing of too much embedded plant, which has higher maintenance costs, and too little forward-looking plant, which has lower maintenance costs.[1171]

368. US West asserts that, while in theory it is correct to adjust expense-to-investment ratios using current-to-book ratios, in practice there is a problem because the current-to-book ratio is based on reproduction costs and the model estimates replacement costs.[1172] US West defines reproduction cost as the cost of reproducing the existing plant using today's prices and replacement cost as the cost of replacing the existing plant with equipment that harnesses new technologies and is priced at today's prices.[1173] US West claims that our methodology actually increases the mismatch between historic and forward-looking investment levels because the reproduction costs are not the same as the replacement costs.[1174] We agree that reproduction costs are not the same as replacement costs because the mix of equipment and technology will differ, but we disagree with US West's characterization of this as a mismatch.

369. US West estimates that applying current-to-to book ratios to existing investment would generate reproduction costs that are 141 percent higher than historic costs.[1175] US West claims that, in contrast, forward-looking models generally show that the cost of replacing those facilities would be slightly less than historic costs, if new technologies were deployed. US West's claim that our methodology results in a mismatch because of these cost differences, however, is wrong. Rather, the differences between reproduction costs and replacement costs merely show that the mix of technologies has changed. The hypothetical example US West uses to illustrate its argument fails to account for changes in technology. The following hypothetical

[1170] *See* SBC *Inputs Further Notice* comments at 14-18; Sprint *Inputs Further Notice* comments at 55-59; US West *Inputs Further Notice* comments at 21-26.

[1171] AT&T/MCI *Inputs Further Notice* reply comments at 38.

[1172] US West *Inputs Further Notice* comments at 23-24.

[1173] US West *Inputs Further Notice* comments at 23-24.

[1174] US West *Inputs Further Notice* comments at 23-24.

[1175] US West *Inputs Further Notice* comments at 24-25. US West indicates that it used the Telephone Plant Index (TPI) to derive the 141 percent figure. US West implies, therefore, that the TPI is a reproduction cost index. This raises questions with respect to how a reproduction index deals with old technology that cannot be purchased today at any price. Without detailed knowledge about the TPI, we cannot say whether it reflects only reproduction costs or may also reflect replacement costs when new technology has replaced old technology.

example illustrates how changes in the mix of technology will change maintenance expenses.[1176] If historic investment on a company's books consists of 100 miles of copper plant, at a cost of $10 per mile, and 10 miles of fiber plant, at a cost of $1 per mile, then the historic cost is $1010. If current maintenance costs are $10 for the copper plant and $0.10 for the fiber plant, the total maintenance expense is $10.10. If the price of copper increases to $15 per mile and the price of fiber decreases to 80 cents per mile, then the reproduction costs would increase to $1508. If the forward-looking model designs a network with 60 miles of copper and 50 miles of fiber, the resulting replacement cost is $940.[1177] Using our methodology, we use the current-to-book ratios of 1.5 ($15/$10) and .8 (80 cents divided by $1) to revalue the copper and fiber investment, respectively, at current prices, and the resulting maintenance expense for the forward-looking plant would be $6.58 rather than $10.10.[1178] This does not result in a mismatch. In our hypothetical example, the maintenance costs for fiber were substantially less on a per-mile basis than they were for copper. Thus, we would expect the forward-looking plant with considerably more fiber and less copper to have lower maintenance costs than the current plant, which has more copper. Because the mix of plant changes, the Commission should not, as US West suggests, simply adjust book investment to current dollars to derive maintenance expenses for the forward-looking plant estimated by the model.

370. Sprint argues that we should simply divide the current year's actual expense for each account by the average plant balance associated with that expense.[1179] Sprint claims that, when this ratio is applied to the investment calculated by the model, forward-looking expense reductions occur in two ways: (1) the investment base is lower due to the assumed economies of scale in reconstructing the forward-looking network all at one time; and (2) greater use of fiber in the forward-looking network reduces maintenance costs because less maintenance is required of fiber than of the copper in embedded networks.[1180] Sprint claims that reducing maintenance for a current-to-book ratio as well as for technological factors constitutes a "double-dip" in

---

[1176] The values used in this example are hypothetical and do not represent actual input values.

[1177] Our hypothetical example reflects US West's contention that reproduction costs are significantly higher than replacement costs and that replacement costs are only slightly lower than historic costs.

[1178] To revalue the copper investment, we multiply $1000 by 1.5 (=$1500); then to calculate the expense-to-investment ratio, we divide current maintenance expenses for copper by the adjusted copper investment ($10/$1500 = .0067). Similarly, to revalue the fiber investment, we multiply $10 by .8(=$8); then to calculate the expense-to-investment ratio, we divide current maintenance expenses for fiber by the adjusted fiber investment ($.10/8=.0125). Finally, we apply these adjusted expense-to-investment ratios to the forward-looking plant to derive the forward-looking maintenance expenses: $900 x .0067 ($6.03) + $40 x .0125(.50) = $6.58.

[1179] Sprint *Inputs Further Notice* comments at 55.

[1180] Sprint *Inputs Further Notice* comments at 55.

maintenance expense reduction.[1181]

371. Sprint's claim that our methodology constitutes a "double dip" in reducing maintenance expenses is misleading because the effect of using current-to-book ratios depends upon whether current costs have risen or fallen relative to historic costs. Current-to-book ratios are used to restate a company's historic investment account balances, which reflect investment decisions made over many years, in present day replacement costs. Thus, if current costs are higher than historic costs for a particular investment account, the current-to-book ratio will be greater than one, and the expense-to-investment ratio for that account will decrease when the investment (the denominator in the ratio) is adjusted to current replacement costs.[1182] Sprint calls this double dipping because copper costs have risen and the model uses less copper plant than that which is reflected on Sprint's books. If current costs are lower than historic cost, however, the current-to-book ratio will be less than one and the adjusted expense-to-investment ratio for that account will increase when the investment (the denominator in the ratio) is adjusted to current replacement costs. Fiber cable and digital switching costs, for example, have fallen relative to historic costs. Sprint essentially is arguing that our methodology is wrong because it understates Sprint's historical costs. The input values we select are not intended to replicate a particular company's historic costs, for the reasons discussed above.[1183]

372. SBC disputes our assumption that the model takes into account variations in the type of plant installed because, as investment in a particular type of plant varies, so do the associated expense costs.[1184] SBC argues that expenses do not vary simply because investment varies.[1185] Nonetheless, SBC believes that developing a ratio of expense to investment and applying it to forward-looking investments is a reasonable basis for identifying forward-looking plant specific expenses.[1186] SBC complains that our methodology is inconsistent, however, because it has defined two completely different sets of forward-looking investments: one based on historical ARMIS investments adjusted to current amounts; and another derived on a bottom-up basis employing the cost model.[1187] Until we reconcile these "inconsistencies," SBC

[1181] Sprint *Inputs Further Notice* comments at 55.

[1182] For example, if a pole cost $200 to install in 1980, and $400 today, the current-to-book ratio is $400/$200 = 2.0. If the maintenance expense associated with the pole is $20, the expense-to-investment ratio on the books is $20/$200 = .10; and the expense-to-investment ratio adjusted by the current-to-book ratio is $20/$400 = .05.

[1183] *See supra* para. 351.

[1184] SBC *Inputs Further Notice* comments at 15.

[1185] SBC *Inputs Further Notice* comments at 15.

[1186] SBC *Inputs Further Notice* comments at 15.

[1187] SBC *Inputs Further Notice* comments at 16.

recommends that we use unadjusted historical investment amounts in developing plant specific expense factors, because they are closer to SBC's historical plant specific expenses.[1188]

373. Although they characterize the issue somewhat differently, US West, Sprint, and SBC essentially argue that our methodology is wrong because it understates their historical costs. AT&T and MCI counter that a forward-looking network often will result in lower costs than an embedded network and that the trend in the industry has been to develop equipment and practices to minimize maintenance expense.[1189] AT&T and MCI claim that, if there is any problem with our maintenance expense ratios, it is that they reflect the servicing of too much embedded plant, which has higher maintenance costs, and too little forward-looking plant, which has lower maintenance costs.[1190] AT&T and MCI further claim that, if our analysis had been based exclusively on financial information that reflected equipment consistent with the most-efficient forward-looking practices, the maintenance expenses would have been lower.[1191]

374. None of the commenters provide a compelling reason why we should not use current-to-book ratios to adjust historic investment to current costs. SBC in fact suggests that the Commission consider using the Telephone Plant Index (TPI) in future years to convert expense estimates to current values.[1192] SBC appears to be confusing the effect of measuring inputs in current dollars, which it recognizes is reasonable, and the end result of the calculation, which includes the impact of measuring all inputs in current dollars, changes in the mix of inputs, the impact of least-cost optimal design used by the model, and the model's engineering criteria. The relationship between maintenance costs and investment in the Commission's methodology is related to all of these factors.

375. Sprint also claims that our methodology understates maintenance costs, because it assumes new plant and the average maintenance rate will be higher than the rate in an asset's first year.[1193] AT&T and MCI dispute Sprint's claim that maintenance costs per unit of plant increase over time.[1194] Sprint provides an example which purports to show that an asset with a ten year

[1188] SBC *Inputs Further Notice* comments at 16-17, Attachment A (comparing Southwestern Bell/Texas costs of 5.96 percent of related investments to the Commission's proposed 3.08 percent of related investment).

[1189] AT&T/MCI *Inputs Further Notice* reply comments at 38.

[1190] AT&T/MCI *Inputs Further Notice* reply comments at 38.

[1191] AT&T/MCI *Inputs Further Notice* reply comments at 38.

[1192] SBC *Inputs Further Notice* comments at 15.

[1193] Sprint *Inputs Further Notice* comments at 55.

[1194] AT&T/MCI *Inputs Further Notice* reply comments at 38.

life, a ten percent maintenance fee in the first year, and annual costs increasing annually at three percent, would result in an average maintenance rate of 11.55 percent.[1195] Sprint's example, however, does not consistently apply our methodology. Sprint's example fails to apply the current-to-book ratio to the total and average plant in service estimates used in the example. When the current-to-book ratio is applied to the total and average plant in service estimates, the resulting maintenance rate is ten percent for all years.

376. BellSouth argues that the investment calculated by the model is unrealistically low because sharing assigned to the telephone company is unrealistically low and fill factors are unrealistically high.[1196] BellSouth argues that, because it has shared in cost of trenching, this does not mean the maintenance cost for buried cable would be less, and in fact, the costs may be higher.[1197] BellSouth apparently is confused about the Commission's methodology, because the sharing percentages apply only to the costs of structure, not the costs of the cable.

C. Common Support Services Expenses

1. Background

377. Common support services expenses include corporate operations expenses, customer service expenses, and plant non-specific expenses. Corporate operations expenses are those costs associated with general administrative, executive planning, human resources, legal, and accounting expenses for total company operations. Customer services expenses include marketing, billing, operator services, directory listing, and directory assistance costs.[1198] Plant

[1195] Sprint *Inputs Further Notice* comments at 55-57, Attachment 10a.

[1196] BellSouth *Inputs Further Notice* comments, Attachment B at B-19.

[1197] BellSouth *Inputs Further Notice* comments, Attachment B at B-16.

[1198] Corporate operations and customer service expenses include the following ARMIS accounts and their subaccounts:

- 6610 - Marketing Total
  - 6611 - Product Management
  - 6612 - Sales
  - 6613 - Product Advertising
- 6620 - Service Expense Total
  - 6621 - Call Completion (Operator Service Expense)
  - 6622 - Number Services (Directory Publishing Expense)
  - 6623 - Customer Services
- 6710 - Executive and Planning Total
  - 6711 - Executive
  - 6712 - Planning
- 6720 - General and Administrative

non-specific expenses are common network operations and maintenance types of expenses, including engineering, network operations, power, and testing expenses, that are considered general or administrative overhead to plant operations.[1199]

378. In the *Inputs Further Notice*, we proposed a methodology using regression analysis to estimate common support services expenses on a per-line basis. We noted that, unlike plant-specific expenses, common support services expenses are costs that cannot readily be associated with any particular maintenance expense or investment account.[1200] In the regression methodology, we used publicly available 1996 ARMIS expense data[1201] and minutes of use information from NECA,[1202] by study area, to estimate the portion of these company-wide expenses that should be supported by the federal high-cost mechanism.[1203] Specifically, we used the average of the estimates from two specifications that estimated total expenses per line as a function of the percentage of switched lines, the percentage of special lines, and toll minutes per line, either in combination (Specification 1) or separated between intrastate and interstate toll minutes (Specification 2).[1204] The specifications were designed to separate the portion of

---

6721 - Accounting and Finance
6722 - External Relations
6723 - Human Resources
6724 - Information Management
6725 - Legal
6726 - Procurement
6727 - Research and Development
6728 - Other General and Administrative

1199 Plant non-specific expenses include the following ARMIS expense accounts:

6510 - Other Property Plant and Equipment Expense
6530 - Network Operations

1200 *Inputs Further Notice* at para. 213.

1201 Data was taken from 1996 ARMIS 43-01, Subject to Separations (Column F) for Accounts 6610, 6620, 6710 and 6720. Data was taken from 1996 ARMIS 43-03, Subject to Separations (Column M) for Accounts 6510 and 6530. Line counts were taken from 1996 ARMIS 43-08, Table III, Total Switched Lines (Column DJ) and Total Access Lines (Column DM).

1202 Dial Equipment Minutes of Use (DEMs) for 1996 were taken from NECA and are available on the Commission's Web site at http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/neca.html.

1203 *Inputs Further Notice* at para. 217.

1204 *See Inputs Further Notice* at para. 218-19. Specification 1 used the following regression equation: Expense/Total Lines = β_1 (Switched Lines/Total Lines)+ β_2 (Special Lines/Total Lines)+ β_3 (Toll Minutes/Total Lines). Specification 2 used the following equation: Expense/Total Lines = β_1 (Switched Lines/Total Lines)+ β_2 (Special Lines/Total Lines)+ β_3 (State Toll Minutes/Total Lines)+ β_4 (Interstate Toll Minutes/Total Lines).

expenses attributable to special access lines and toll usage, which are not supported by the federal high-cost mechanism, from the portion of expenses attributable to switched lines and local usage, which are supported.

379. As with plant-specific operations expenses, we tentatively concluded that input values for corporate operations, customer service, and plant non-specific expenses should be estimated on a nationwide basis, rather than a more disaggregated basis.[1205] In reaching this tentative conclusion, we recognized that parties have argued that these types of expenses may vary as a result of company-specific plant configurations, geographic and labor demographic variables, one-time exogenous costs, and non-recurring adjustments such as re-engineering expenses.[1206] We observed that we had not been able to distinguish significant differences in regional wage differentials for administrative services based solely on ARMIS expense data for these accounts.[1207] Moreover, costs associated with corporate overhead and customer service accounts are not directly linked to a specific company's investment levels. We tentatively concluded that these types of administrative and service expenses are less dependent on carrier physical plant or geographic differentials than on factors that also correlate to company size (number of lines) and demand (minutes of use).[1208]

380. After estimating common support services expenses using the regression methodology, we made certain adjustments to remove additional portions of those expenses attributable to services that are not supported by the federal universal service support mechanism. The expenses we removed were associated with services that could be identified and estimated from ARMIS expense data.[1209] We tentatively concluded that 95.6 percent of marketing expenses should be attributed to non-supported services, based on an Economics and Technology, Inc. (ETI) analysis.[1210] In addition, we adjusted the estimates for non-supported service costs related to coin operations and collection, published directory, access billing, interexchange carrier office operation, and service order processing.[1211] We noted that non-recurring expenses for corporate operations can be significant and that our estimates should be

[1205] *See Inputs Further Notice* at para. 214.

[1206] *Inputs Further Notice* at para. 215.

[1207] *Inputs Further Notice* at para. 215.

[1208] *Inputs Further Notice* at para. 215.

[1209] *Inputs Further Notice* at para. 223.

[1210] *Inputs Further Notice* at para. 224.

[1211] *Inputs Further Notice* at para. 225.

adjusted to account for these one-time charges.[1212] We explained, however, that we had been unable to find an objective public data source or discern a systematic method for excluding these costs from the ARMIS expense data used in the regression methodology.[1213] We sought comment on how to identify, estimate, and remove these one-time non-recurring expenses.[1214]

381. We also adjusted our estimates for common support services expenses by converting the values, which were based on 1996 ARMIS data, to 1999 values.[1215] Specifically, we reduced the estimated expenses by a 6.0 percent productivity factor for each year (1997 and 1998) and added an inflation factor based on the fixed weighted Gross Domestic Product Price Index (GDP-PI) for 1997 (2.1120 percent) and for 1998 (2.1429 percent).[1216] That is, we proposed a net reduction of 3.888 percent for 1997 and 3.8571 percent for 1998, and sought comment on this method for converting expenses to 1999 values.[1217]

2. Discussion

382. Consistent with our tentative conclusions, we adopt input values that estimate the average common support services expenses that will be incurred by non-rural carriers on a per-line basis, rather than a set of company-specific common support services expenses.[1218] We affirm our tentative conclusion that input values for corporate operations, customer service, and

---

[1212] *Inputs Further Notice* at para. 220-222.

[1213] *Inputs Further Notice* at para. 221.

[1214] *Inputs Further Notice* at para. 222.

[1215] *Inputs Further Notice* at para. 226.

[1216] *Inputs Further Notice* at para. 226.

[1217] *Inputs Further Notice* at para. 226.

[1218]

Aggregate ARMIS Accounts	Expense Input Values	
6510 Other Property, Plant, and Equipment	$ (0.05)	
6530 Network Operations	1.48	
6610 Marketing		0.09
6620 Service Expense/Customer Operations	3.62	
6700 Executive, Planning, General, and Administrative		2.18
Total Common Support Services Expenses Per Line, Per Month		$ 7.32

Rather than using the $7.32 directly as an input value, the model uses this amount, annualized and adjusted for uncollectibles, or $92.46316, which appears in cell C33 of the per line tab of the wire center expense module.

plant non-specific expenses should be estimated on a nationwide basis, rather than a more disaggregated basis. As noted above, we find that for universal service purposes nationwide averages are more appropriate than company-specific values.[1219] We conclude that we should use Specification 1 of our proposed regression methodology to estimate expenses for ARMIS accounts 6510 (Other Property, Plant, and Equipment); 6530 (Network Operations); 6620 (Service Expense/Customer Operations); and 6700 (Executive, Planning, General, and Administrative).[1220] As discussed below, we use an alternative methodology to estimate expenses for ARMIS account 6610 (Marketing).[1221] We conclude that we should use 1998 ARMIS data in both methodologies, and an estimate of 1998 Dial Equipment Minutes of Use (DEMs) in the regression equation, to calculate these input values. We clarify that the ARMIS data we use to calculate these estimates are based on ARMIS accounts for all *non-rural* ARMIS-filing companies. We find that it is appropriate to include only data from the non-rural ARMIS-filing companies in calculating the expense per line for common support services expenses.[1222]

383. Current Data and Use of Productivity Factor. The input values we adopt in this Order are explained more fully in Appendix D, which contains a summary of the per-line, per-month input values for plant non-specific expenses, corporate operations expenses, and customer services expenses, including regression results, calculations, and certain adjustments made to the data based on the methodologies described below.[1223] Because we used 1996 ARMIS data in our regression methodology to estimate our proposed input values for common support services expenses, we proposed a method of converting those estimates to 1999 values.[1224] Specifically, we proposed using a productivity factor of 6.0 percent for the years 1997 and 1998 to reduce the estimated input values.[1225] We further proposed adjusting the expense data for those years with an inflation factor based on the Gross Domestic Product Price Index (GDP-PI) in order to bring

[1219] *See supra* para. 348.

[1220] Specifically, we adopt estimates using results solely from the Specification 1 regression equation: Expense/Total Lines = β1 (Switched Lines/Total Lines) + β2 (Special Lines/Total Lines) + β3 (Toll Minutes/Total Lines) rather than an average of results from two model specifications, as proposed. *See Inputs Further Notice* at para. 218.

[1221] *See infra* paras. 403-407.

[1222] As noted above, although some rural companies file ARMIS reports, the mechanism we adopt today will be used, beginning January 1, 2000, to determine high-cost support for non-rural carriers. *See supra* para. 346.

[1223] *See* Appendix D at D-5.

[1224] *Inputs Further Notice* at para. 226

[1225] *Inputs Further Notice* at para. 226

the input values up to current expenditure levels.[1226]

384. AT&T and MCI claim that the 6.0 productivity factor is too low,[1227] while most LEC commenters contend that it is too high.[1228] Sprint argues that expenses should not be adjusted for a productivity or an inflation factor and that we should use 1998 data.[1229] GTE argues that no productivity adjustments are necessary, if we use current, company-specific ARMIS data to develop input values.[1230] Although we generally decline to adopt company-specific input values for common support services expenses, we agree that using the most currently available ARMIS data (1998) obviates the need to adjust our estimates for either productivity gains or an inflation factor at this time. We believe, however, that there should be an incentive for increased productive efficiency among carriers receiving high-cost universal service support. Accordingly, we believe that a reasonable productivity measure or some other type of efficiency incentive to decrease costs associated with common support services expenses should be incorporated into the universal service high-cost support mechanism in the future. We intend to address this issue in the proceeding on the future of the model.

385. The input values we adopt in this Order are estimates of the portion of company-wide expenses that should be supported by the federal high-cost mechanism.[1231] We derive the estimates using standard economic analysis and forecasting methods. The analysis relies on publicly available 1998 ARMIS expense data and the most current minutes of use information from NECA. This data is organized by study area. The estimate of 1998 DEMs is based on a calculated growth rate of 1997 to 1996 DEMs reported by NECA.[1232] As a result of deleting rural ARMIS-filing companies and including company study area changes since 1996, pooling of

[1226] *Inputs Further Notice* at para. 226

[1227] *See* AT&T/MCI *Inputs Further Notice* comments at 46-47.

[1228] *See e.g.,* Aliant *Inputs Further Notice* comments at 2-3; Bell Atlantic *Inputs Further Notice* comments at 22; BellSouth *Inputs Further Notice* comments at B-21-B-23; USTA *Inputs Further Notice* comments at 2.

[1229] Sprint *Inputs Further Notice* comments at 60, 68.

[1230] GTE *Inputs Further Notice* comments at 88.

[1231] Data were taken from 1998 ARMIS 43-03, Total Regulated (Column I) for Accounts 6610, 6620, 6710, 6720, 6510, and 6530. Line counts were taken from 1998 ARMIS 43-08, Table III, Total Switched Lines (Column DJ) and Total Access Lines (Column DM).

[1232] Dial Equipment Minutes of Use (DEMS) for 1996 and 1997 were taken from NECA, available on the Commission's web site at http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/neca.html. Estimated 1998 DEMs were calculated by multiplying the number of 1997 DEMs for each study area by the ratio of 1997 DEMs to 1996 DEMs for that study area. Actual 1998 DEMs classified by local, interstate and intrastate toll minutes needed for use as variables in the regression analysis are not currently available from NECA.

the 1998 data sets provides expense, minutes of use, and line count data for 80 study areas.[1233] This is in comparison to the 91 study areas resulting from pooling the 1996 data described in the *Inputs Further Notice*.[1234]

386. Some parties object to our using data at the study area level, because they claim that ARMIS-filing companies report data in two distinct ways. Ameritech and US West argue that parent companies generally assign a significant portion of plant non-specific and customer operations expenses across their operating companies on the basis of an allocation mechanism.[1235] As a result, they claim that a simple regression on the study area observations will produce coefficients that reflect a blend of two relationships: the cost-based relationship and the allocation-based relationship, of which only the former is appropriate to measure.[1236] They argue further that it is necessary to model the allocation method explicitly, to net out the latter data, or to aggregate the data to the parent company level. Although we acknowledge that our accounting rules provide carriers with some flexibility, we expect that the allocation mechanism used by the parent company represents underlying cost differences among its study areas.[1237] We find that it is reasonable to assume that the companies use allocation mechanisms that are based on cost relationships to allocate costs among their study areas. Accordingly, we find that it is reasonable to use ARMIS data at the study area level in the regression methodology.

387. Regression Methodology. As described in the *Inputs Further Notice*, we adopt standard multi-variate regression analysis to determine the portion of corporate operations expenses, customer services expenses, and plant non-specific expenses attributable to the services that should be supported by the federal high-cost mechanism.[1238] We adopt an equation (Specification 1) which estimates total expenses per line as a function of the percentage of switched lines, the percentage of special lines, and toll minutes per line.[1239] We use this

[1233] *See* Appendix D at D-1.

[1234] *Inputs Further Notice* at para. 217.

[1235] *See* Ameritech *Inputs Further Notice* comments at 28; US West *Inputs Further Notice* comments, Attachment A at 27.

[1236] *See* Ameritech *Inputs Further Notice* comments at 28; US West *Inputs Further Notice* comments at Attachment A, 27.

[1237] To the extent a particular company believes that its ARMIS filings do not represent cost differences among its study areas, we would be interested in receiving more detailed information.

[1238] Standard multi-variate regression analysis uses ordinary least squares with more than one variable.

[1239] Expense/Total Lines = $\beta 1$ (Switched Lines/Total Lines) + $\beta 2$ (Special Lines/Total Lines) + $\beta 3$ (Toll Minutes/Total Lines).

regression methodology to estimate the expenses attributable to universal service for the following accounts:

> Other Property, Plant, and Equipment (6510);
> Network Operations (6530);
> Service Expense/Customer Operations (6620); and
> Executive, Planning, General and Administrative (6700).

We adopt this specification, rather than an average of the two specification estimates suggested in the *Inputs Further Notice*, to separate the portion of expenses that could be estimated as attributable to special access lines and toll usage, which are not supported by the federal high-cost mechanism, from switched lines and local usage.[1240] As explained below, we use an adjusted weighted average of study areas to estimate the support expense attributable to Account 6610, Marketing.

388. Several parties contend that our regression analysis is flawed.[1241] Sprint, for example, claims that we have exaggerated the significance of our statistical findings beyond a level justified by the regression result; and have made the often-committed error of interpreting our regression results in a way that implies causality.[1242] US West argues that, although there is a causal relationship between the level of expenses and the variables we use in the regression, the coefficient of determination or R^2 is fairly low, which implies that the causal relationship only explains a small portion of the total costs.[1243] GTE claims that our regression is mis-specified because it utilizes only the mix of output as explanatory variables, and excludes important variables related to differences in input prices and production functions.[1244] Because of this mis-specification and the omitted variables, GTE also claims that our equations have a low predictive ability, as measured by the R^2s.[1245]

389. We disagree with commenters who claim that there is little explanatory value in

---

[1240] *See* US West *Inputs Further Notice* comments, Attachment A at 22 (claiming it is inappropriate to average the two specifications).

[1241] *See, e.g.,* Ameritech *Inputs Further Notice* comments at 25-28; GTE *Inputs Further Notice* comments at 79-82; Sprint *Inputs Further Notice* comments at 61-65; US West *Inputs Further Notice* comments at 53-57, Attachment A at 20-27.

[1242] Sprint *Inputs Further Notice* comments at 61.

[1243] US West *Inputs Further Notice* comments at 55.

[1244] GTE *Inputs Further Notice* comments at 81.

[1245] GTE *Inputs Further Notice* comments at 81.

our regression analysis.[1246] In accounts 6620, 6700, 6530 the regressions explain a high degree of the variability in the expense variables.[1247] Only account 6510 (Other Property, Plant, and Equipment) has a low R^2, which is not surprising given the reported data in this account. Based on the 1998 ARMIS data, the resulting regression coefficient for this expense category is negative due to the numerous negative expenses reported by carriers in 1998. Because the ARMIS reports represent actual 1998 expenses incurred by the non-rural telecommunications companies within their various study areas, we find that it is appropriate to include this negative expense in our calculations. We note, however, that inclusion of this account in our calculations represents less than one percent of the total expense input for common support services expenses.[1248]

390. We believe that our regressions represent a cost-causative relationship, and that common support services expenses are a function of the number of total lines served, plus the volume of minutes. Because in the long run, all costs are variable, we disagree with commenters who suggest that our methodology is flawed because we do not include an intercept term in our regression equation to represent fixed or start-up costs.[1249] As discussed above, the model is intended to estimate long-run forward-looking cost over a time period long enough so that all costs may be treated as variable and avoidable.[1250] Moreover, the federal high-cost mechanism calculates support on a per-line basis, which is distributed to eligible carriers based upon the number of lines they serve. We would not provide support to carriers with no lines. Nor would we vary support, which is portable, between an incumbent and a competitive eligible telecommunications carrier, based on differences in their fixed or start-up costs. We explicitly assume, therefore, that if a company has zero lines and zero minutes, it should have zero expenses. Thus, we have no constant or fixed cost in our regressions. We also believe that these expenses are driven by the number of channels, not the number of physical lines.

[1246] According to our calculations using the 1998 data, the R^2s for the four regressions are:

Account:	6620	6700	6510	6530
R^2:	0.96	0.92	0.20	0.95

We note that the commenters' analysis was based on the 1996 ARMIS data.

[1247] As we discuss below, we no longer use the regression for the 6610 account.

[1248] We calculate an expense input value of -$0.05 for Account 6510 (Other Property, Plant, and Equipment) and a total expense input value of $7.32 for total common support services expenses, per line, per month.

[1249] *See, e.g.,* Sprint *Inputs Further Notice* comments at 62-64 & n.15.

[1250] *See supra* para. 351.

391. That is, our assumptions imply that expenses are a linear function of lines and minutes.[1251] We next need to separate out the common support services expenses related to special access lines and toll minutes, because these services are not supported by the federal high-cost mechanism. Therefore, we split the lines variable into switched and special access lines, and we split the minutes variable into local and toll minutes. In this modified equation, expenses are a function of switched lines, plus special access lines, plus local minutes, plus toll minutes.[1252] We believe that changes in local minutes, however, should not cause changes in common support services expenses that are not already reflected in the expenses associated with switched lines. We find that it is reasonable to assume that local calls do not increase these overheard costs in the same way that toll minutes do. For example, in most jurisdictions local calls are a flat-rated service and additional local calling requires no additional information on the customer's bill. With toll calling, however, even subscribers that have some kind of a calling plan receive detailed information about those calls. It is reasonable to assume that adding an additional line on a subscriber's bill for a toll call causes overhead costs that are not caused by local calls. Moreover, toll calling outside a carrier's serving area involves the costs associated with completing that call on another carrier's network. As discussed below, we tested our assumption that local calls do not affect costs in the same way that toll calls do by running the regressions to include local minutes. Based on theory and our analysis, we decided to drop the local minutes variable, so that expenses are a function of switched lines, plus special access lines, plus toll minutes.[1253] Because we are calculating a per-line expense estimate, we divide all the variables by the total number of lines to derive our final equation: expenses divided by total lines equals the percentage of switched lines, plus the percentage of special lines, plus toll minutes divided by total lines.[1254]

392. US West claims that our regressions may not be based on appropriate cost-causative relationships, because we count special access lines by channels and not by physical pairs.[1255] The ARMIS data used in the regressions count special lines as channels. That is,

---

[1251] Expenses = β_1 Lines + β_2 DEMS + ε.

[1252] Expenses = β_1 Switched Lines + β_2 Special Lines + β_3 Local DEMS + β_4 Toll DEMs + ε.

[1253] Expenses = β_1 Switched Lines + β_2 Special Lines + β_3 Toll DEMs + ε.

[1254] Expenses/Total Lines = β_1 (Switched Lines/Total Lines) + β_2 (Special Lines/Total Lines) + β_3 (Toll DEMs/Total Lines) + ε'.

[1255] US West *Inputs Further Notice* comments at Attachment A, 21. US West also claims that our regression analysis estimates a common support per minute of access of $0.02, which does not include any of the capital or maintenance costs associated with the switching investment used to provide access. Because the traffic sensitive common costs associated with access services alone exceeds the current access charge rate of approximately $.01 to $.02 per minute, US West claims that are analysis shows that access charges are priced below costs. US West *Inputs Further Notice* comments at 56-57. The coefficient for toll is an estimate of the increase in expenses due to an increase in 1000 toll minutes. Summing across all accounts and dividing by 1000, according to our calculations special access lines are counted as DS0 equivalents: a DS1 has 24 channels, and a DS3 has 672 channels. US West contends that it is far from clear how this method of counting special access lines reflects how these services cause expenses, because it is clear that DS1s and DS3s are not priced as if they cause 24 and 672 times the amount of expenses as a narrowband line.[1256]

393. The fact that DS1s and DS3s are priced differently in the current marketplace does not imply that it is improper to count lines as channels. US West's suggested alternative, counting special lines as physical pairs, would assume that a residential customer with two lines causes the same amount of overhead expenses as a special access customer with one DS1 line. To the contrary, we find that it is reasonable to assume that more overhead expenses are devoted to winning and keeping the DS1 customer than the residential customer. Further, we expect that more overhead expenses are related to customers using higher capacity services than those using lower capacity services. Accordingly, we find that it is reasonable to use channel counts in our regression equations.[1257]

394. Some commenters also criticized our regression analysis on the grounds that variables are highly correlated and that the predicted coefficients are not stable.[1258] In particular, US West claims that the confidence intervals and standard errors are large and that a dividing-the-sample experiment leads to drastically different results.[1259] While these commenters are correct that the correlation values are high for the raw variables, the values are not high once the variables under consideration are adjusted by dividing by total lines.[1260] We find that the correlation values are all very reasonable. We note, in particular, the -1 correlation between switched lines and special lines. The fact that switched lines plus special lines equals one is the reason the regression cannot be run with a separate constant. We note that our parameterization has switched lines, special lines, and toll minutes as explanatory variables. We have chosen not

an estimate of the expense cost per toll minute is equal to $ 0.0006331807.

1256 US West *Inputs Further Notice* comments, Attachment A at 21.

1257 We note that we also count switched business lines as channels in our regression equations.

1258 *See, e.g.,* Ameritech *Inputs Further Notice* comments at 27-28; GTE *Inputs Further Notice* comments at 79-80; US West *Inputs Further Notice* comments, Attachment A at 21-22.

1259 US West *Inputs Further Notice* comments at 53-57, Attachment A at 20-27.

1260 The correlation matrix for the variables under consideration is:

	switched	special	toll	local
switched	1.00	-1.00	0.54	0.06
special	-1.00	1.00	-0.54	-0.06
toll	0.54	-0.54	1.00	-0.13
local	0.06	-0.06	-0.13	1.00

to include local minutes in our regressions for theoretical reasons. So, the key correlation values are the correlations of toll minutes with special lines and with switched lines. We find that those values are reasonable.

395. Several commenters suggested that we use local minutes as an explanatory variable.[1261] Despite our tentative conclusion that our regressions should not include local minutes as a variable, in response to these comments, we re-ran each of the regressions with local minutes per line as an additional variable. In three of the four regressions, the coefficient for local minutes was not significant at the five percent level, and for account 6700, its sign was the opposite of what was expected.[1262] The resulting difference in the estimated expenses attributable to supported services was very small in magnitude as well. If we used the local minutes variable in our parameterization, after summing across all expense accounts, our per-line, per-month estimate for a switched line would be approximately $0.01 more.[1263] Given our belief that local minutes should not influence these expenses, the lack of significance in the coefficients, and the overall lack of impact when the variable was consistently included in the regressions, we conclude that we should not include local DEMs per line in our specifications.

396. Except for the inclusion of local minutes as a variable, no commenters have suggested a better parameterization or methodology for using the ARMIS data to estimate expense inputs for these accounts. Further, no commenters have suggested an alternative publicly available data set to use for our estimation of expense input values. We acknowledge that there is substantial variation in the underlying expense data taken from the ARMIS reports. Common support services expenses often contain charges unrelated to the specified relationships in the regression equation. For example, there are many one-time expenses and non-recurring

[1261] *See, e.g.*, Ameritech *Inputs Further Notice* comments at 25-28; GTE *Inputs Further Notice* comments at 79-82; Sprint *Inputs Further Notice* comments at 61-65; US West *Inputs Further Notice* comments at 53-57, Attachment A at 20-27.

[1262] *See* Appendix D at D-6.

[1263] The table below shows the cost per switched line without local minutes in the equation (nloc), with local minutes in the equation and an average number of local minutes for each line (wloc), and the difference between the two in dollars.

	nloc	wloc	diff
lm6620	3.39	3.62	-0.24*
lm6700	2.47	2.18	0.30
lm6510	-0.05	-0.05	0.00
lm6530	1.41	1.48	-0.07

We note that the 6620 account is the one regression where local minutes variable is significant. In the other cases it is not.

charges associated with these accounts. We have tried to limit the effect of this problem by making adjustments to the expense data, as discussed below. Given the data limitations and the parameterization we have chosen, we find that the estimated coefficients are the best estimate of the applicable expenses, regardless of the resulting standard errors.

397. Removal of One-Time Expenses. In the *Inputs Further Notice*, we discussed our efforts to adjust estimates of common support services expenses to account for one-time and non-recurring expenses.[1264] We sought comment on the need for information about and estimates of various types of exogenous costs and common support service expenses that are recovered through non-recurring charges and tariffs. These expenses include specific one-time charges for the cost of mergers or acquisitions and process re-engineering, and network and interexchange carrier connection, disconnection, and re-connection (i.e., churn) costs.

398. In the *Inputs Further Notice*, we tentatively concluded that we should not use an analysis submitted by AT&T and MCI to estimate one-time and non-recurring expenses for corporate and network operations expenses.[1265] This analysis averaged five years (1993-1997) of data from Security and Exchange Commission (SEC) 10-K and 10-Q filings for all tier one companies to identify and calculate a percentage estimate of corporate and network operations expenses classified as one-time and non-recurring charges associated with these types of activities. Our tentative conclusion not to rely on the AT&T and MCI analysis to make these adjustments was based on the fact that we were using 1996 ARMIS data to estimate the expense inputs. Because the SEC reports do not indicate whether the one-time expenses were actually made solely during a specific year indicated, we tentatively concluded that we could not use the analysis' five year average or the actual 1996 SEC figures to make adjustments to the 1996 ARMIS data. In the *Inputs Further Notice,* we noted however that the AT&T and MCI analysis indicates that one-time expenses for corporate and network operations can be significant.[1266] We sought comment on how to identify and estimate one-time and non-recurring expenses associated with these common support services.

399. AT&T and MCI disagree with our tentative decision to reject their one-time cost estimates and argue that it is better to estimate one-time costs through use of the SEC reports, although these reports may imperfectly establish the precise date of the occurrence, than to fail to exclude these costs at all.[1267] Although some LEC commenters may agree that we should adjust our estimates to exclude one-time and non-recurring expenses, they provide no data or

[1264] *Inputs Further Notice* at paras. 220-225.

[1265] *Inputs Further Notice* at para. 221.

[1266] *Inputs Further Notice* at para. 221.

[1267] AT&T/MCI *Inputs Further Notice* comments at 45-46.

methodology to accomplish this, other than suggesting that we should get this information from the companies.[1268] GTE claims that unless companies implement specific tracking mechanisms, these data are not generally or easily identified after the fact.[1269]

400. We now reconsider our tentative conclusion not to use the analysis submitted by AT&T and MCI to adjust our network and corporate operations expense estimates to account for one-time and non-recurring expenses. We do so for a number of reasons. First, we received no additional information on publicly available data sources or other reasonable methods to estimate these one-time and non-recurring costs at this time. Second, the problems associated with determining the actual costs of 1996 one-time expenses based on the SEC reports are obviated because we are using 1998 expense data to estimate the forward-looking input values. We find that using the estimated average of one-time costs over the five preceding years (1993-1997) to adjust 1998 data is a reasonable method to determine the impact of costs related to mergers and acquisitions and work force restructuring. Further, we believe any adjustments for one-time costs based on the AT&T and MCI analysis may be biased downward after comparing the number of companies involved in these types of activities in 1998 and 1999 to those in 1993-1997.[1270] Accordingly, we adjust downward estimated expenses in account 6530 (Network Operations) by 2.6 percent and in account 6700 (Executive, Planning, General, and Administrative) by 20 percent.

401. Removal of Non-Supported Expenses. In the *Inputs Further Notice*, we also discussed our efforts to adjust marketing and other customer service expenses to account for recurring expenses that are not related to services supported by the federal high-cost mechanism.[1271] The non-supported expenses we attempted to identify include vertical features

[1268] SBC does not believe one-time and non-recurring costs are significant, but agrees that they should be excluded to the extent they are significant. SBC suggests we could either base our inputs on company data that does not include these costs or base the inputs on data from years where it is known that no one-time or non-recurring activities occurred. SBC *Inputs Further Notice* comments at 20. Sprint suggests that current information with respect to one-time corporate operations expenses should be supplied by the companies on an annual basis. Sprint *Inputs Further Notice* comments at 65. GTE, on the other hand, agrees with our tentative conclusion and argues that we should not attempt to adjust our input values for one-time, non-recurring, and non-supported costs. GTE argues that, if we do so, we should also adjust our estimates to account for certain cost increases due to regulatory requirements, and other factors. If any adjustments are made, GTE claims that company-specific cost adjustments would have to be requested from each company annually. GTE *Inputs Further Notice* comments at 82.

[1269] GTE *Inputs Further Notice* comments at 82.

[1270] The following companies have either filed notice with the Commission or have indicated in the press that they were or are actively engaged in merger discussions and activity: Bell Atlantic, GTE, US WEST, Ameritech, SBC, Frontier, Puerto Rico Telephone, Cincinnati Bell, Aliant Communications, and Sprint.

[1271] *Inputs Further Notice* at para. 221, 223-225.

expenses, billing and collection expenses not related to supported services, operational support systems and other expenses associated with providing unbundled network elements and wholesale services to competitive local exchange carriers. We proposed adjustments to extract non-supported service costs related to marketing, which is discussed separately below,[1272]coin operations, published directory, access billing, interexchange carrier office operation, and service order processing.[1273] Specifically, we made percentage reductions to the regression coefficient results for specific expense accounts based on a time trend analysis of average ARMIS 43-04 expense data for five years (1993-1997).

402. Some commenters argue that our proposed methodology removes non-supported services twice because these expenses were already taken out by the regression when expenses are subdivided among switched lines, special lines, and toll minutes.[1274] Although we agree, as discussed below, that our methodology double counted the marketing expenses associated with special access lines, we do not agree with the theory that combining a percentage reduction with the regression methodology invariably removes expenses twice. For example, vertical features associated with switched lines such as call waiting are not supported, but the expenses associated with call waiting are not removed using the regression analysis. If we had the data to separately identify and remove vertical features expenses from switched lines, we believe that it would be appropriate to do so and to continue using the regression analysis to separate the remaining expenses. Nonetheless, upon further analysis, we find that we should not adopt our proposed method of removing these non-supported recurring expenses. We find that this method is not sufficient to adequately identify non-supported common support service expenses due to differences in account classifications from the ARMIS 43-03 and ARMIS 43-04 reports. Therefore, we do not utilize the time trend analysis or take reductions for these non-supported expenses in the input values at this time. We recognize that this causes an overstatement of in our estimate of the expenses attributable to supported services in account 6620 (Service Expense and Customer Operations). Unlike the case with marketing, however, we do not have an alternative source of information on which to base a methodology for removing the non-supported expenses in this account. We plan to seek comment on a verifiable and systematic method to identify and remove these costs in the proceeding on the future of the model.

403. Marketing. As explained in the *Inputs Further Notice,* we made an adjustment to the Account 6610 (Marketing)[1275] regression coefficient based on an analysis made by

---

[1272] *See infra* paras. 403-407.

[1273] *See Inputs Further Notice* at para. 225.

[1274] *See, e.g.,* GTE *Inputs Further Notice* comments at 84; Sprint *Inputs Further Notice* comments at 67.

[1275] Account 6610 Marketing consists of three sub-accounts: 6611 Product Management, 6612 Sales, and 6613 Advertising.

Economics and Technology, Inc. (ETI).[1276] The ETI analysis offered a method for disaggregating product management, sales, and advertising expenses for basic (residential) telephone service from total marketing costs. Based on information from the New England Telephone Cost Study, ETI attributed an average of 95.6 percent of company marketing costs to non-supported customers or activities, such as vertical and new services. Relying on this analysis, we reduced the input estimate to reflect 4.4 percent of marketing expenses determined by the regression. In the *Inputs Further Notice*, we tentatively concluded that this was the most accurate method on the record for apportioning marketing expenses between supported and non-supported services.[1277]

404. We agree with commenters that, in making this adjustment to the post-regression analysis input estimate, we incorrectly estimated marketing expenses because reductions were taken twice for special access lines.[1278] We agree with the commenters that any adjustments to exclude expenses based on the type of service should be made from total relevant marketing expenses rather than the regression results. Therefore, we do not use the regression methodology to estimate marketing expenses. Instead, using the 1998 ARMIS data, we adjust the total weighted average of relevant expenses for all study areas.

405. Commenters also point out that the adjustment figure of 4.4 percent based on the ETI Study as initially reported was determined under the assumption that only expenses attributable to residential local service would be supported.[1279] Further, the ETI estimate of costs associated with the marketing of supported services was calculated by taking a percentage of expenses only from Account 6611, Product Management. Specifically, the ETI estimate did not include any relevant expenses from Account 6613, Product Advertising. As noted in the *Inputs Further Notice*, funding support for marketing is to be based on those expenses associated with advertising. Section 214 of the Communications Act requires eligible telecommunications carriers to advertise the availability of residential local exchange and universal service supported services.[1280] Moreover, we note that under the current high cost loop support mechanism, carriers receive no support for marketing.[1281]

[1276] *Inputs Further Notice* at para. 224.

[1277] *Inputs Further Notice* at para. 225.

[1278] *See, e.g.,* Sprint *Inputs Further Notice* comments at 65-66 (arguing direct reduction of total company marketing expenses for only ETI factor is an acceptable method); Ameritech *Inputs Further Notice* comments at 29; US West *Inputs Further Notice* comments, Attachment at 27-28.

[1279] *See,, e.g.,* Ameritech *Inputs Further Notice* comments at 29; GTE *Inputs Further Notice* comments at 83; US West *Inputs Further Notice* comments, Attachment at 28.

[1280] 47 U.S.C. § 214(e)(1)(B).

[1281] *See, e.g.,* NECA, Universal Service Fund 1999 Submission of 1998 Study Results, Oct.1, 1999 at Tab 2.

406. We received further documentation and an alternative analysis from ETI which included an estimate for advertising expenditures.[1282] The revised analysis included proportional allocations of advertising costs based on the percentage of lines estimated for primary line residential service and single-line business service. ETI also used line count source material from the Preliminary Statistics of Common Carriers 1998 rather than relying on 1996 data used in its original analysis.

407. Based on the new information provided and the lack of any reasonable alternative presented by the commenters, we calculate an input estimate of supported advertising expenses using the ETI study and 1998 ARMIS expenses.[1283] By adding a proportional allocation for multi-line business advertising expenses to the ETI alternative analysis (which only included an estimate representing primary line and single line business advertising costs), we conclude that 34.4 percent of Account 6613, Product Advertising, would be the most appropriate expense amount for the advertising of universal service.[1284] Because the additional data provided by ETI allowed for the calculation and estimate of supported and non-supported advertising expenditures, we did not allocate costs associated with product management or sales. As previously mentioned, these marketing activities are not specifically required for support under Section 214 of the Communications Act and currently receive no high cost loop support. Taking 34.84 percent of total 1998 advertising expenses for the 80 non-rural high cost study areas and dividing by total lines per month, the average per line per month input value for advertising support is $0.09. This level of advertising expenses represents 5.82 percent of total 1998 marketing costs for non-rural carriers.

408. Local Number Portability. There is an additional input value that we estimate separately from our consideration of other expense input values. Specifically, the synthesis model has a user-adjustable input for the per-line costs associated with local number portability (LNP). In the *Inputs Further Notice*, we proposed a per-line monthly LNP cost of $0.39, based

---

The data collection instructions identify the accounts that are included in calculating high-cost loop support. Accounts 6610 (Total Marketing), 6611(Product Management), 6612(Sales), and 6613(Advertising) do not appear in the list of accounts included in calculating high-cost loop support.

[1282] *See* Susan Baldwin, An Alternative Analysis of Marketing Expenses Related to Calculation of USF Support. This paper supplements the earlier ETI study: Susan M. Baldwin, Lee L. Selwyn, Economics and Technology, Inc. *Converging on a Cost Proxy Model Primary Line Basic Residential Service,* August 1996.

[1283] *See* Appendix D at D-7 for analysis. For further information regarding formulas and calculations, see the spreadsheet posted on the Commission's Web site.

[1284] Although the statute requires advertising of the supported services, as noted above, we do not find that this requires advertising of secondary lines to consumers already receiving the supported services.

on a weighted average of the LNP rates filed by the LECs available at that time.[1285] AT&T and MCI point out that the Commission suspended and investigated some of those rates, and that the rates we approved are generally lower than the rates we used to estimate our LNP input value.[1286] They argue that we should use the line-weighted nationwide average of approved LNP rates, which they estimate currently is $.032.[1287] GTE claims that there is no justification for using the nationwide average LNP rate, as suggested by AT&T and MCI, because the approved LNP rates provide the best representation of each company's LNP costs.[1288] We agree with GTE and in this instance depart from our general practice of using nationwide input values in the federal universal service support mechanism. Because the Commission has investigated and approved LNP rates for most LECs, we find that it is appropriate to use the company-specific input values listed in Appendix D.[1289] For those carriers that have not yet filed an LNP tariff, we will use the line-weighted nationwide average of approved LNP rates.

D. GSF Investment

1. Background

409. GSF investment includes buildings, motor vehicles, and general purpose computers. The synthesis model platform uses a three-step algorithm to estimate GSF investment. First, for each study area, the model calculates a GSF investment ratio for each GSF account by dividing the ARMIS investment for the account by the ARMIS total plant in service (TPIS) less GSF investment. The values proposed in the *Inputs Further Notice* used 1996 ARMIS data in this step.[1290] Second, the model calculates a preliminary estimate for GSF investment for each account by multiplying the model's estimate of TPIS by the GSF investment ratios developed in step one.[1291] Third, the model reduces the preliminary GSF investment estimates for each account by multiplying these estimates by one of two factors.[1292]

[1285] *See Inputs Further Notice* at Appendix A, A-31.

[1286] AT&T/MCI *Inputs Further Notice* comments at 47.

[1287] AT&T/MCI *Inputs Further Notice* comments at 47.

[1288] GTE *Inputs Further Notice* reply comments at 32.

[1289] *See* Appendix D at D-8.

[1290] In the synthesis model, ARMIS data for each non-rural study area are contained in the "1996 Actuals" tab of the expense modules.

[1291] As calculated by the model, TPIS excludes GSF investment.

[1292] The synthesis model platform incorporates HAI's expense and GSF module. *See Platform Order*, 13 FCC Rcd at 21361, para. 91.

410. In the *Inputs Further Notice*, we tentatively concluded that the model's preliminary estimates of GSF investment should be reduced in the third step of the algorithm, because only a portion of GSF investment is related to the cost of providing the services supported by the federal mechanism, but that we should not use the same factors as those used in the HAI model.[1293] We noted that the HAI sponsors used one factor for some accounts and a different factor for others, but had not explained why either particular factor should be used.[1294] Rather than using two different factors, we proposed using a factor that reflects the percentage of customer operations, network operations, and corporate operations used to provide the supported services. Specifically, we proposed calculating preliminary GSF investment on a study area specific basis (steps one and two), and then multiplying these estimates by a nationwide allocation factor derived from the regression methodology that we used to estimate the portion of common support services expenses attributable to switched lines and local usage.[1295]

2. Discussion

411. We conclude that the model's preliminary estimates of GSF investment should be reduced in the third step of the algorithm, because we find that only a portion of GSF investment is related to the cost of providing the services supported by the federal mechanism. In response to certain comments, however, we modify our proposed allocation factor, as discussed below. Although we reject commenters' arguments that the preliminary GSF investment should not be reduced at all, we agree that we should not exclude facility-related maintenance expenses in our proposed allocation factor. In addition, we modify our method of calculating the denominator of our allocation factor so that both the numerator and denominator are simple averages. Finally, we clarify that the ARMIS TPIS used in the first step of the algorithm excludes ARMIS GSF investment.

[1293] *Inputs Further Notice* at 211.

[1294] The HAI model used the following two factors to reduce the preliminary GSF investment estimates: (1) one minus the Total Operations General Support Allocator (Total Operations Allocator) or (2) the Office Worker General Support Allocator (Office Worker Allocator). Each of these allocators is a fraction. The Total Operations Allocator is the ratio of the sum of customer operations expenses and corporate operations expenses to total operating expenses. The Office Worker Allocator is the ratio of the sum of corporate operations expenses and network operations expenses to the sum of customer operations expenses, corporate operations expenses and network operations expenses. The Total Operations Allocator is applied to the Motor Vehicles, Garage Work Equipment, and Other Work Equipment accounts. The Office Worker Allocator is applied to the Furniture, Office Equipment, Buildings and General Purpose Computer accounts. *See* HAI Dec. 11, 1997 submission.

[1295] The proposed ratio was the sum of customer operations expenses, network operations expenses, and corporate operations expenses attributable to the supported services, to the sum of those expenses calculated on a total regulated basis.

412. Reduction of Preliminary GSF Estimate. Several LEC commenters argue that the preliminary GSF investment should not be reduced by an allocator in the third step of the algorithm.[1296] SBC contends that the factor we use to reduce our preliminary GSF investment estimates substantially underestimates the GSF amounts related to the supported services.[1297] SBC claims that the ratios used to estimate the preliminary GSF investment already provides a reasonable basis for allocating GSF to supported services, because the GSF ratio (derived from the ARMIS accounts) is only applied to investment identified by the model as associated with supported services.[1298] BellSouth also claims that the TPIS calculated by the model is the investment necessary to provide the supported services and that no further reductions in the preliminary GSF investment estimate are appropriate.[1299] Sprint similarly claims that by applying a book GSF ratio to the forward-looking plant necessary to provide supported services, the modeled GSF plant also has been converted to a forward-looking level necessary to provide the supported services. Sprint contends that applying an additional allocator is not necessary and has the effect of reducing GSF plant twice.[1300]

413. We disagree with SBC's contention that only a portion of GSF is assigned to supported services in deriving our preliminary estimates of GSF investment.[1301] To the contrary, the GSF ratio is applied to all model investment, which includes the investment required to provide both supported and non-supported services. As discussed above, the model estimates the cost of providing services for all businesses and households within a geographic region, including the provision of special access, private lines, and toll services.[1302] Because these services are not supported by the federal high-cost mechanism, the preliminary GSF investment estimate must be adjusted to reflect the portion of GSF investment attributable to the supported

[1296] *See, e.g.,* BellSouth *Inputs Further Notice* comments at Attachment B, B-21; SBC *Inputs Further Notice* comments at 17; Sprint *Inputs Further Notice* comments at 59-60. US West also claims generally that our multi-step process results in a significant reduction in costs "assumed to be recoverable." US West *Inputs Further Notice* comments at 47.

[1297] SBC *Inputs Further Notice* comments at 17.

[1298] SBC *Inputs Further Notice* comments at 17.

[1299] BellSouth *Inputs Further Notice* comments at Attachment B, B-21.

[1300] Sprint *Inputs Further Notice* comments at 59-60. Sprint also claims that we used a mathematically incorrect method to compute the GSF ratio by including ARMIS GSF investment in the denominator and then applying that to TPIS investment as calculated by the model, which does not include GSF investment. We clarify below, that the ARMIS GSF investment used in the denominator also excludes GSF investment, and we thus calculate the ratio as Sprint suggests: ARMIS GSF plant divided by ARMIS TPIS less ARMIS GSF plant. *See infra* para. 417.

[1301] *See SBC Inputs Further Notice* comments at 17.

[1302] *See supra* paras. 49, 391.

services. Thus, BellSouth's assertion that the TPIS calculated by the model is the investment necessary to provide the supported services is wrong. For the same reasons, we reject Sprint's argument that, by applying the book GSF ratio, the modeled GSF plant has somehow been converted to a forward-looking level necessary to provide the supported services. On the contrary, the conversion estimates the amount of GSF investment attributable to all services, supported and non-supported. The second reduction is required to estimate the amount of GSF investment that should be supported by the federal universal service support mechanism.

414. Allocation Factor. Assuming that we use an allocator to reduce preliminary GSF investment, several commenters criticize the particular allocator that we proposed in the *Inputs Further Notice.* For example, GTE questions why we used only expenses for customer operations, network operations, and corporate operations in the allocation calculation and excluded plant-specific expenses.[1303] GTE argues that plant-specific operations also use GSF investments and should be counted in the calculation. SBC also argues that GSF investment supports all aspects of a LEC's operations, and contends that it makes no sense to exclude facility-related maintenance expenses in our proposed allocation factor.[1304] We agree that expenses for plant-specific operations expenses should be included in our calculation of the nationwide allocation factor derived from the regression methodology. Accordingly, the allocation factor we adopt to estimate GSF investment includes plant-specific operations expenses.[1305]

415. GTE also contends that the forward-looking way to calculate a GSF investment ratio is to convert all ARMIS investments to current values using current-to-book ratios, before calculating an adjusted ARMIS GSF to TPIS investment ratio.[1306] Although we concede there is some logic to GTE's argument that we should convert ARMIS GSF investments to current values by using current-to-book ratios, we note that this would require a change in the model platform. As we explain above, the model platform uses a three-step algorithm to estimate GSF investment.[1307] Although we can easily change the input value for the factor used in step three,

1303 GTE *Inputs Further Notice* comments at 77. Although GTE agrees that we should not base a reduction to the preliminary GSF investment on the same factors used in the HAI model, GTE claims our proposed methodology has several problems.

1304 SBC *Inputs Further Notice* comments at 18.

1305 Due to equations embedded in the HAI expense module, the total operations general support allocator is set equal to one minus the office worker general support allocator. That is, because one factor is one minus the other in the HAI expense module, to use the same allocation factor for all GSF investment, we must enter one minus the factor in some instances. *See* Appendix D at D-9.

1306 GTE *Inputs Further Notice* comments at 77.

1307 *See supra* para. 409

we could not adjust the ARMIS data by applying a current-to-book factor without modifying the model platform.[1308] Proposals to change the model platform are properly addressed in response to pending petitions for reconsideration of the *Platform Order* or the proceeding on the future of the model.

416. Finally, GTE claims that our estimation of the universal service portion of the GSF investment is flawed because our regression methodology uses a wrong specification and incorrectly excludes expenses.[1309] GTE also claims that the calculation allocator itself is flawed because the numerator is a simple average of expenses derived from the regression results, but the denominator is a weighted average of the total expenses developed from ARMIS data.[1310] GTE argues that the type of average in the numerator and denominator should match.[1311] While we do not agree that our regression methodology is flawed, we find that GTE has pointed out an inconsistency in our GSF methodology. Specifically, we agree that we should use the same type of average in both the numerator and denominator of our allocation factor. As a result, we use the simple average of total expenses in the denominator of the allocation factor we adopt for estimating the portion of GSF attributable to supported services.[1312]

417. Clarification. BellSouth claims that the algorithm used to estimate GSF investment contains an error in consistency. BellSouth suggests that in step one we should determine the ratio of ARMIS-based GSF investment to the ARMIS-based TPIS less GSF investment.[1313] In step two, this ratio is multiplied by the TPIS investment determined by the model, which excludes GSF. We clarify that the model calculates GSF investment as BellSouth suggests it should. That is, the model uses ARMIS-based TPIS less GSF investment.[1314] US

[1308] We also do not at this time consider Bell Atlantic's suggestion that we develop GSF investments on some other basis, such as an activity based approach, rather than as a ratio of investment. *See* Bell Atlantic *Inputs Further Notice* comments at 21. Such an approach also would require changes to the model platform.

[1309] GTE *Inputs Further Notice* comments at 77-78.

[1310] GTE *Inputs Further Notice* comments at 78.

[1311] GTE *Inputs Further Notice* comments at 78.

[1312] Specifically, the GSF allocator is the ratio of universal service expenses to total company expenses. Universal service expenses are determined by the following: switched lines to total lines times loop maintenance plus switched lines to total lines times circuit maintenance plus local DEMs to total DEMs times switch maintenance plus $7.32, which is the per-line, per month amount for the common support services expenses attributed to the supported services, as discussed above. *See supra* note 855. Total company expenses are the sum of loop maintenance, circuit, switch maintenance, and the total corporate overhead. This allocator is .6769.

[1313] BellSouth *Inputs Further Notice* comments at Attachment B, B-20.

[1314] This can be verified by examining the formulas in the " 96 Actuals" tab of the expense modules.

West claims that in the second step of the algorithm the synthesis model includes only fifty percent of the building investment and no land investment.[1315] The synthesis model incorporates the HAI switching and expense modules and calculates the investment related to wire center buildings and land in the switching module. So, US West is mistaken that fifty percent of the building and land investment is eliminated, because this investment is added back in calculating switching costs.[1316]

418. For the reasons stated above, we adopt input values for GSF investment that reflect the portion of GSF investment attributable to the cost of providing the services supported by the federal mechanism. Specifically, we calculate preliminary GSF investment on a study area specific basis, using 1998 ARMIS data, and then multiply these estimates by a nationwide allocation factor derived from the regression methodology that we used to estimate the portion of common support services expenses attributable to switched lines and local usage and the portion of plant-specific operations expenses attributable to the supported services.[1317] The allocation factor is the sum of plant specific operations expenses, customer operations expenses, network operations expenses, and corporate operations expenses attributable to the supported services, divided by the sum of those expenses calculated on a total regulated basis.

VIII. CAPITAL COSTS

A. Depreciation

1. Background

419. We now consider the inputs related to the calculation of depreciation expenses. The model uses "adjusted projection lives" to recover the current costs of the assets.[1318] Under this approach, the annual depreciation charges associated with an asset are computed by dividing the asset's current cost by its adjusted projection life.[1319] A shorter life will increase the annual

[1315] US West *Inputs Further Notice* comments at 48.

[1316] To the extent that not all of the land investment is included in the synthesis model logic, such a change would require a change to the model platform.

[1317] *See* Appendix D at D-9.

[1318] *1997 Further Notice,* 12 FCC Rcd at 18570, para. 149. The projection life of an asset is the asset's expected service life at installation, reflecting not only the physical life of the equipment, but also the obsolescence associated with the replacement of older equipment with equipment that uses new technologies and forecasts of future replacements. The adjusted projection life of an asset is its projection life adjusted by its future net salvage value. Future net salvage is the percentage of the asset's value that the owner expects to obtain when selling the asset at the end of its useful life. *Id.*

[1319] Depreciation charges are computed in this manner for the first year. In subsequent years, depreciation charges are computed using reserve.

depreciation expense.

420. In the *Universal Service Order*, the Commission concluded that "economic lives and future net salvage percentages used in calculating depreciation expense should be within the FCC-authorized range" and use currently authorized depreciation lives.[1320] In the *1997 Further Notice*, the Commission tentatively concluded that it should adopt depreciation expenses that reflect a weighted average of the rates authorized for carriers that are required to submit their rates to us.[1321] The Commission also sought comment on whether adjusted projected asset lives should reflect the lives of facilities and equipment dedicated to providing only the services supported by universal service or whether the asset lives should reflect a decision to replace existing plant with plant that can provide broadband services.[1322] The *May 4 Public Notice* requested further information on these issues.[1323]

421. In the *Inputs Further Notice*, we tentatively adopted a method of depreciation that should be used in the model, i.e., how depreciation allowances should be allocated over the life of an asset.[1324] Because the Commission's depreciation accounting rules require the use of straight-line equal-life-group depreciation, rather than a more accelerated depreciation method, we tentatively concluded that this method, which is used for all Commission-proposed depreciation, is also appropriate for use in the high-cost support mechanism.[1325]

2. Discussion

[1320] *Universal Service Order*, 12 FCC Rcd at 8913-14, para. 250 (criterion 5).

[1321] *1997 Further Notice*, 12 FCC Rcd at 18571, para. 152.

[1322] *Id.*

[1323] *See Inputs Public Notice*.

[1324] *Inputs Further Notice* at para. 231.

[1325] 47 C.F.R. § 32.2000(g). The equal-life-group procedure subdivides all units of a plant account installed in a particular year (a "vintage") into groups in which all units are expected to have the same life span. Each group is depreciated using the straight-line method, which spreads depreciation costs equally over the life of the group. *See Amendment of Part 31 (Uniform System of Accounts for Class A and B Companies) so as to Permit Depreciable Property to be Placed in Groups Comprised of Units with Expected Equal Life for Depreciation Under the Straight-Line Method*, Report and Order, 83 FCC2d 267 (1980), recon., 87 FCC2d 916 (1981), supplemental opinion, 87 FCC2d 1112 (1981) [*Straight-Line Equal-Life-Group Report and Order*]. Thus, the annual depreciation of a single vintage of a plant account equals the sum of the depreciation amounts of all surviving life-groups from that vintage. For a discussion of the equal-life-group method of depreciation, see Bryan Clopton, "Equal Life Group Depreciation Rates", in National Ass'n of Regulatory Utility Commissioners, Public Utility Depreciation Practices at 165-186 (August 1996) [Public Utility Depreciation Practices].

a. Method of Depreciation

422. For the reasons explained below, we adopt a straight-line equal-life-group method of depreciation. Further, we select curve shapes to be used to distribute equal-life groups in each plant account.[1326]

423. Most commenters support our tentative conclusion to use the straight-line equal-life-group method of depreciation.[1327] Ameritech argues, however, that the Commission's adoption of a straight-line depreciation method in other contexts need not limit us to that method for use in this model, and that "the method of depreciation for a specific study area needs to be consistent with any study that underlie [sic] the development of economic lives or net salvage."[1328] Although Ameritech may correctly assert that there is no requirement that we adopt a method of depreciation simply because it is the method previously adopted by the Commission in another context, we believe that the Commission's adoption, in other proceedings, of the straight-line equal-life-group method reflects the well-considered conclusion that this method of depreciation is best-suited to determining the economic costs of providing local service. The straight-line equal-life-group depreciation method is also consistent with our method of developing economic lives and net salvage for the same plant accounts. Because the Commission consistently uses a straight-line equal-life-group depreciation method in all other Commission-proposed depreciation, and in light of the general support received in favor of straight-line equal-life-group depreciation, we conclude that straight-line equal-life-group depreciation is appropriate for use in the high-cost support mechanism.[1329]

424. In using the straight-line equal-life-group method of depreciation in other contexts, the Commission has acknowledged that the method necessarily requires the selection of a curve shape for the distribution of the equal-life groups.[1330] The HAI model assumed a

[1326] A curve shape is the result of actuarial analysis which determines the probable frequency of plant mortality for a particular plant account from the time the plant vintage is placed in service to the end of life of the final surviving plant of that vintage. In the equal-life-group methodology, curve shapes are used to determine the number of units of a plant account in each equal-life group. *See generally* Public Utility Depreciation Practices at 111-129. The adopted curve shapes for each plant account are shown in the table attached in Appendix A at A-30.

[1327] See AT&T/MCI *Inputs Further Notice* comments at 47-48; BellSouth *Inputs Further Notice* comments, Appendix B at B-26; GTE *Inputs Further Notice* comments at 85; Sprint *Inputs Further Notice* comments at 75; AT&T/MCI *Inputs Further Notice* reply comments at 41.

[1328] Ameritech *Inputs Further Notice* comments at 30.

[1329] We note, furthermore, in response to the comments of AT&T/MCI, that we intend to follow our standard practice of accounting for the impact of deferred taxes. *See, e.g.,* 47 C.F.R. § 65.830(a)(1).

[1330] *See, e.g., Straight-Line Equal-Life-Group Report and Order*.

single curve shape for all plant accounts.[1331] Because the curve shapes are not easily averaged across all categories, however, we believe that use of the single HAI curve shape will unduly distort the model input values. We, therefore, determine that separate curve shapes should be adopted for each plant account category. Actuaries have developed generic, standardized curve shapes, called Gompertz-Makeham (GM) standard curves, that describe generalized mortality patterns. GM standard curve shapes are recognizable to many knowledgeable parties concerned with depreciation methods and are normally more immediately meaningful to them than nonstandard curve shapes, which are identified by the values for three variables.[1332] For convenience purposes, GM standard curves are often substituted for nonstandard curves. USTA has developed nonstandard curve shapes for most plant accounts based on mortality data provided by its members, using the same methodology approved in other Commission proceedings.[1333] For the remaining plant accounts, the Commission has developed composite curves, also nonstandard, utilizing data from available depreciation studies. Because the GM standard curves are recognizable and convenient to parties interpreting the data inputs in the high-cost model, and because the standardized curves will not vary significantly from the nonstandardized curves, we conclude that GM standard curves will be more useful in the high-cost inputs model than nonstandard curves. For each plant category, therefore, we adopt the GM standard curve shape nearest that developed by USTA or the Commission.[1334]

b. Depreciation Lives and Future Net Salvage Percentages

425. We adopt the tentative conclusion of the *Inputs Further Notice* that we should use HAI's input values with respect to depreciation lives and future net salvage percentages. As explained below, we reject the objections by some commenters that the HAI input values are not

[1331] Letter from Chris Frentrup, MCI WorldCom, to Magalie Roman Salas, FCC, dated July 16, 1999 (AT&T/MCI July 15 *ex parte*).

[1332] The variables describing a nonstandard curve shape are not usually meaningful in and of themselves. There are an infinite number of curves that the variables could describe and the variables themselves offer no insight into the shape of the curve until they have been used to actually plot the curve they describe. Until that has been done the depreciation consequences of a particular set of variables are unknown. The GM standard curves are a set of thirteen generalized curves that may stand in place of the infinite number of possible nonstandard curves. Because of the small, finite number of GM standard curves, a person familiar with depreciation practices will recognize the depreciation consequences of a particular identified GM standard curve. For a detailed discussion of GM standard curves, formerly known as Bell standard curves, see American Telegraph & Telephone, Engineering Economy 345-65 (1977).

[1333] *See* Public Utility Depreciation Practices at 120-26.

[1334] See Public Utility Depreciation Practices at 123-25 for a discussion regarding the method for matching generalized curves to observed life table values. The adopted curve shapes for each plant account category are shown in the table attached in Appendix A at A-30..

appropriate for determining depreciation rates in a competitive environment.

426. In estimating depreciation expenses, the model uses the projected lives and future net salvage percentages for the asset accounts in Part 32 of the Commission's rules.[1335] Traditionally, the projected lives and future net salvage values used in setting a carrier's rates have been determined in a triennial review process involving the state commission, the Commission, and the carrier. In order to simplify this process, the Commission has prescribed ranges of acceptable values for projected lives and future net salvage percentages.[1336] The Commission's prescribed ranges reflect the weighted average asset life for regulated telecommunications providers. These ranges are treated as safe harbors, such that carriers that incorporate values within the ranges into their depreciation filings will not be challenged by the Commission. Carriers that submit life and salvage values outside of the prescribed range must justify their submissions with additional documentation and support.[1337] Commission-authorized depreciation lives are not only estimates of the physical lives of assets, but also reflect the impact of technological obsolescence and forecasts of equipment replacement. We believe that this process of combining statistical analysis of historical information with forecasts of equipment replacement generates forward-looking projected lives that are reasonable estimates of economic lives and, therefore, are appropriate measures of depreciation.

427. We disagree with comments by incumbent LECs that the Commission's prescribed ranges are not appropriate for determining depreciation rates in a competitive environment.[1338] These parties argue that rapid changes in technology and competition in local telecommunications markets will diminish asset lives significantly below the Commission's prescribed range by causing existing equipment to become obsolete more quickly.[1339] We agree

[1335] *See* 47 C.F.R. § 32.2000(j)

[1336] *See* 47 C.F.R. § 32.2000(g)(iii).

[1337] The Commission has proposed streamlining the depreciation prescription process by, *inter alia*, expanding the prescribed range for the digital switching plant account and eliminating salvage from the depreciation process. *See 1998 Biennial Regulatory Review -- Review of Depreciation Requirements for Incumbent Local Exchange Carriers*, Notice of Proposed Rulemaking, CC Docket No. 98-137, 13 FCC Rcd 20542 (1998).

[1338] Ameritech *Inputs Further Notice* comments at 31-32; Bell Atlantic *Inputs Further Notice* comments at 7, 23-24, and Attachment B, at 7-10; BellSouth *Inputs Further Notice* comments, Appendix B at B–23-B–26; Cincinnati Bell Telephone *Inputs Further Notice* comments at 5; GTE *Inputs Further Notice* comments at 85-86; SBC *Inputs Further Notice* comments at 21-23; Sprint *Inputs Further Notice* comments at 76-79; *see also* Aliant June 1, 1998 comments at 3-4; Ameritech June 1, 1998 comments at 4; BCPM June 1, 1998 comments at 11-13; GTE June 1, 1998 comments at 15-16; Southwestern June 1, 1998 comments at 9-10.

[1339] Ameritech *Inputs Further Notice* comments at 31-32; Bell Atlantic *Inputs Further Notice* comments at 7, 23-24, and Attachment B, at 7-10; BellSouth *Inputs Further Notice* comments, Appendix B at B–24-B–26; GTE *Inputs Further Notice* comments at 85-86; Sprint *Inputs Further Notice* comments at 76-79; *see also* BCPM June 1, 1998 comments at 12; SBC June 1, 1998 comments at 17; GTE June 1, 1998 comments at 16; Ameritech June 1, with GSA, AT&T and MCI that there is no evidence to support the claim that increased competition or advances in technology require the use of shorter depreciation lives in the model than are currently prescribed by the Commission.[1340] The Commission's prescribed lives are not based solely on the engineered life of an asset, but also consider the impacts of technological change and obsolescence. We note that the depreciation values we adopt are generally at the lower end of the prescribed range. We also find compelling the data presented in GSA's comments showing that, although the average depreciation rate for an incumbent LEC's Total Plant in Service is approximately seven percent, incumbent LECs are retiring plant at a four percent rate.[1341] This difference has allowed depreciation reserves to increase so that the depreciation reserve-ratio is currently greater than 50 percent.[1342] We conclude that the existence of this difference implies that the prescribed lives are shorter than the engineered lives of these assets. In addition, this difference provides a buffer against technological change and competitive risk for the immediate future. We, therefore, conclude that the Commission's prescribed ranges are appropriate to determine depreciation rates for use in the federal high-cost mechanism.

428. We also decline to adopt the values for projected lives and net salvage percentages submitted by several incumbent LEC commenters. These commenters propose adoption of default values for projected lives and salvage based LEC industry date surveys[1343] or on similar values currently used by LECs for financial reporting purposes.[1344] The LEC industry data survey's projected lives generally fall outside of the Commission's prescribed ranges.[1345] This is significant because the values that fall outside of the prescribed ranges represent accounts that reflect the overwhelming majority of plant investment, thus potentially triggering a dramatic

1998 comments at 4.

[1340] AT&T/MCI *Inputs Further Notice* comments at 47-48; GSA *Inputs Further Notice* comments at 5-6, Attachment 1; *see also* HAI June 1, 1998 comments at 13.

[1341] GSA *Inputs Further Notice* comments at 5-6, Attachment 1.

[1342] *Id.*

[1343] *See*, *e.g.*, Ameritech *Inputs Further Notice* comments at 31-32 (recommending adoption of values endorsed by Technology Futures, Inc.).

[1344] *See*, *e.g.*, Bell Atlantic *Inputs Further Notice* comments at 24; GTE *Inputs Further Notice* comments at 86; SBC *Inputs Further Notice* comments at 22-23.

[1345] The eight categories in which BCPM's values fall outside required ranges for projected lives were: Digital Circuit Equipment; Digital Switching; Aerial Cable-Metallic; Aerial Cable-Non-Metallic; Underground Cable-Metallic; Underground Cable-Non-Metallic; Buried Cable-Metallic; and Buried Cable-Non-Metallic. The two categories in which BCPM's values fall outside required ranges for net salvage percentage were Digital Circuit Equipment and Poles.

distortion of the estimated cost of providing the supported services. Moreover, these commenters assert that technological advances and competition will have the effect of displacing current technologies, but offer no specific evidence that this displacement will occur at greater rates than the forward-looking Commission-authorized depreciation lives take into account. The record is particularly silent regarding the displacement of technologies associated with the provision of services supported by the federal high-cost mechanism. We do not believe that the LEC industry data survey's projected lives have been adequately supported by the record in this proceeding to justify their adoption.

429. We also agree with GSA's comments that the projected-life values currently used by LECs for financial reporting purposes are inappropriate for use in the model.[1346] In addition, the commenters proposing these values have not explained why the values used for financial reporting purposes would also reflect economic depreciation. The depreciation values used in the LECs' financial reporting are intended to protect investors by preferring a conservative understatement of net assets, partially achieving this goal by erring on the side of over-depreciation. These preferences are not compatible with the accurate estimation of the cost of providing services that are supported by the federal high-cost mechanism. We, therefore, decline to adopt the projected life values used by LECs for financial reporting purposes.

430. In the *1997 Further Notice*, the Commission tentatively concluded that it should adopt depreciation expenses that reflect a weighted average of the rates authorized for carriers that are required to submit their rates to us.[1347] The values submitted by the HAI sponsors essentially reflect such a weighted average. The HAI values represent the weighted average depreciation lives and net salvage percentages from 76 study areas.[1348] According to the HAI sponsors, these depreciation lives and salvage values reflect the experience of the incumbent LEC in each of these study areas in retiring plant and its projected plans for future retirements.[1349]

431. In the *Inputs Further Notice*, we tentatively concluded that HAI's values represent the best forward-looking estimates of depreciation lives and net salvage percentages.[1350] Generally, these values fall within the ranges prescribed by the Commission for projected lives and net salvage percentages. Although the HAI values for four account categories fall outside of

---

1346 GSA *Inputs Further Notice* reply comments at 5.

1347 *1997 Further Notice*, 12 FCC Rcd at 18571, para. 152.

1348 HAI June 1, 1998 comments at 10.

1349 *Id.*

1350 The proposed values for these inputs are listed in Appendix A.

the Commission's prescribed ranges,[1351] these values still reflect the weighted average of projected lives and net salvage percentages that were approved by the Commission and, therefore, are consistent with the approach proposed in the *1997 Further Notice*. As noted above, the fact that an approved value falls outside of the prescribed range simply means that the carrier proposing the value was required to provide additional justification to the Commission for this value. We are satisfied that HAI calculated its proposed rates using the proper underlying depreciation factors and that HAI's documentation supports the selection of these values. We, therefore, adopt HAI's values for estimating the depreciation lives and net salvage percentages.

B. Cost of Capital

432. We now adopt the conclusions that we tentatively reached in the *Inputs Further Notice* regarding the cost of capital. For the reasons discussed below, we do not find that any commenter has provided a compelling argument for altering the current federal rate of return of 11.25 percent, absent the adoption of a different rate of return by the Commission in a rate prescription order.

433. The cost of capital represents the annual percentage rate of return[1352] that a company's debt-holders and equity holders require as compensation for providing the debt and equity capital that a company uses to finance its assets.[1353] In the *Universal Service Order*, the Commission concluded that the current federal rate of return of 11.25 percent is a reasonable rate of return by which to determine forward-looking costs.[1354]

434. GSA, AT&T and MCI comment that the cost of capital for incumbent LECs is well below 11.25 percent.[1355] Bell Atlantic advocates a cost of capital rate in the range of 12.75

[1351] HAI's lives and salvage values fall within the Commission's prescribed ranges with the exception of values for four accounts: Digital Circuit Equipment; Garage Work Equipment; Operator Systems; and Poles.

[1352] Rate of return is the percentage which a telephone carrier is authorized to earn on its rate base. For example, if the rate of return is 11.25% and the rate base is $1 million, the carrier is authorized to earn $112,500.

[1353] *See Local Exchange Carriers' Rates, Terms, and Conditions for Expanded Interconnection Through Physical Collocation for Special Access and Switched Transport*, Second Report and Order, CC Docket No. 93-316212, FCC Rcd 18370, 18765 (1997).

[1354] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250.

[1355] AT&T/MCI *Inputs Further Notice* comments at 50-51 (arguing that forward-looking cost of capital is approximately 8.5-9.0 percent, but endorsing HAI value of 10.01 percent); GSA *Inputs Further Notice* comments at 6-7 (noting that GSA had recommended 9.5 percent in rate of return proceeding); AT&T/MCI *Inputs Further Notice* reply comments at 41 (arguing that true forward-looking cost of capital is 8.64 percent); *see also* HAI June 1, 1998 comments at 13.

to 13.15 percent.[1356] GTE and USTA dispute the lower cost of capital asserted by AT&T and MCI and GSA.[1357] All commenters addressing this issue agreed that, if a different rate of return is adopted in a rate prescription order, that value should be adopted in the model.[1358]

435. We find that the commenters proposing an adjustment to the cost of capital have failed to make an adequate showing to justify rates that differ from the current 11.25 percent federal rate of return. We conclude, therefore, that the current rate is reasonable for determining the cost of providing services supported by the federal high-cost mechanism. If the Commission, in a rate prescription order, adopts a different rate of return, we conclude the federal mechanism should use the more recently determined rate of return.

C. Annual Charge Factors

436. We also now adopt our tentative conclusion in the *Inputs Further Notice* to use HAI's annual charge factor methodology. As explained below, we find this appropriate because the synthesis model uses a modified version of HAI's expense module.

437. Incumbent LECs develop cost factors, called "annual charge factors," to determine the dollar amount of recurring costs associated with acquiring and using particular pieces of investment for a period of one year. Incumbent LECs develop these annual charge factors for each category of investment required. The annual charge factor is the sum of depreciation, cost of capital, adjustments to include taxes on equity, and maintenance costs.

438. To develop annual charge factors, the BCPM proponents proposed a model with user-adjustable inputs to calculate the depreciation and cost of capital rates for each account.[1359] The BCPM proponents stated that this account-by-account process was designed to recognize that all of the major accounts have, among other things, differing economic lives and salvage values that lead to distinct capital costs.[1360] HAI's model is also user adjustable and reflects the

---

[1356] Bell Atlantic *Inputs Further Notice* comments at 23.

[1357] USTA *Inputs Further Notice* reply comments at 3-4; GTE *Inputs Further Notice* reply comments at 34-35; *see also* BCPM Dec. 11 submission (advocating an 11.36 percent cost of capital).

[1358] *See, e.g.,* Ameritech *Inputs Further Notice* comments at 33-34; AT&T/MCI *Inputs Further Notice* comments at 50-51 (but advocating adoption of different rate for model if rate prescription proceeding will not be concluded prior to January 1, 2000 implementation of model); GSA *Inputs Further Notice* comments at 6-7; USTA reply comments at 3.

[1359] BCPM Dec. 11 submission at 80.

[1360] *Id.* BCPM's model includes all of the methodologies that are in practice today, including: Deferred taxes; Mid-year, Beginning Year, and End Year placing conventions; Gompertz-Makeham Survival Curves; Future Net Salvage Values; Equal Life Group Methods; and others. The model also incorporates separate Cost of Debt and sum for the three inputs: depreciation, cost of capital, and maintenance costs.[1361] In the *Inputs Further Notice*, the Commission tentatively adopted HAI's annual charge factor methodology, and invited comment on this tentative decision.[1362] GTE argues that the annual charge factors should be company specific, in order to make the cost calculations in the optimization phase and the expense module comparable.[1363] We do not believe it would be appropriate to adopt GTE's proposal of using company-specific annual charges, because we are adopting nationwide averages for all other inputs, including those that make up the annual charge. Adopting company-specific annual charges would therefore result in likely inconsistencies between various related inputs and in the model as a whole. AT&T and MCI support the use of the HAI annual charge factor methodology.[1364]

439. Because the synthesis model uses HAI's expense module, with modifications, we adopt HAI's annual charge factor methodology, utilizing the capital cost and expense inputs adopted above.[1365] We believe that HAI's annual charge factor methodology is consistent with other inputs used in the model adopted by the Commission, and is, therefore, easier to implement and yields more reasonable results.

IX. PROPOSED MODIFICATION TO PROCEDURES FOR DISTINGUISHING RURAL AND NON-RURAL COMPANIES

A. Background

440. In the *Universal Service Order*, the Commission determined that rural and non-rural carriers will receive federal universal service support determined by separate mechanisms until at least January 1, 2001.[1366] The Commission stated that it would define rural carriers as those carriers that meet the statutory definition of a rural telephone company in section 153(37) of the Communications Act.[1367] Under this definition, a "local exchange carrier operating entity"

Equity rates, along with the Debt to Equity ratio. *Id.*

[1361] HAI Dec. 11 submission at 41.

[1362] *Inputs Further Notice* at para. 242.

[1363] GTE *Inputs Further Notice* comments at 87.

[1364] AT&T/MCI *Inputs Further Notice* comments at 51.

[1365] The expense module contains the expense values including plant-specific maintenance ratios and the algorithms that determine monthly cost per-line, given the results of all other modules.

[1366] *Universal Service Order*, 12 FCC Rcd at 8927, para. 273.

[1367] *See* 47 U.S.C. § 153(37); *Universal Service Order*, 12 FCC Rcd at 8944, para. 310.

is deemed a "rural telephone company" to the extent that such entity--

> (A) provides common carrier service to any local exchange carrier study area that does not include either--
>
> (i) any incorporated place of 10,000 inhabitants or more, or any part thereof, based on the most recently available population statistics of the Bureau of the Census; or
>
> (ii) any territory, incorporated or unincorporated, included in an urbanized area, as defined by the Bureau of the Census as of August 10, 1993;
>
> (B) provides telephone exchange service, including exchange access, to fewer than 50,000 access lines;
>
> (C) provides telephone exchange service to any local exchange carrier study area with fewer than 100,000 access lines; or
>
> (D) has less than 15 percent of its access lines in communities of more than 50,000 on the date of enactment of the Telecommunications Act of 1996.

441. In addition, the Commission determined that LECs should self-certify their status as a rural company each year to the Commission and their state commission.[1368] On September 23, 1997, the Bureau released a Public Notice requiring carriers seeking to be classified as rural telephone companies to file a letter with the Commission by April 30 of each year certifying that they meet the statutory definition.[1369] The *Self-Certification Public Notice* requires a LEC certifying as a rural carrier to explain how it meets at least one of the four criteria set forth in the statutory definition.[1370] On June 22, 1998, the Accounting Policy Division (Division) released a Public Notice with a list of the approximately 1,400 carriers that had certified as rural carriers as of April 30, 1998.[1371] On March 16, 1999, the Bureau released a Public Notice revising the annual deadline for LECs seeking to be classified as rural carriers to July 1 of each year. In the *Inputs Further Notice*, the Commission extended the July 1, 1999, recertification filing deadline to October 15, 1999.[1372] On September 27, 1999, the Division released a Public Notice further extending the deadline to December 1, 1999, in consideration of the possibility that certain

---

[1368] *Universal Service Order*, 12 FCC Rcd at 8943-44, para. 310.

[1369] Self-Certification as a Rural Telephone Company, *Public Notice*, CC Docket No. 96-45, DA 97-1748 (rel. Sept. 23, 1997) (*Self-Certification Public Notice*).

[1370] *See* 47 U.S.C. § 153(37).

[1371] Commission Acknowledges Receipt of Letters Self-Certifying LECs as Rural Telephone Companies, *Public Notice*, CC Docket No. 96-45, DA 98-1205 (rel. June 22, 1998).

[1372] *Inputs Further Notice* at para. 255.

carriers might not be required to file the certification letter in light of the action we take in this Order.[1373]

442. Because a vast majority of the carriers certifying as rural telephone companies serve fewer than 100,000 access lines, we tentatively concluded in the *Inputs Further Notice* that we should adopt new filing requirements for carriers filing rural self-certification letters.[1374] We proposed that carriers who serve fewer than 100,000 access lines should not have to file the annual rural certification letter unless their status has changed since their last filing.[1375] We also sought comment on certain terms relevant to the definition of a rural telephone company in section 153(37) of the Act.[1376] In addition, we sought comment on whether the Commission should reconsider its use of section 153(37) to distinguish rural telephone companies from non-rural telephone companies.[1377]

B. Discussion

443. Consistent with our tentative conclusion in the *Inputs Further Notice*, we eliminate the annual filing requirements for carriers serving fewer than 100,000 access lines that have self-certified as rural, unless changes occur in their status as rural carriers. In addition, we will require carriers serving study areas with more than 100,000 access lines to file rural self-certifications that are consistent with the statutory interpretation discussed below. Thereafter, such carriers also will be required to file only in the event of a change in their status.

444. As discussed below, we interpret "local exchange operating company" in section 153(37) of the Act to refer to the legal entity that provides local exchange service. In addition, we interpret "communities of more than 50,000" in that section to refer to legally incorporated

[1373] *Common Carrier Bureau Extends Rural Carrier Recertification Filing Deadline*, Public Notice, CC Docket No. 96-45, DA 99-1948 (rel. September 27, 1999).

[1374] *Inputs Further Notice* at para. 246.

[1375] *Id.* The National Exchange Carrier Association, Inc. (NECA) has requested that the Commission eliminate the annual rural certification process. NECA states that the majority of carriers that meet the rural definition are small LECs with limited resources, whose status is not likely to change. Letter from Richard A. Askoff, NECA to Irene Flannery, FCC, dated April 9, 1999.

[1376] *Inputs Further Notice* at paras. 251-53.

[1377] *Id.* at para. 254.

localities, consolidated cities, and census-designated places with populations of more than 50,000 according to Census Bureau statistics.

445. With respect to our request for comment on whether we should reconsider our use of section 153(37) to distinguish rural telephone companies from non-rural companies, we conclude below that we should not use an alternative definition of rural telephone company to determine which companies are subject to the rural or non-rural high-cost support mechanisms.

446. Because of settled expectations in this ongoing proceeding, the Commission will accept a carrier's current rural self-certification for purposes of calculating support based on that status for calendar year 2000. We will require carriers serving study areas with more than 100,000 access lines to certify their rural status by July 1, 2000, for purposes of receiving support beginning January 1, 2001.

1. Annual Filing Requirement

447. Carriers serving study areas with fewer than 100,000 access lines. We adopt the proposed change in the annual self-certification requirement for rural carriers and will require that carriers serving fewer than 100,000 access lines file a rural self-certification letter only if their status has changed since their last filing. All commenters addressing this issue urge the Commission to eliminate annual filing requirements.[1378] We believe that this is a better approach because the overwhelming majority of the companies that filed rural certification letters qualified as rural telephone companies under the 50,000- or 100,000-line thresholds identified in the statute. Access line counts can be verified easily with publicly available data. Further, this relaxation in filing requirements will lessen the burden on rural carriers. We estimate that this change will eliminate the filing requirement for approximately 1,380 of the carriers that filed in 1998, many of which are small businesses on which even limited regulatory requirements may be unduly burdensome. We, therefore, conclude that carriers serving study areas with fewer than 100,000 access lines that already have certified their rural status need not re-certify for purposes of receiving support beginning January 1, 2000, and need only file thereafter if their status changes. As explained below, we must determine the status for carriers serving study areas with more than 100,000 access lines.

[1378] ALLTEL *Further Inputs Notice* comments at 2; Alaska Telephone Association *Further Inputs Notice* comments at 2; Bentleyville Telephone Company *Further Inputs Notice* comments at 1; CenturyTel *Further Inputs Notice* comments at 7; Citizens Utilities *Further Inputs Notice* comments at 6; GTE *Further Inputs Notice* comments at 91; GVNW Consulting (GVNW) *Further Inputs Notice* comments at 2; Matanuska Telephone Association (MTA) *Further Inputs Notice* comments at 1; NECA *Further Inputs Notice* comments at 2; Rural Telephone Coalition (RTC) *Further Inputs Notice* comments at 8; Skyline Telephone Membership Corporation *Further Inputs Notice* comments at 1, 3; South Slope Cooperative Telephone Company *Further Inputs Notice* comments at 1-2; TXU Communications Telephone Company (TXU) *Further Inputs Notice* comments at 6; USTA *Further Inputs Notice* comments at 6; Virgin Islands Telephone Corporation (Vitelco) *Further Inputs Notice* comments at 7; Yukon Telephone Company *Further Inputs Notice* comments at 1.

448. We believe, as GTE suggests, that carriers generally (although not uniformly) have filed for rural status in this proceeding on a study area basis. Indeed, the synthesis model that has been posted on the Commission's Web site -- allowing carriers to determine how the Commission has been treating them throughout this proceeding -- estimates cost on a study area basis.[1379] Not all carriers, however, have uniformly filed for rural status on a study area basis, as we noted in the *Inputs Further Notice*, resulting in inconsistencies that must be resolved in order to assure equitable treatment of all carriers. These inconsistencies will be addressed below.

449. Carriers serving study areas with more than 100,000 access lines. For purposes of calculating high cost support using the model for the year 2000, we will continue to treat carriers as rural if they have previously self-certified as rural carriers. We will then require rural carriers serving study areas with more than 100,000 access lines to file certification letters by July 1, 2000, for their year 2001 status. Commenters that address the issue broadly support re-certification requirements that require these carriers to re-certify only if their status has changed, rather than require them to re-certify each year.[1380] Finding that the relaxed re-certification requirements will reduce administrative burdens for carriers subject to rural certification and for the Commission, we conclude that certified rural carriers with more than 100,000 access lines need only re-certify their status if it changes. Therefore, in 2001 and subsequent years, a carrier serving study areas with more than 100,000 access lines and claiming rural status will be required to file only if its status changes.

2. Statutory Terms

450. As noted in the *Inputs Further Notice*, carriers' line counts are readily available to the Commission, but information about service territories and communities served are not. As a result, the Commission can easily determine whether a carrier satisfies criteria (B) or (C) of the rural telephone company definition,[1381] because these criteria are based on information that can be verified easily with publicly available data -- the number of access lines served by a carrier.

[1379] The model also estimates cost on a wire center basis. Also, we note that PRTC and Anchorage Telephone Utility previously had been excluded from the non-rural model runs because of the unavailability of data for Puerto Rico and Alaska, but those companies have participated in the proceeding on the presumption that were non-rural. The formerly unavailable data is now available, and has been incorporated into the model posted on the Commission's web site. *See* Letter from Charles A. White, PNR, to Magalie Roman Salas, FCC, dated July 29, 1999 (PNR July 29 *ex parte*).

[1380] *See, e.g.,* ALLTEL *Inputs Further Notice* comments at 2; CenturyTel *Inputs Further Notice* comments at 7; GVNW *Inputs Further Notice Comments* at 2; MTA *Inputs Further Notice Comments* at 1; NECA *Inputs Further Notice* comments at 2; TXU *Inputs Further Notice* comments at 6; USTA *Inputs Further Notice* comments at 6; TXU *Inputs Further Notice* reply comments at 4.

[1381] 47 U.S.C. § 153(37)(B), (C).

In contrast, criteria (A) and (D) require additional information and analysis to verify a carrier's self-certification as a rural company.[1382] Specifically, under criterion (A), a carrier is rural if its study area does not include "any incorporated place of 10,000 inhabitants or more" or "any territory . . . in an urbanized area," based upon Census Bureau statistics and definitions.[1383] Under criterion (D), a carrier is rural if it had "less than 15 percent of its access lines in communities of more than 50,000 on the date of enactment of the [1996 Act]."[1384]

451. We conclude that criterion (A), by referencing Census Bureau sources, can be applied consistently without further interpretation by the Commission. We will require, however, that carriers self-certifying as rural telephone companies pursuant to criterion (A) include with their self-certification letter a description of the study areas in which they provide service and the basis for their assertion that they meet the requirements of criterion (A).

452. In the *Inputs Further Notice*, we sought comment on the meaning of the term "local exchange operating entity." Commenters have offered three different interpretations of this term. Many commenters suggest that we should interpret the term as applying at the study area level.[1385] Although in most cases an operating entity will provide service to only one study area within a state, that is not always the case. As a result, the study area approach could mean classifying a carrier at an organizational level smaller than the actual legal entity responsible for the provision of the local exchange services (e.g., a "division" of a company). In contrast, AT&T and MCI argue that the term should mean the holding company within a state whose affiliates provide the local exchange services.[1386] The third interpretation has been proposed by RTC and Citizens Utilities, who argue that the most natural understanding of "local exchange operating entity" is the legal entity responsible for the provision of local exchange services, regardless of whether that entity serves a single or multiple study areas.[1387] We conclude that this interpretation is the most reasonable one.

[1382] Most carriers asserting rural status under criteria (A) or (D) also claim rural status under the access line thresholds in criteria (B) or (C). In those cases, the Commission does not need additional information to verify the carrier's rural status.

[1383] 47 U.S.C. § 153(37)(A).

[1384] 47 U.S.C. § 153(37)(D).

[1385] CenturyTel *Further Inputs Notice* comments at 3-4; Commonwealth Telephone Company (Commonwealth) *Further Inputs Notice* comments at 4-5; GTE *Further Inputs Notice* comments at 92-93; USTA *Further Inputs Notice* comments at 7; USTA *Further Inputs Notice* reply comments at 4-5; Vitelco *Further Inputs Notice* comments at 8; Vitelco *Further Inputs Notice* reply comments at 1-4.

[1386] AT&T/MCI *Inputs Further Notice* comments at 42.

[1387] Citizens Utilities *Further Inputs Notice* comments at 3-5; RTC *Further Inputs Notice* comments at 9-11; RTC *Further Inputs Notice* reply comments at 2; TXU *Further Inputs Notice* reply comments.

453. We believe that it is most logical to classify the carrier at the actual corporate level through which it offers its local exchange services. As RTC and Citizens Utilities point out, it is that entity that has legal responsibility for the provision of the local exchange services.[1388] The holding company interpretation proposed by MCI and AT&T seems to rest upon the concern that study area designations will be manipulated and, as a result, carriers will inappropriately be eligible for support as rural carriers, when they should not be.[1389] We do not believe that the potential for manipulation of the federal universal service support mechanism by rural carriers poses the threat that AT&T and MCI suggest; to the contrary, the study area waiver process provides the Commission with oversight over the creation, division, and combination of study areas.[1390]

454. On the other hand, if a carrier should be operating within multiple study areas, we see no basis for interpreting the term "local exchange operating entity" in a manner that would ignore the legal entity responsible for the provision of services by designating a subunit of the legal entity as the local exchange operating entity for a particular study area. Rather, it is more reasonable to have the term local exchange operating entity be synonymous with the corporate entity bearing legal responsibility for the services provided.[1391]

455. Although we adopt Citizen Utilities' interpretation of "local exchange operating entity," we reject its proposed interpretation of criterion (C). Citizens Utilities proposes that a local exchange carrier operating entity be considered a rural carrier for each of its study areas, regardless of whether those study areas have fewer than 100,000 access lines, if any single study area in which it operates contains fewer than 100,000 access lines.[1392] Under this interpretation, which only Citizens Utilities supports, an incumbent LEC offering service to a significant portion of a state, including major urban areas, could be certified as a rural carrier for all study areas that it serves within the state if it merely has one outlying study area with less than 100,000 access lines. We find this interpretation to be inconsistent with the statutory language that an entity is an rural telephone company only "to the extent" that it serves a study area with fewer

---

[1388] Citizens Utilities *Further Inputs Notice* comments at 3-5; RTC *Further Inputs Notice* comments at 9-11; RTC *Further Inputs Notice* reply comments at 2; TXU *Further Inputs Notice* reply comments.

[1389] *See* AT&T/MCI *Inputs Further Notice* comments at 42.

[1390] Study areas have been "frozen" since November 15, 1984, except where a waiver has been obtained. 47 C.F.R. § 36 (App.) (defining "study area").

[1391] We further note that it appears that some carriers with multiple study areas within a state will have a separate corporate entity for each study area. As a result, for these carriers there would be little practical difference between the first interpretation and the one that we adopt.

[1392] Citizens Utilities *Further Inputs Notice* comments at 6.

than 100,000 lines. Essentially, Citizens Utilities' interpretation would read that limiting language out of section 153(37). The effect of such a reading would be to permit some of the largest LECs in the nation to claim rural status for all of their study areas if they happen to serve a rural study area within in the state. Such an interpretation would undermine not only the Commission's universal service support mechanisms, but also the fundamental procompetitive policies underlying the 1996 Act.[1393] We do not believe that this could be what Congress intended when it specified that carriers would be deemed rural telephone companies "to the extent" that they satisfied the various criteria, including criterion (C) pertaining to serving study areas with less than 100,000 access lines. Accordingly, consistent with the language of the statutory provision, its purpose, and its context in the Act, we adopt the interpretation that a LEC may be properly considered a rural carrier with respect to those study areas to which its operating company provides service to fewer than 100,000 access lines. In contrast, a LEC will be deemed a non-rural carrier for study areas serving more than 100,000 access lines unless it satisfies one of the other criteria under section 153(37).

456. We also sought comment in the *Inputs Further Notice* regarding the proper interpretation of "communities of more than 50,000." GTE offers an interpretation of this phrase based on the definition of "rural area" in section 54.5 of the Commission's rules.[1394] GTE calculates its percentages of rural and non-rural lines by determining whether each of its wire centers is associated with a metropolitan statistical area (MSA). The lines in each wire center associated with an MSA are considered to be urban, unless the wire center has rural pockets, as defined by the most recent Goldsmith Modification.[1395] The approach suggested by GTE in its comments has merit because it prevents rural treatment of a suburban area adjacent to a census-designated place. At this time, however, there is no information on the record to indicate that this circumstance presents a serious problem in our determination of a carrier's status as a rural or non-rural company. Other commenters addressing the issue support the definition of

[1393] For example, if a carrier with more than one study area could claim that it was rural because one of its study areas served less than 100,000 lines, it could, under Citizen Utilities' definition of criterion (C), also claim that it was exempt from the obligations of 251(c) throughout its service territory.

[1394] GTE *Further Inputs Notice* comments at 94-96. Section 54.5 provides the following definition of rural area:

> A "rural area" is a non-metropolitan county or county equivalent, as defined in the Office of Management and Budget's (OMB) Revised Standards for Defining Metropolitan Areas in the 1990s and identifiable from the most recent Metropolitan Statistical Area (MSA) list released by OMB, or any contiguous non-urban Census Tract or Block Numbered Area within an MSA-listed metropolitan county identified in the most recent Goldsmith Modification published by the Office of Rural Health Policy of the U.S. Department of Health and Human Services.

47 C.F.R. § 54.5.

[1395] *See* 47 C.F.R. § 54.5.

"communities of more than 50,000" by using Census Bureau statistics for legally incorporated localities, consolidated cities, and census-designated places,[1396] and some specifically reject the use of the Commission's definition in section 54.5 because of the added complication of its use.[1397]

457. Because GTE's approach is more complicated and difficult to administer and because the consequences of the approach would reach only a few, if any, rural carriers' study areas, we decline to adopt GTE's interpretation of "communities of more than 50,000." Instead, we now adopt the use of Census Bureau statistics for legally incorporated localities, consolidated, cities, and census-designated places for identifying communities of more than 50,000, as Census Bureau statistics are widely available and may be consistently applied by the Commission. We further require that, when a carrier files for rural certification under criterion (D), it must include in its certifying letter a list of all communities of more than 50,000 to which it provides service, the population of those communities, the number of access lines serving those communities, and the total number of access lines the carrier serves.

3. Identification of Rural Telephone Companies

458. States apply the definition of rural telephone company in determining whether a rural telephone company is entitled to an exemption under section 251(f)(1) of the Act and in determining, under section 214(e)(2) of the Act, whether to designate more than one carrier as an eligible telecommunications carrier in an area served by a rural telephone company.[1398] Although the Commission used the rural telephone company definition to distinguish between rural and non-rural carriers for purposes of calculating universal service support, there is no statutory requirement that it do so. The Commission adopted the Joint Board's recommendation to allow rural carriers to receive support based on embedded costs for at least three years, because, as compared to large LECs, rural carriers generally serve fewer subscribers, serve more sparsely populated areas, and do not generally benefit as much from economies of scale and scope.[1399] The Commission also noted that, for many rural carriers, universal service support provides a large share of the carriers' revenues, and thus, any sudden change in the support mechanisms may disproportionately affect rural carriers' operations.[1400]

[1396] CenturyTel *Further Inputs Notice* comments at 7; Citizens Utilities *Further Inputs Notice* comments at 7-8; Commonwealth *Further Inputs Notice* comments at 5.

[1397] Citizens Utilities *Further Inputs Notice* comments at 8; Commonwealth *Further Inputs Notice* comments at 5.

[1398] 47 U.S.C. §§ 214(e)(2), 251(f)(1).

[1399] *Universal Service Order*, 12 FCC Rcd at 8936, para. 294.

[1400] *Universal Service Order*, 12 FCC Rcd at 8936, para. 294.

459. In the *Inputs Further Notice*, we sought comment on whether to reconsider the means of distinguishing rural and non-rural carriers. Commenters generally oppose any reconsideration of our decision to use the definition of rural telephone company to distinguish between rural and non-rural carriers for the purpose of evaluating universal service support on the grounds that changing the definition at this time could disrupt the settled expectations that they have developed.[1401] We agree that we should not change our reliance on the statutory definition of rural telephone company to distinguish between rural and non-rural carriers for universal service purposes. Accordingly, we will leave in place the Commission's decision to use the definition of rural telephone company in section 153(37) of the Communications Act to distinguish rural telephone companies from non-rural ones.

X. PROCEDURAL MATTERS AND ORDERING CLAUSE

A. Final Regulatory Flexibility Analysis

460. As required by the Regulatory Flexibility Act (RFA),[1402] an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Inputs Further Notice*.[1403] The Commission sought written public comment on the proposals in the *Inputs Further Notice*, including comments on the IRFA. The Final Regulatory Flexibility Analysis (FRFA) in this Order conforms to the RFA, as amended.[1404]

461. *Need for and Objectives of This Order*. In the *Universal Service Order*, the Commission adopted a plan for universal service support for rural, insular, and high-cost areas to replace longstanding federal subsidies to incumbent local telephone companies with explicit, competitively neutral federal universal service mechanisms.[1405] In doing so, the Commission adopted the recommendation of the Joint Board that an eligible carrier's support should be based upon the forward-looking economic cost of constructing and operating the networks facilities and functions used to provide the services supported by the federal universal service mechanism.

[1401] CenturyTel *Further Inputs Notice* comments at 6; Commonwealth *Further Inputs Notice* comments at 2; Citizens Utilities *Further Inputs Notice* comments at 3; GTE *Further Inputs Notice* comments at 96-98; RTC *Further Inputs Notice* comments at 15; RTC *Further Inputs Notice* reply comments at 2; TXU *Further Inputs Notice* reply comments at 4; USTA *Further Inputs Notice* comments at 7.

[1402] *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. § 601 *et seq*., has been amended by the Contract with America Advancement Act of 1996, Pub. L. No. 104-121, 110 Stat. 847 (1996) (CWAAA). Title II of the CWAAA is the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA).

[1403] *Inputs Further Notice* at paras. 257-271.

[1404] *See* 5 U.S.C. § 604.

[1405] *Universal Service Order*, 12 FCC Rcd. 8776.

462. In the *Universal Service Order*, the Commission also determined that rural and non-rural carriers will receive federal universal service support determined by separate mechanisms until at least January 1, 2001.[1406] The Commission stated that it would define rural carriers as those carriers that meet the statutory definition of a rural telephone company in section 153(37) of the Communications Act.[1407] We have found that carriers self-certifying as rural have not always applied section 153(37) uniformly.[1408] In section IX of this Order, we clarify our interpretation of section 153(37). We also address the possibility that our annual self-certification requirements may be modified or eliminated in order to reduce the reporting burden on filing entities.

463. Our plan to adopt a mechanism to estimate forward-looking costs for larger, non-rural carriers has proceeded in two stages. On October 28, 1998, the Commission completed the first stage of this proceeding: the selection of the model platform. The platform encompasses the aspects of the model that are essentially fixed, primarily assumptions about the design of the network and network engineering. In this Order, we complete the second stage of this proceeding, by selecting input values for the cost model, such as the cost of cables, switches and other network components, in addition to various capital cost parameters.

464. *Summary and Analysis of the Significant Issues Raised by Public Comments in Response to the IRFA*. No comments were received specifically in response to the IRFA. We received several comments, however, addressing concerns that may affect small entities. These comments universally supported our proposal, adopted in this Order,[1409] to reduce the burden of carriers self-certifying as rural by eliminating the annual filing requirement.

465. *Description and Estimate of the Number of Small Entities to which the Order will Apply*. The RFA generally defines "small entity" as having the same meaning as the term "small business," "small organization," and "small government jurisdiction."[1410] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act, unless the Commission has developed one or more definitions that are appropriate to its activities.[1411] Under the Small Business Act, a "small business concern" is one that: (1) is

[1406] *Id.* at 8927, para. 273.

[1407] *See* 47 U.S.C. § 153(37); *Universal Service Order*, 12 FCC Rcd at 8944, para. 310.

[1408] *See Inputs Further Notice* at para. 249.

[1409] *See* section IX, above.

[1410] 5 U.S.C. § 601(6).

[1411] 5 U.S.C. § 601(3) (incorporating by reference the definition of "small business concern" in 5 U.S.C. § 632).

independently owned and operated; (2) is not dominant in its field of operation; and (3) meets any additional criteria established by the SBA.[1412] The SBA has defined a small business for Standard Industrial Classification (SIC) category 4813 (Telephone Communications, Except Radiotelephone) to be small entities when they have no more than 1,500 employees.[1413]

466. We have included small incumbent LECs in this present RFA analysis. As noted above, a "small business" under the RFA is one that, *inter alia*, meets the pertinent small business size standard (*e.g.*, a telephone communications business having 1,500 or fewer employees), and "is not dominant in its field of operation."[1414] The SBA's Office of Advocacy contends that, for RFA purposes, small incumbent LECs are not dominant in their field of operation because any such dominance is not "national" in scope.[1415] We have therefore included small incumbent LECs in this RFA analysis, although we emphasize that this RFA action has no effect on Commission analyses and determinations in other, non-RFA contexts.

467. Local Exchange Carriers. Neither the Commission nor SBA has developed a definition of small providers specifically directed toward LECs. The closest applicable definition under SBA rules is for telephone communications companies other than radiotelephone (wireless) companies. The most reliable source of information regarding the number of LECs nationwide of which we are aware appears to be the data that we collect annually in connection with the Telecommunications Relay Service (TRS).[1416] According to our most recent data, 1,410 companies reported that they were engaged in the provision of local

---

Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition in the Federal Register."

[1412] 15 U.S.C. § 632. *See, e.g., Brown Transport Truckload, Inc. v. Southern Wipers, Inc.*, 176 B.R. 82 (N.D. Ga. 1994).

[1413] 13 C.F.R. § 121.201.

[1414] 5 U.S.C. § 601(3).

[1415] Letter *from* Jere W. Glover, Chief Counsel for Advocacy, SBA, *to* William E. Kennard, Chairman, FCC (May 27, 1999). The Small Business Act contains a definition of "small business concern," which the RFA incorporates into its own definition of "small business." *See* 15 U.S.C. § 632(a) (Small Business Act); 5 U.S.C. § 601(3) (RFA). SBA regulations interpret "small business concern" to include the concept of dominance on a national basis. 13 C.F.R. § 121.102(b). Since 1996, out of an abundance of caution, the Commission has included small incumbent LECs in its regulatory flexibility analyses. *Implementation of the Local Competition Provisions of the Telecommunications Act of 1996*, CC Docket, 96-98, First Report and Order, 11 FCC Rcd 15499, 16144-45 (1996).

[1416] *See* 47 C.F.R. § 64.601 *et seq*.

exchange service as incumbents.[1417] Although it seems certain that some of these carriers are not independently owned and operated, or have more than 1,500 employees, we are unable at this time to estimate with greater precision the number of LECs that would qualify as small business concerns under SBA's definition. Consequently, we estimate that there are fewer than 1,410 small entity LECs that may be affected by this Order. We also note that, with the exception of our clarification of the definition of rural carrier under section 153(37) and the modification of reporting requirements, the rules adopted by this Order apply only to larger, non-rural LECs.

468. *Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements.* This Order imposes no new reporting, recordkeeping, or other compliance requirements. As discussed more fully in section IX, above, this Order immediately eliminates the requirement that carriers serving study areas with fewer than 100,000 access lines must annually file letters certifying themselves as rural carriers in order to remain in the rural carrier universal service support mechanism. Further, this Order eliminates, after the July 1, 2000, filing deadline, the requirement that rural carriers serving study areas with more than 100,000 access lines must file annual self-certification letters. All rural carriers must, however, notify the Commission in the event of a change in rural status.

469. The overall effect of this Order will be to reduce reporting, recordkeeping, and other compliance requirements for small entities.[1418] This benefit will apply to all carriers deemed rural under section 153(37), regardless of whether they are a small or large entity. Carriers serving study areas with fewer than 100,000 access lines--which are more likely to be small entities than those serving study areas with more than 100,000 access lines--will be most immediately benefited, as no further filings will be required of them unless and until their rural status changes. The largest carriers will generally be non-rural and not affected by this change in reporting. To the extent that large and small entities are treated differently, therefore, small entities will not carry a disproportionately high cost of compliance.

470. *Steps Taken to Minimize Significant Economic Impact on Small Entities and Significant Alternatives Considered.* As noted above and discussed more fully in section IX, with respect to reporting requirements affecting small entities, we eliminate the burden of an annual filing requirement for rural carriers. For carriers serving study areas with fewer than 100,000 access lines, this change is effective immediately. Rural carriers serving study areas with more than 100,000 access lines will be required to file a self-certification letter by July 1, 2000, but will not be required to refile additional annual certifications unless their status changes. These changes have at their heart consideration of the resources of small entities, and will reduce, if not eliminate, the costs of compliance for small entities. The alternative to this

[1417] FCC, *Carrier Locator: Interstate Service Providers*, at Figure 1 (Jan. 1999).

[1418] *See* para. 447, *supra*.

approach would have been to require additional unnecessary self-certification letters from the vast majority of filing carriers, even though the data supporting those self-certifications are easily verified by publicly available documentation.[1419] The other changes to Commission rules that we adopt in this Order affect only larger, non-rural LECs, and should have no direct affect on small entities.

471. *Report to Congress*. The Commission will send a copy of this Order, including this FRFA, in a report to be sent to Congress pursuant to the Small Business Regulatory Enforcement Fairness Act of 1996.[1420] In addition, the Commission will send a copy of the this Order, including FRFA, to the Chief Counsel for Advocacy of the Small Business Administration. A copy of this Order and FRFA (or summaries thereof) will also be published in the Federal Register.[1421]

B. Paperwork Reduction Act Analysis

472. The decision herein has been analyzed with respect to the Paperwork Reduction Act of 1995, Pub. L. 104-13, and has been approved in accordance with the provisions of that Act. On August 4, 1999, the Office of Management and Budget approved the proposed requirements contained in the *Inputs Further Notice* under OMB control number 3060-0793.

C. Ordering Clauses

473. IT IS ORDERED, pursuant to Sections 1, 4(i) and (j), 201-209, 218-222, 254, and 403 of the Communications Act, as amended, 47 U.S.C. §§ 151, 154(i), 154(j), 201-209, 218-222, 254, and 403 that this Report and Order IS HEREBY ADOPTED.

474. IT IS FURTHER ORDERED that the Commission's Office of Public Affairs, Reference Operations Division, SHALL SEND a copy of this Report and Order, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

[1419] *See* para. 447, *supra.*

[1420] *See* 5 U.S.C. § 801(a)(1)(A).

[1421] *See* 5 U.S.C. § 604(b).

Magalie Roman Salas
Secretary

Separate Statement of
Commissioner Gloria Tristani

Re: *Federal-State Joint Board on Universal Service; Ninth Report & Order and Seventeenth Order on Reconsideration. CC Docket No. 96-45*

Federal-State Joint Board on Universal Service; Forward-Looking Mechanism for High Cost Support for Non-Rural LECs. CC Docket Nos. 96-45 & 97-160.

In adopting these Orders, the Commission has taken an important step towards fulfilling its mandate under the 1996 Act to ensure that all Americans have access to telecommunications and information services. The new high-cost mechanism, together with the selected inputs, establishes a specific, predictable, and sufficient mechanism to preserve and advance universal service. I believe that the mechanism will provide sufficient resources to the states to ensure reasonable comparability of rates among states. Moreover, I am pleased that the Commission will be ready to provide forward-looking support to non-rural carriers based on this mechanism, effective January 1, 2000.

I commend my fellow Joint Board members, the Joint Board staff, and the Common Carrier Bureau for their outstanding cooperation in developing the model and model inputs. I likewise commend the outside parties who worked with the Joint Board and the Bureau throughout this process. I look forward to continued cooperation as we confront the other pieces of universal service reform, including adjusting interstate access charges to account for explicit support, selecting an appropriate methodology for rural carriers serving high cost areas, and addressing the needs of unserved and underserved areas.

DISSENTING STATEMENT OF COMMISSION FURCHTGOTT-ROTH

Re: *Federal-State Joint Board on Universal Service*, Ninth Report & Order and Eighteenth Order on Reconsideration, CC Docket No. 96-45; *Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, Tenth Report and Order, CC Docket Nos. 96-45, 97-160.

In the companion orders that it releases today, the Commission finalizes its implementation of a computer model that it will use to determine the total cost of providing service to every resident in the country. It plans to use this model to distribute universal service support among "non-rural carriers," the term that is used to describe the large telephone companies that serve rural areas. As I have said at earlier stages in this proceeding, this Commission's approach to universal service is fundamentally at odds with the Telecommunications Act generally and specifically with its express directive that the Commission "preserve and advance" universal service. Moreover, its adoption of this unwieldy model is inconsistent with the Act's mandate that universal service support be "specific" and "predictable." Finally, as a consequence of the Commission's action today, consumers will now pay higher bills for dubious subsidies to large companies. I therefore dissent from these orders.

The Orders Are Inconsistent With Congress's Objective of Preserving Universal Service Support for Rural Carriers. By way of background, four years ago, universal service was a $2 billion per year program targeted mostly at small, rural telephone companies. Today, as a result of the Commission's unwarranted interference in the existing universal service system and the new programs that it has dreamed up, the program costs taxpayers more than $5 billion a year.

I believe that this proceeding illustrates, yet again, that this Commission has its universal service priorities entirely backward. Section 254 of the Telecommunications Act of 1996 was drafted with rural carriers in mind. The primary objective of that provision was to ensure that rural carriers continued to receive sufficient funding to enable them to provide local service at rates comparable to those in urban areas. In light of this objective, the Commission should have turned first to the matter of preserving rural universal service. Instead, the Commission has squandered a tremendous amount of its employees' time and taxpayers' money coming up with an entirely new approach to universal service. And the matter of universal service support for rural carriers has been this Commission's very last priority.

I am relieved to see that the Commission has in these orders taken steps to ensure that funding for rural carriers will not decrease – at least in the near term. I have little confidence, however, that rural carriers can count on this promise for long. This Commission has so substantially increased universal service funding for other, less essential programs that, if and when it finally turns to addressing the issue of rural universal service support, I question whether there will be any money left for rural telephone companies.

The Commission's Model Is Unwieldy, Easily Manipulated, and Will Require Constant Maintenance. Not only does the Commission have its universal service priorities wrong, but also the model on which it relies is inconsistent with the Telecommunications Act's requirement that universal service support be "specific" and "predictable." The model is an immensely complicated computer program that requires around 180 hours – more than one week – to run. Since issuing an October 1998 NPRM in which it proposed this model, the Commission has made numerous changes to the model platform, and each change has required interested parties to go back to their computers and spend days testing the model. Only in the last few weeks has the Commission decided on final input values. In my view, it is unclear whether interested parties have even had the opportunity meaningfully to comment on a final version of the model, as the Administrative Procedure Act requires.

The model is also completely dependent on hundreds of assumptions about the local exchange markets and costs. The bottom line is that, simply by making different assumptions about local exchange networks, or by picking different input values for costs, the Commission is able to push the end result in whatever direction it chooses. I do not believe that a system that can be manipulated in this way will generate the "specific" and "predictable" universal service support that the 1996 Act requires. In addition, the fact that the Commission has found it necessary to tinker with this model so extensively reflects its fundamental lack of confidence in its model.

The model is also going to be enormously time-consuming and expensive to maintain. Each time technology or prices change, the Commission's staff will be required to adjust the model. I am opposed to wasting resources on this effort.

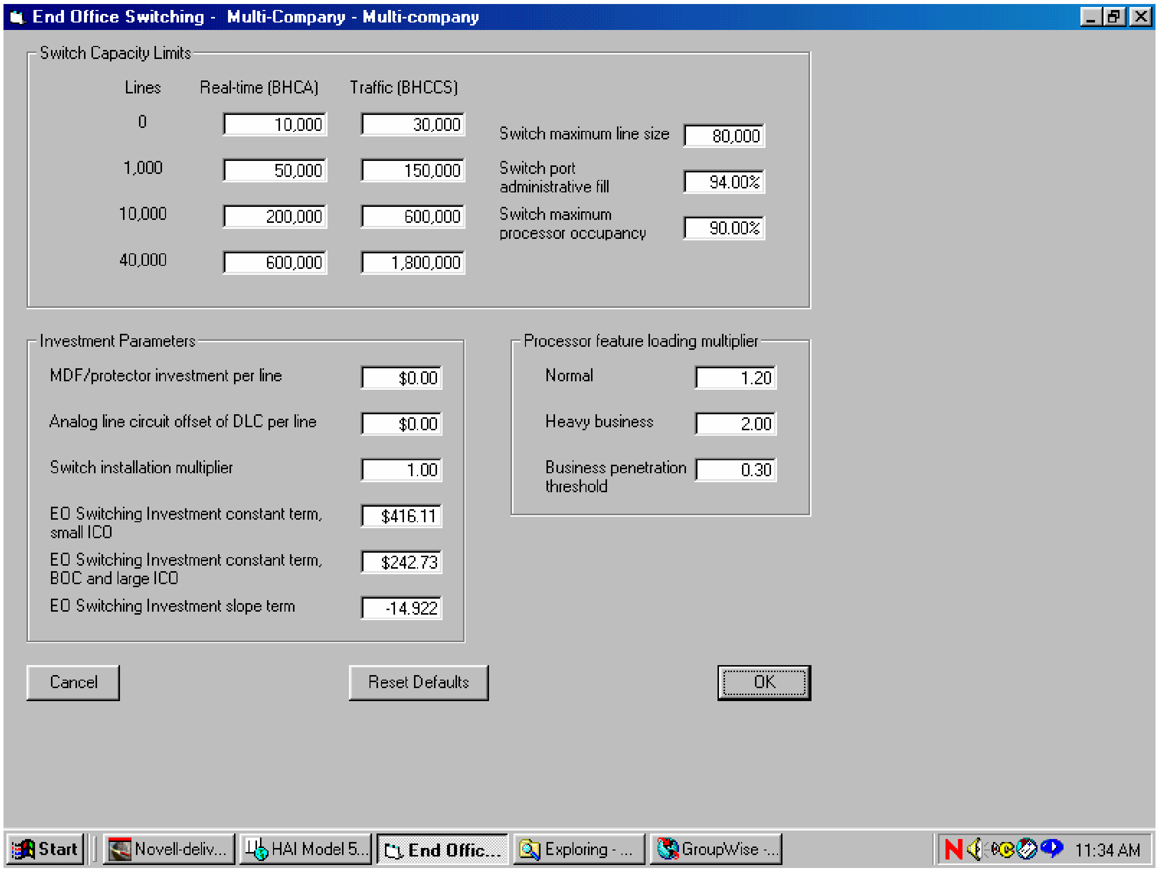
The Commission's Approach to Universal Service Means that Consumers Will Pay More. As a final matter, I want to point out what the Commission's current approach to high-cost universal service will mean for consumers. According to the model, carriers in a few states (primarily Mississippi and Alabama) should receive significantly more funding than they currently do, and the Commission plans to increase subsidies for carriers in these states. But the model also says that carriers in many other states should receive *less* universal service funding than they now do. The Commission, however, does not plan to follow the model's guidance with respect to these carriers. Instead, because it committed to Congress in April 1998 that universal service support would not decrease for any state, the Commission plans to continue distributing current levels of universal service support to carriers in all states.

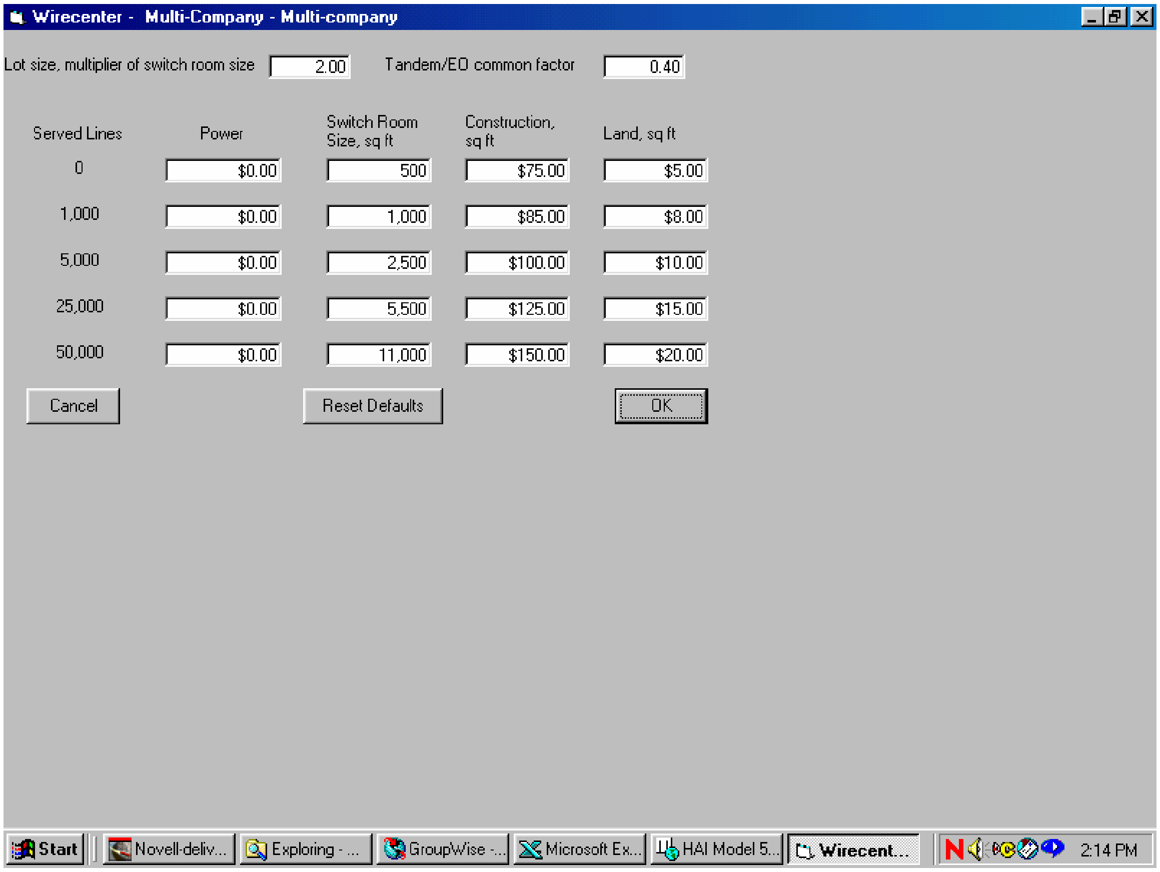
The result of this so-called "hold harmless" requirement is that all carriers will receive as much or more universal service funding as they did before the issuance of these two orders. In other words, the bill for high-cost universal service support will go up, and consumers' phone bills are going to increase correspondingly. I predict that these will be only the first of several increases that consumers can expect to see in the upcoming months as a result of this Commission's misguided universal service policies.

APPENDIX A

Input Values

Part 2: Switching and Expense Modules


End Office Switching - Multi-Company - Multi-company
Switch Capacity Limits
Lines
Real-time (BHCA)
Traffic (BHCCS)
0
10,000
30,000
1,000
50,000
150,000
10,000
200,000
600,000
40,000
600,000
1,800,000
Switch maximum line size
80,000
Switch port administrative fill
94.00%
Switch maximum processor occupancy
90.00%
Investment Parameters
MDF/protector investment per line
$0.00
Analog line circuit offset of DLC per line
$0.00
Switch installation multiplier
1.00
EO Switching Investment constant term, small ICO
$416.11
EO Switching Investment constant term, BOC and large ICO
$242.73
EO Switching Investment slope term
-14.922
Processor feature loading multiplier
Normal
1.20
Heavy business
2.00
Business penetration threshold
0.30
Cancel
Reset Defaults
OK
Start
Novell-deliv...
HAI Model 5...
End Offic...
Exploring - ...
GroupWise -...
11:34 AM



Wirecenter - Multi-Company - Multi-company

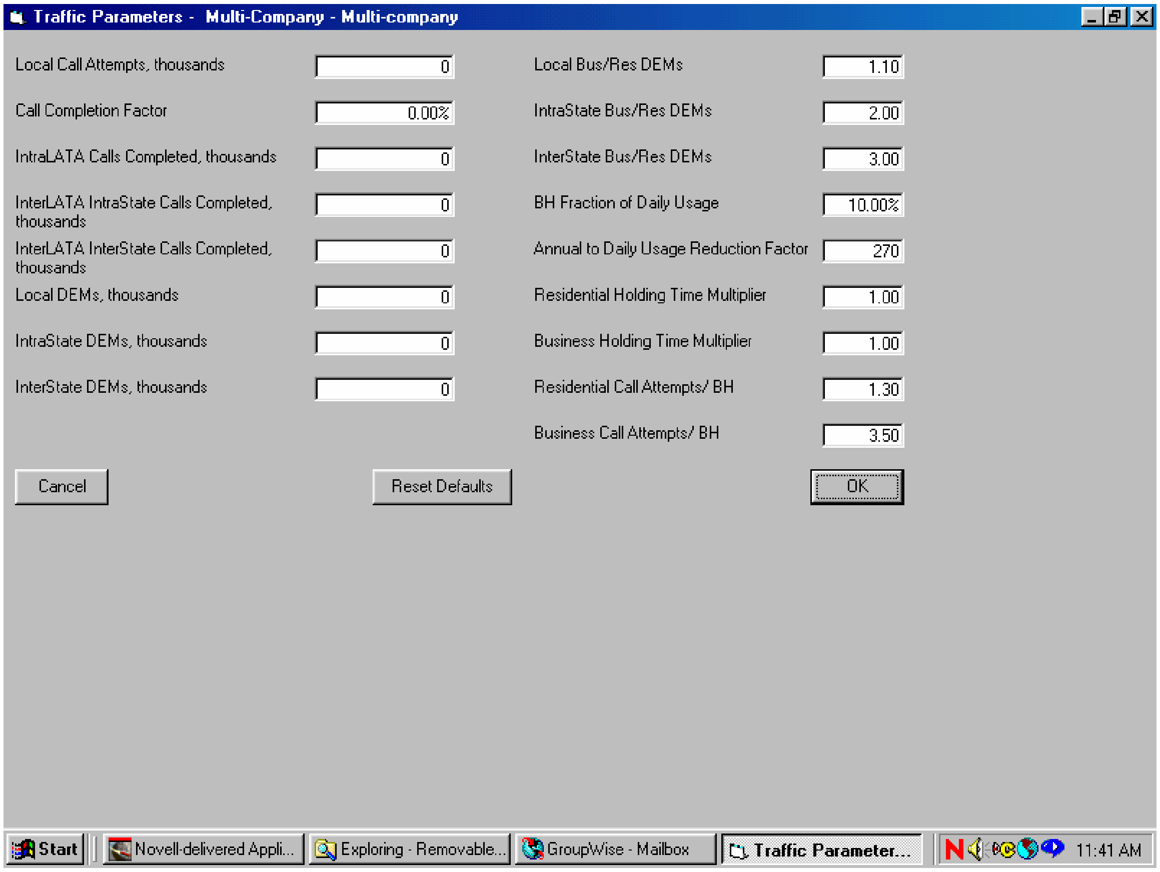
Lot size, multiplier of switch room size: 2.00

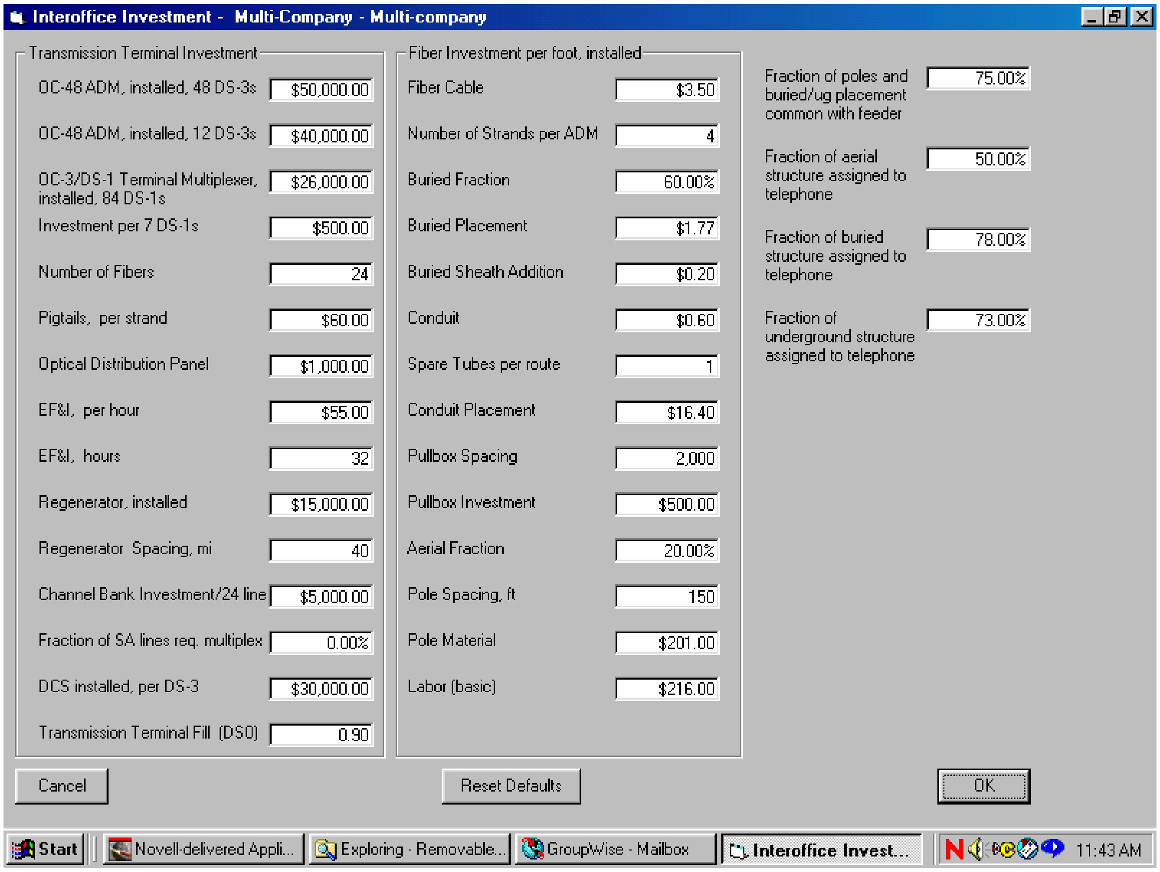
Tandem/EO common factor: 0.40

Served Lines	Power	Switch Room Size, sq ft	Construction, sq ft	Land, sq ft
0	$0.00	500	$75.00	$5.00
1,000	$0.00	1,000	$85.00	$8.00
5,000	$0.00	2,500	$100.00	$10.00
25,000	$0.00	5,500	$125.00	$15.00
50,000	$0.00	11,000	$150.00	$20.00

Cancel | Reset Defaults | OK

Start | Novell-deliv... | Exploring - ... | GroupWise -... | Microsoft Ex... | HAI Model 5... | Wirecent... | 2:14 PM


Traffic Parameters - Multi-Company - Multi-company
Local Call Attempts, thousands
0
Call Completion Factor
0.00%
IntraLATA Calls Completed, thousands
0
InterLATA IntraState Calls Completed, thousands
0
InterLATA InterState Calls Completed, thousands
0
Local DEMs, thousands
0
IntraState DEMs, thousands
0
InterState DEMs, thousands
0
Local Bus/Res DEMs
1.10
IntraState Bus/Res DEMs
2.00
InterState Bus/Res DEMs
3.00
BH Fraction of Daily Usage
10.00%
Annual to Daily Usage Reduction Factor
270
Residential Holding Time Multiplier
1.00
Business Holding Time Multiplier
1.00
Residential Call Attempts/ BH
1.30
Business Call Attempts/ BH
3.50
Cancel
Reset Defaults
OK
Start
Novell-delivered Appli...
Exploring - Removable...
GroupWise - Mailbox
Traffic Parameter...
11:41 AM


Interoffice Investment - Multi-Company - Multi-company

Transmission Terminal Investment

OC-48 ADM, installed, 48 DS-3s	$50,000.00
OC-48 ADM, installed, 12 DS-3s	$40,000.00
OC-3/DS-1 Terminal Multiplexer, installed, 84 DS-1s	$26,000.00
Investment per 7 DS-1s	$500.00
Number of Fibers	24
Pigtails, per strand	$60.00
Optical Distribution Panel	$1,000.00
EF&I, per hour	$55.00
EF&I, hours	32
Regenerator, installed	$15,000.00
Regenerator Spacing, mi	40
Channel Bank Investment/24 line	$5,000.00
Fraction of SA lines req. multiplex	0.00%
DCS installed, per DS-3	$30,000.00
Transmission Terminal Fill (DS0)	0.90

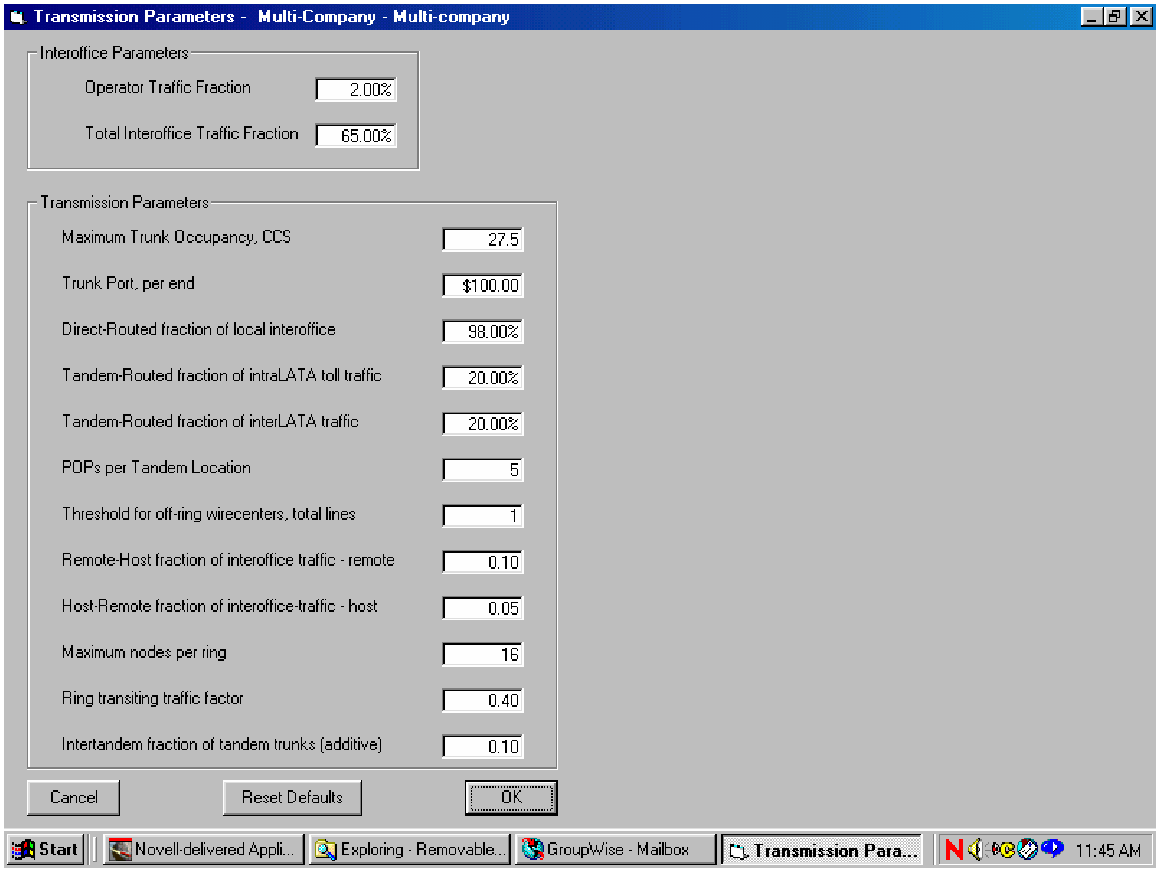
Fiber Investment per foot, installed

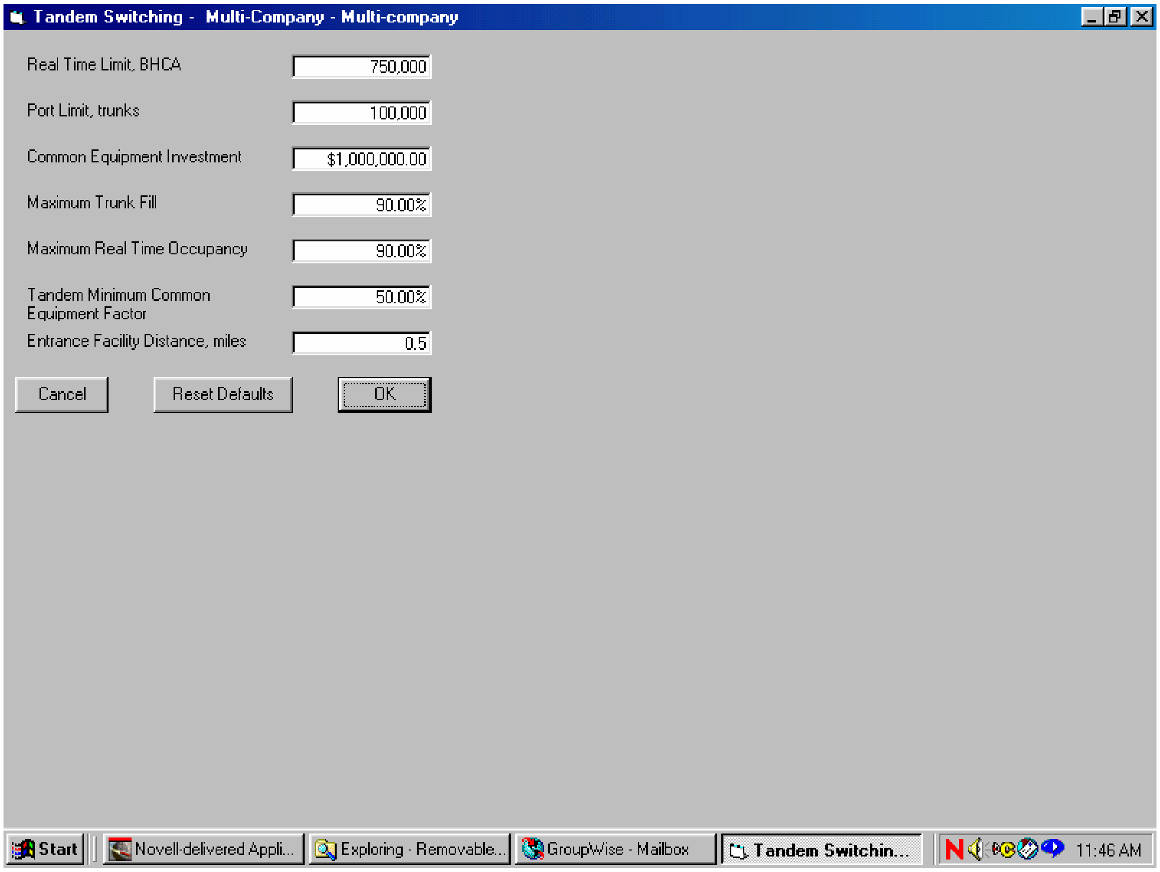
Fiber Cable	$3.50
Number of Strands per ADM	4
Buried Fraction	60.00%
Buried Placement	$1.77
Buried Sheath Addition	$0.20
Conduit	$0.60
Spare Tubes per route	1
Conduit Placement	$16.40
Pullbox Spacing	2,000
Pullbox Investment	$500.00
Aerial Fraction	20.00%
Pole Spacing, ft	150
Pole Material	$201.00
Labor (basic)	$216.00

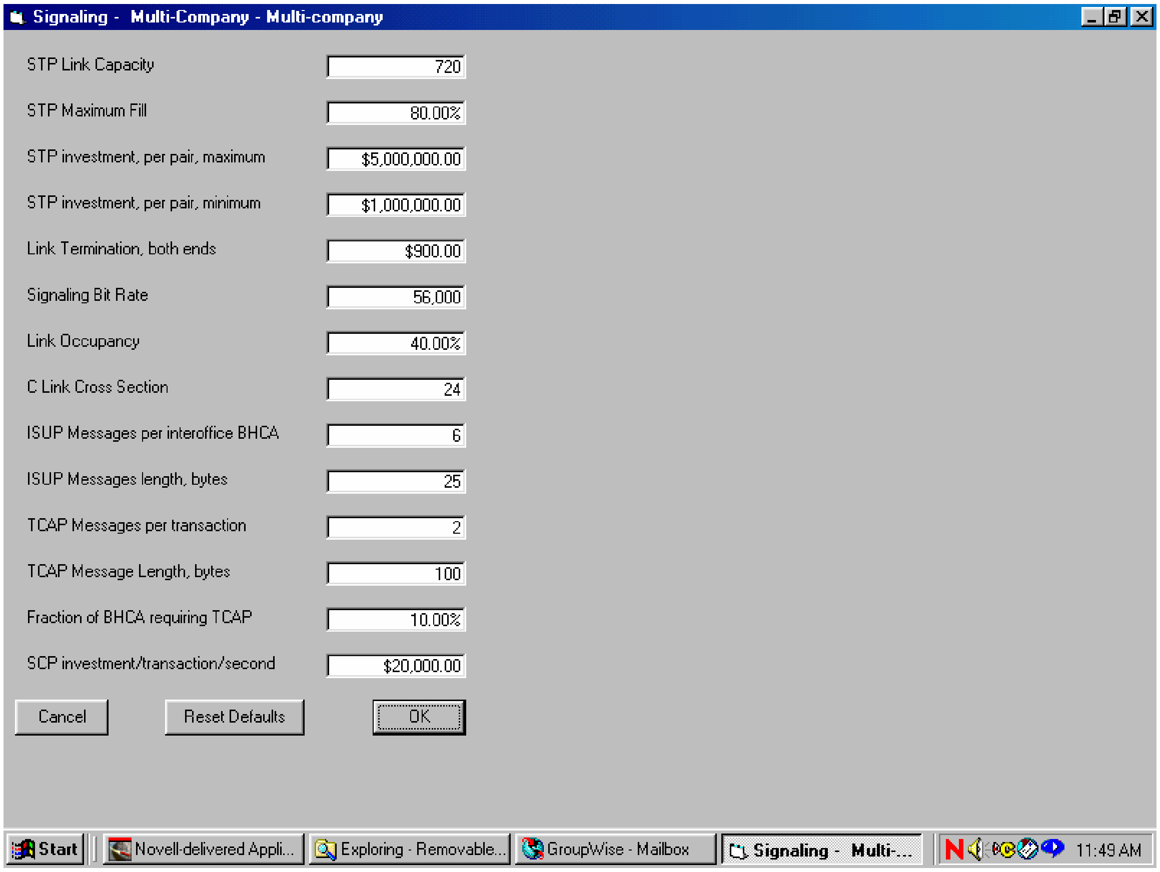
Fraction of poles and buried/ug placement common with feeder	75.00%
Fraction of aerial structure assigned to telephone	50.00%
Fraction of buried structure assigned to telephone	78.00%
Fraction of underground structure assigned to telephone	73.00%

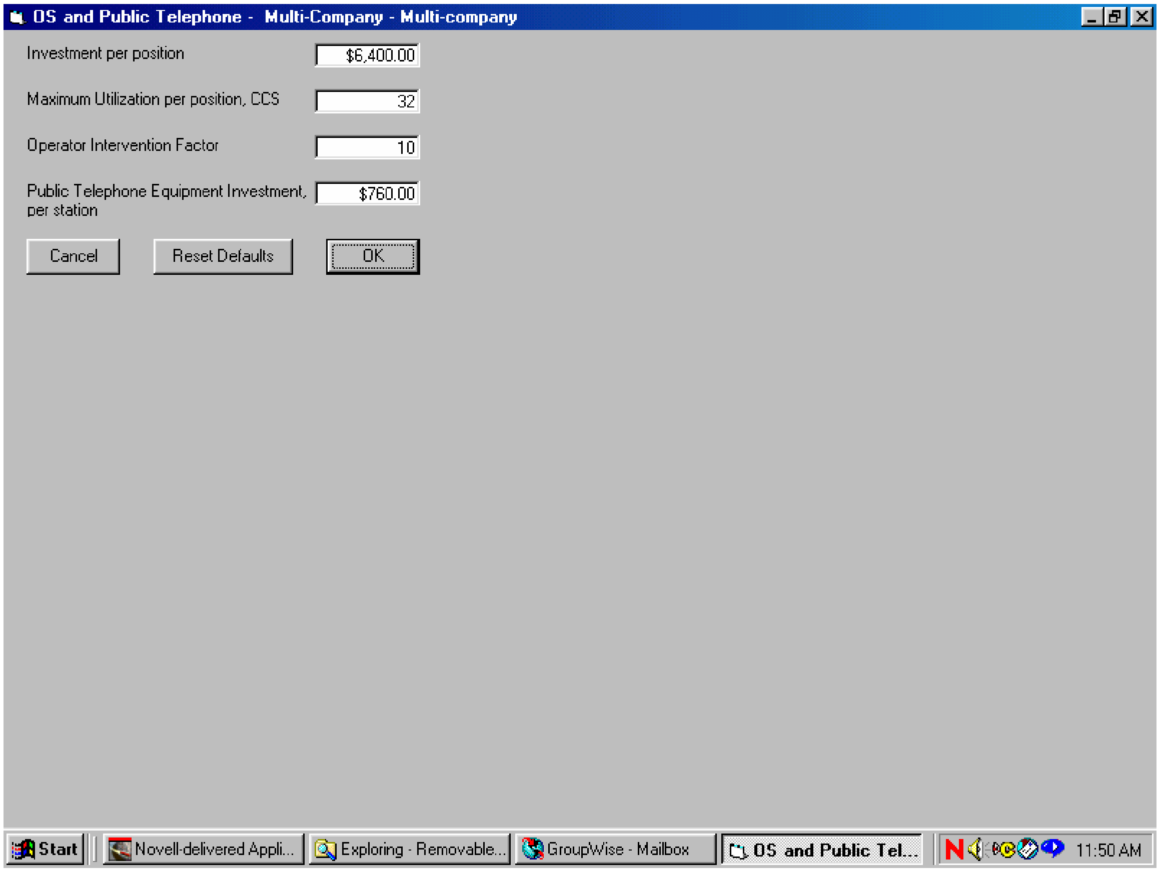
Cancel | Reset Defaults | OK

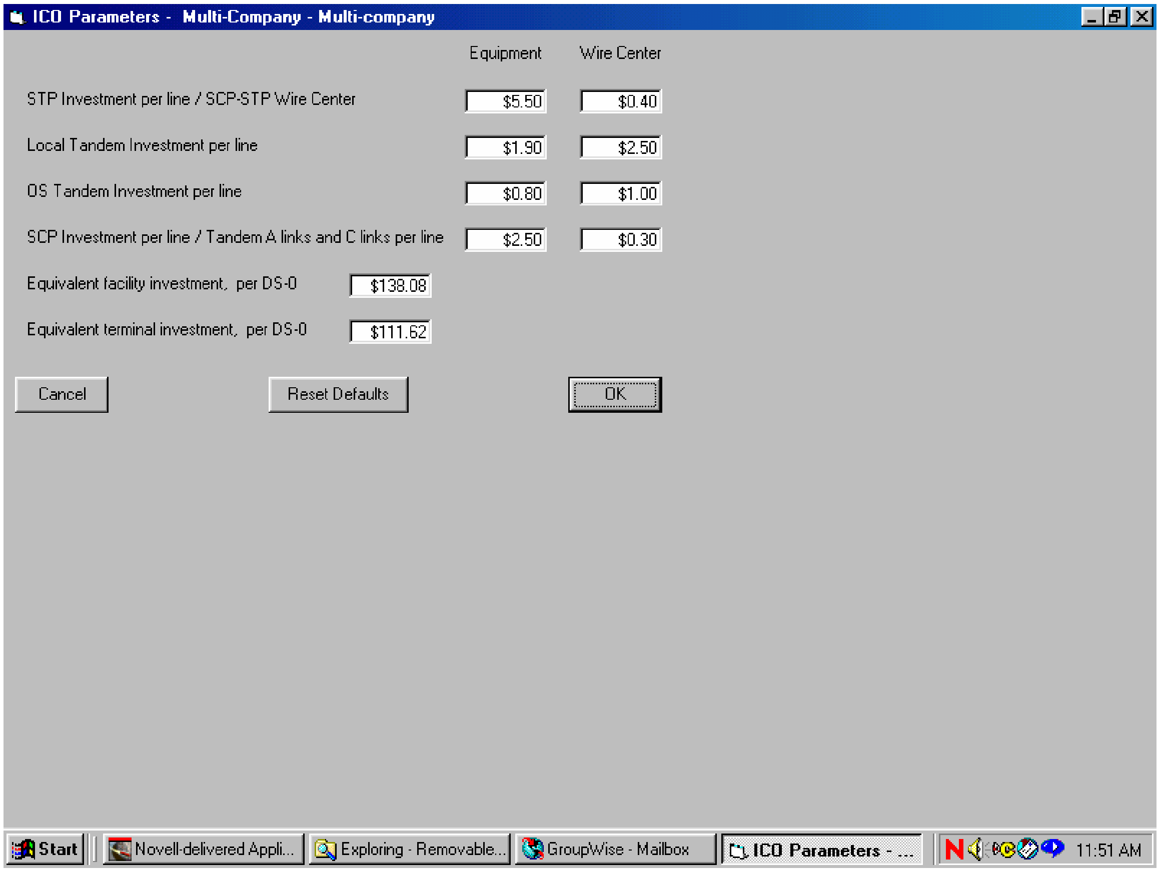
Start | Novell-delivered Appli... | Exploring - Removable... | GroupWise - Mailbox | Interoffice Invest... | 11:43 AM

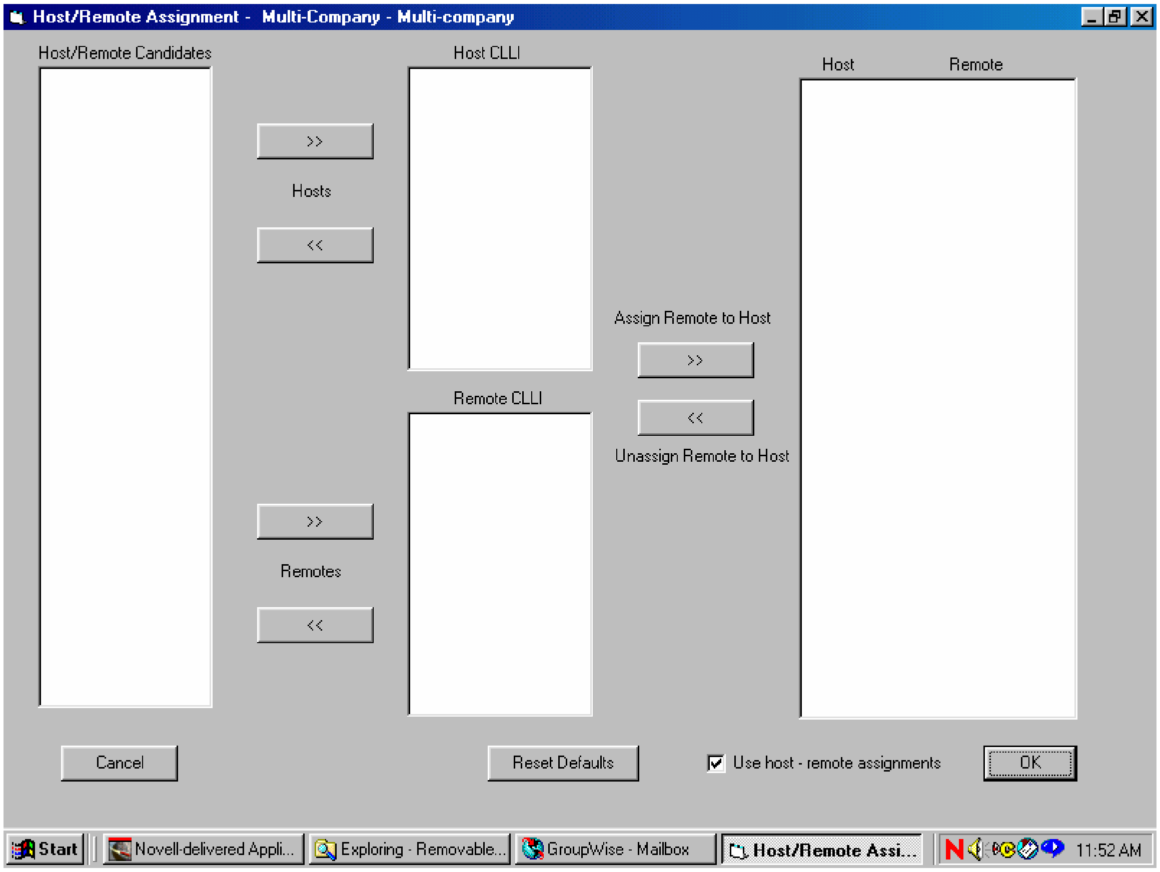

Transmission Parameters - Multi-Company - Multi-company
Interoffice Parameters
Operator Traffic Fraction 2.00%
Total Interoffice Traffic Fraction 65.00%
Transmission Parameters
Maximum Trunk Occupancy, CCS 27.5
Trunk Port, per end $100.00
Direct-Routed fraction of local interoffice 98.00%
Tandem-Routed fraction of intraLATA toll traffic 20.00%
Tandem-Routed fraction of interLATA traffic 20.00%
POPs per Tandem Location 5
Threshold for off-ring wirecenters, total lines 1
Remote-Host fraction of interoffice traffic - remote 0.10
Host-Remote fraction of interoffice-traffic - host 0.05
Maximum nodes per ring 16
Ring transiting traffic factor 0.40
Intertandem fraction of tandem trunks (additive) 0.10
Cancel
Reset Defaults
OK
Start
Novell-delivered Appli...
Exploring - Removable...
GroupWise - Mailbox
Transmission Para...
11:45 AM


Tandem Switching - Multi-Company - Multi-company
Real Time Limit, BHCA
750,000
Port Limit, trunks
100,000
Common Equipment Investment
$1,000,000.00
Maximum Trunk Fill
90.00%
Maximum Real Time Occupancy
90.00%
Tandem Minimum Common Equipment Factor
50.00%
Entrance Facility Distance, miles
0.5
Cancel
Reset Defaults
OK
Start
Novell-delivered Appli...
Exploring - Removable...
GroupWise - Mailbox
Tandem Switchin...
11:46 AM

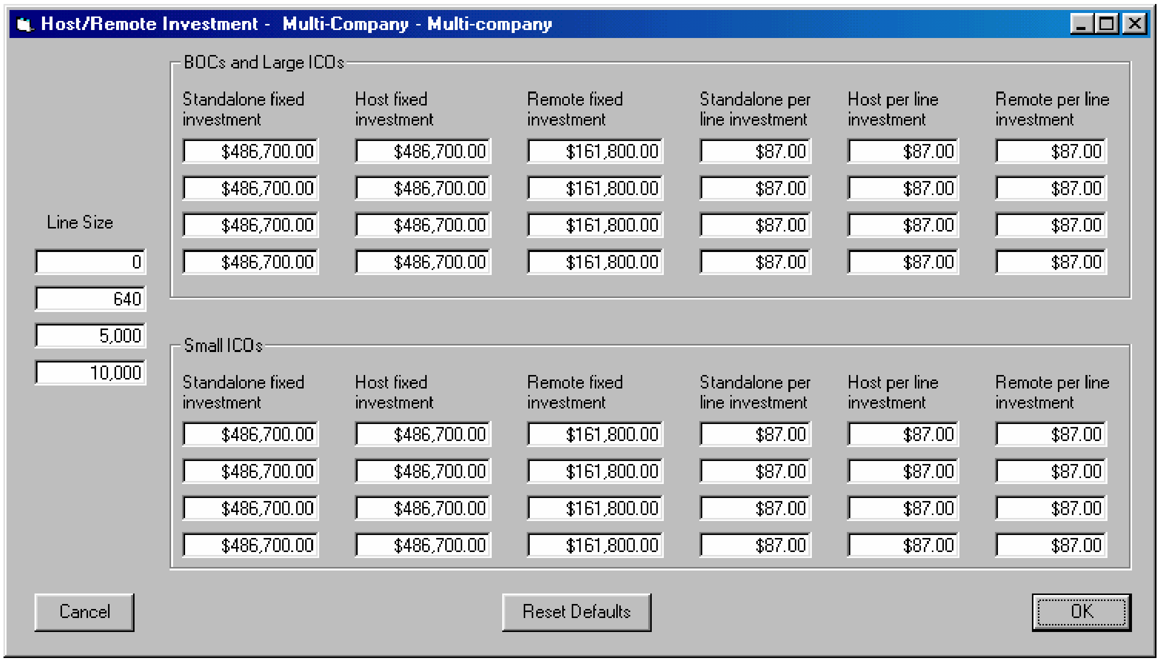

Signaling - Multi-Company - Multi-company
STP Link Capacity 720
STP Maximum Fill 80.00%
STP investment, per pair, maximum $5,000,000.00
STP investment, per pair, minimum $1,000,000.00
Link Termination, both ends $900.00
Signaling Bit Rate 56,000
Link Occupancy 40.00%
C Link Cross Section 24
ISUP Messages per interoffice BHCA 6
ISUP Messages length, bytes 25
TCAP Messages per transaction 2
TCAP Message Length, bytes 100
Fraction of BHCA requiring TCAP 10.00%
SCP investment/transaction/second $20,000.00
Cancel
Reset Defaults
OK
Start
Novell-delivered Appli...
Exploring - Removable...
GroupWise - Mailbox
Signaling - Multi-...
11:49 AM

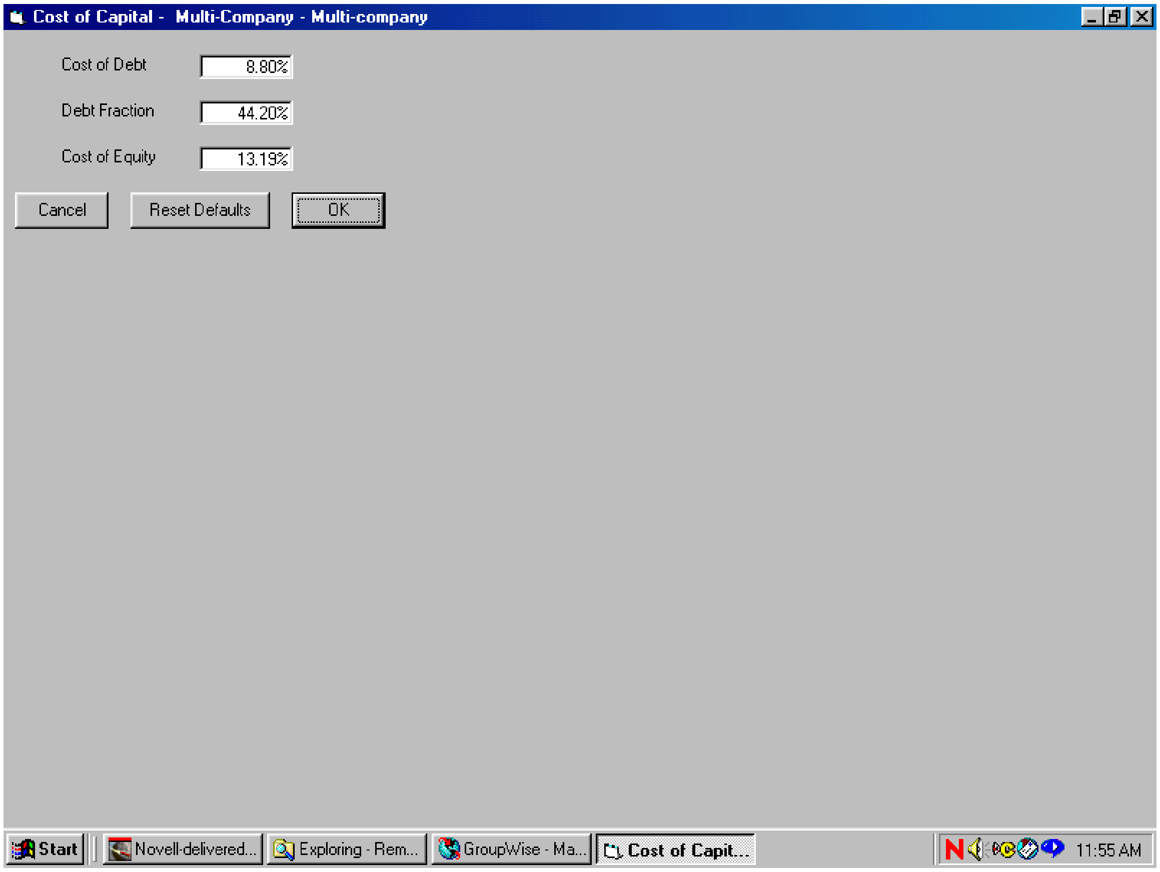

OS and Public Telephone - Multi-Company - Multi-company
Investment per position
$6,400.00
Maximum Utilization per position, CCS
32
Operator Intervention Factor
10
Public Telephone Equipment Investment, per station
$760.00
Cancel
Reset Defaults
OK
Start
Novell-delivered Appli...
Exploring - Removable...
GroupWise - Mailbox
OS and Public Tel...
11:50 AM


ICO Parameters - Multi-Company - Multi-company
Equipment
Wire Center
STP Investment per line / SCP-STP Wire Center
$5.50
$0.40
Local Tandem Investment per line
$1.90
$2.50
OS Tandem Investment per line
$0.80
$1.00
SCP Investment per line / Tandem A links and C links per line
$2.50
$0.30
Equivalent facility investment, per DS-0
$138.08
Equivalent terminal investment, per DS-0
$111.62
Cancel
Reset Defaults
OK
Start
Novell-delivered Appli...
Exploring - Removable...
GroupWise - Mailbox
ICO Parameters - ...
11:51 AM



*Values for Host/Remote Assignment are company-specific and are intentionally left blank in this file. The Host/Remote Assignments are contained in the model DB folder, HM50 file, Lerg.host.remote table.


Host/Remote Investment - Multi-Company - Multi-company
BOCs and Large ICOs
Standalone fixed investment
Host fixed investment
Remote fixed investment
Standalone per line investment
Host per line investment
Remote per line investment
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
Line Size
0
640
5,000
10,000
Small ICOs
Standalone fixed investment
Host fixed investment
Remote fixed investment
Standalone per line investment
Host per line investment
Remote per line investment
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
$486,700.00 $486,700.00 $161,800.00 $87.00 $87.00 $87.00
Cancel
Reset Defaults
OK

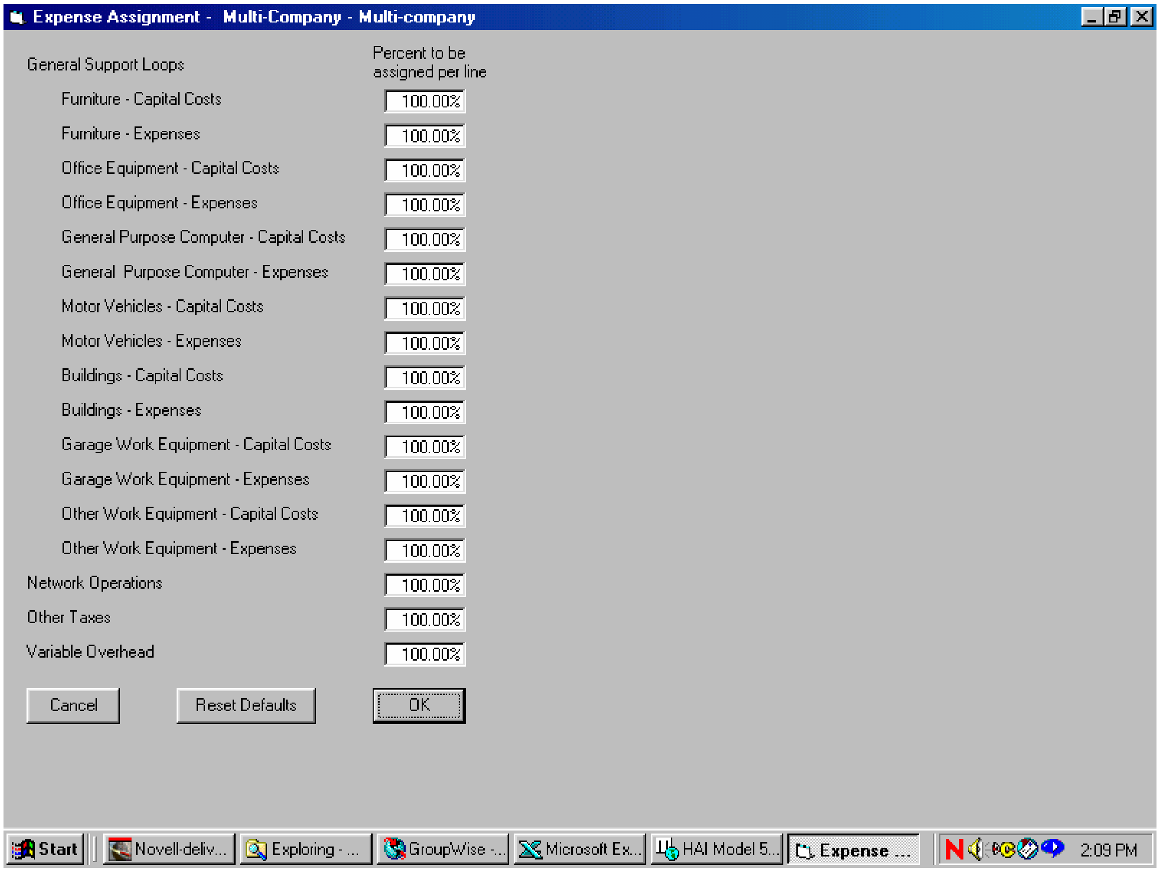


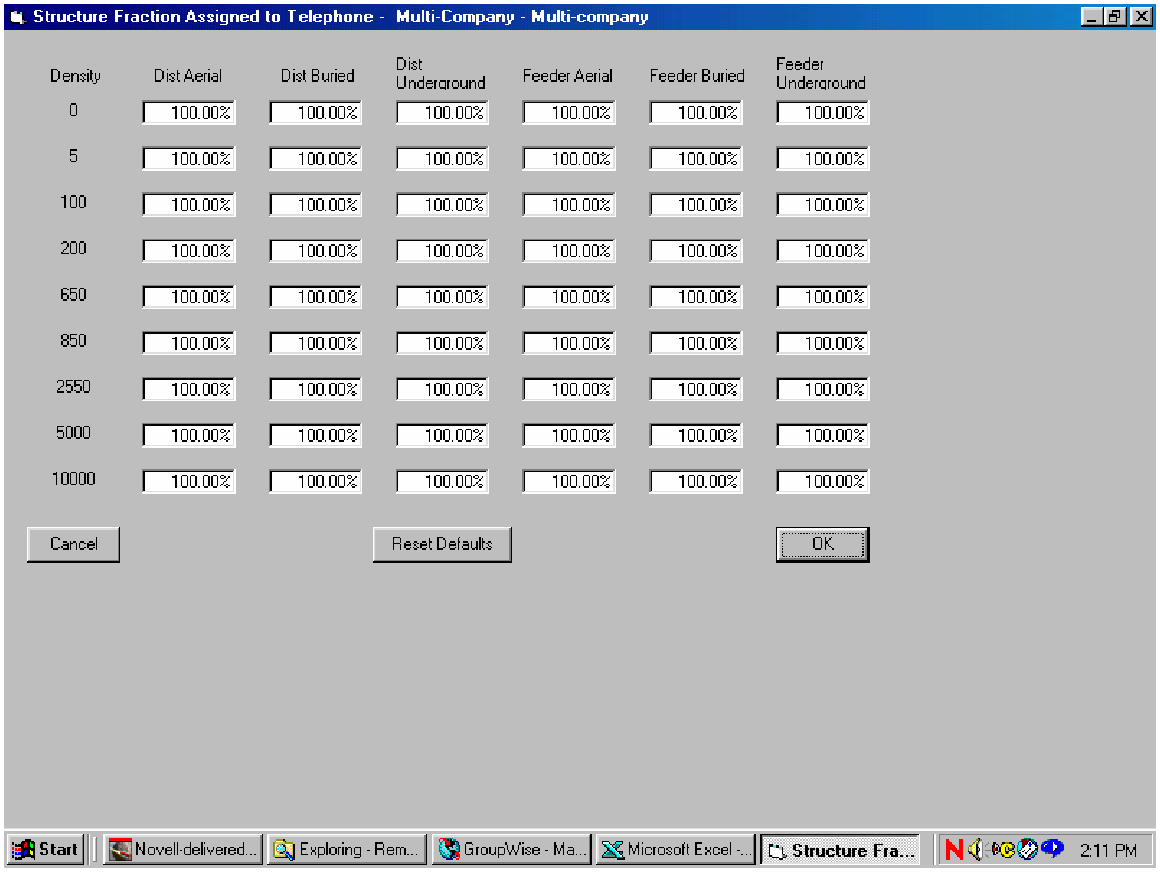
Cost of Capital - Multi-Company - Multi-company
Cost of Debt
8.80%
Debt Fraction
44.20%
Cost of Equity
13.19%
Cancel
Reset Defaults
OK
Start
Novell-delivered...
Exploring - Rem...
GroupWise - Ma...
Cost of Capit...
11:55 AM

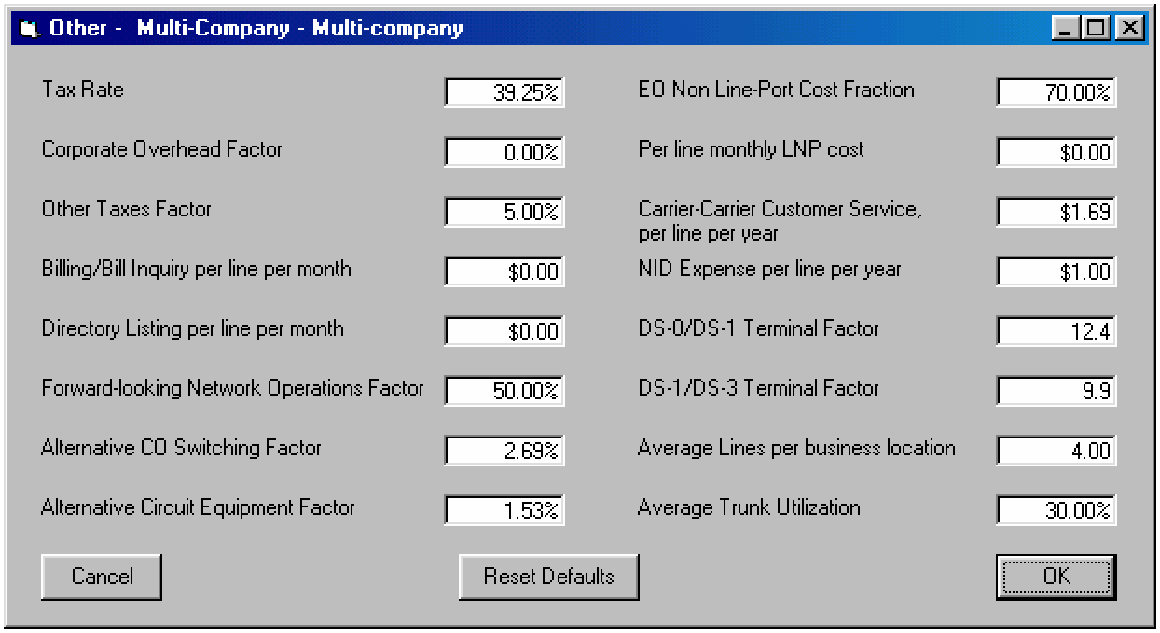
Depreciation - Multi-Company - Multi-company

Account	Description	Economic Life	Net Salvage %	Account	Description	Economic Life	Net Salvage %
2112	Motor Vehicles	8.24	10.38%	2351	Public Telephone Term. Equipment	7.60	5.12%
2115	Garage Work Equipment	12.22	-5.58%	2411	Poles	30.25	-89.98%
2116	Other Work Equipment	13.04	1.69%	2121.1	Aerial Cable - metallic	20.61	-23.03%
2121	Buildings	46.93	1.64%	2421.2	Aerial Cable - non metallic	26.14	-17.53%
2122	Furniture	15.92	4.02%	2422.1	Underground Cable - metallic	25.00	-17.97%
2123.1	Office Support Equipment	10.78	4.12%	2422.2	Underground Cable - non metallic	26.45	-14.58%
2123.2	Company Comm. Equipment	7.40	2.52%	2423.1	Buried Cable - metallic	21.57	-8.39%
2124	General Purpose Computer	6.12	2.29%	2423.2	Buried Cable - non metallic	25.91	-6.91%
2212	Digital Electronic Switching	16.17	1.57%	2426.1	Intrabuilding Cable - metallic	18.18	-15.69%
2220	Operator Systems	9.41	-0.41%	2426.2	Intrabuilding Cable - non metallic	26.11	-10.43%
2232.2	Digital Circuit Equipment	10.24	-0.62%	2442	Conduit Systems	56.19	-9.95%

Cancel | Reset Defaults | OK


Expense Assignment - Multi-Company - Multi-company
General Support Loops
Percent to be assigned per line
Furniture - Capital Costs 100.00%
Furniture - Expenses 100.00%
Office Equipment - Capital Costs 100.00%
Office Equipment - Expenses 100.00%
General Purpose Computer - Capital Costs 100.00%
General Purpose Computer - Expenses 100.00%
Motor Vehicles - Capital Costs 100.00%
Motor Vehicles - Expenses 100.00%
Buildings - Capital Costs 100.00%
Buildings - Expenses 100.00%
Garage Work Equipment - Capital Costs 100.00%
Garage Work Equipment - Expenses 100.00%
Other Work Equipment - Capital Costs 100.00%
Other Work Equipment - Expenses 100.00%
Network Operations 100.00%
Other Taxes 100.00%
Variable Overhead 100.00%
Cancel
Reset Defaults
OK
Start
Novell-deliv...
Exploring - ...
GroupWise - ...
Microsoft Ex...
HAI Model 5...
Expense ...
2:09 PM


Structure Fraction Assigned to Telephone - Multi-Company - Multi-company
Density
Dist Aerial
Dist Buried
Dist Underground
Feeder Aerial
Feeder Buried
Feeder Underground
0 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
5 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
100 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
200 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
650 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
850 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
2550 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
5000 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
10000 100.00% 100.00% 100.00% 100.00% 100.00% 100.00%
Cancel
Reset Defaults
OK
Start
Novell-delivered...
Exploring - Rem...
GroupWise - Ma...
Microsoft Excel -...
Structure Fra...
2:11 PM


Other - Multi-Company - Multi-company
Tax Rate
39.25%
Corporate Overhead Factor
0.00%
Other Taxes Factor
5.00%
Billing/Bill Inquiry per line per month
$0.00
Directory Listing per line per month
$0.00
Forward-looking Network Operations Factor
50.00%
Alternative CO Switching Factor
2.69%
Alternative Circuit Equipment Factor
1.53%
EO Non Line-Port Cost Fraction
70.00%
Per line monthly LNP cost
$0.00
Carrier-Carrier Customer Service, per line per year
$1.69
NID Expense per line per year
$1.00
DS-0/DS-1 Terminal Factor
12.4
DS-1/DS-3 Terminal Factor
9.9
Average Lines per business location
4.00
Average Trunk Utilization
30.00%
Cancel
Reset Defaults
OK

APPENDIX A

Input Values

Part 3: Capital Costs

Account	USOA Category GrUpROR 16.01%	Economic Life	Net Salvage Percent	Adjusted Projection Life	Rgltry Deprec Method DefTax:	IRS Deprec Category TRUE	SL/SL	SL/Accel	ELG/ELG	ELG/Accel	Selected KACF
							Capital Annual Charge Factors (RegDeprec/TaxDeprec)				
2112	Motor Vehicles	8.24	0.1038	9.194376	elg	2	0.202106	0.182596	0.202419	0.181483	0.181483
2115	Garage Work Equipment	12.22	-0.0558	11.57416	elg	3	0.182903	0.165529	0.181323	0.164976	0.164976
2116	Other Work Equipment	13.04	0.0169	13.26416	elg	2	0.174079	0.149475	0.168837	0.1494	0.1494
2121	Buildings	46.93	0.0164	47.71248	elg	6	0.150941	0.134557	0.150121	0.133878	0.133878
2122	Furniture	15.92	0.0402	16.58679	elg	3	0.163143	0.140292	0.158946	0.140065	0.140065
2123.1	Office Support Equipment	10.78	0.0412	11.24322	elg	3	0.185005	0.168117	0.183124	0.167662	0.167662
2123.2	Company Comm Equipment	7.4	0.0252	7.591301	elg	2	0.222954	0.206413	0.223643	0.20537	0.20537
2124	Computers	6.12	0.0229	6.263433	elg	2	0.249096	0.235937	0.249314	0.235185	0.235185
2212	Digital Switching	16.17	0.0157	16.42792	elg	2	0.163532	0.136172	0.16217	0.135036	0.135036
2220	Operator Systems	9.41	-0.0041	9.371577	elg	2	0.2003	0.18049	0.200098	0.179483	0.179483
2232.2	Digital Circuit Equipment	10.24	-0.0062	10.1769	elg	2	0.192912	0.171924	0.191334	0.171178	0.171178
2351	Public Telephone	7.6	0.0512	8.010118	elg	2	0.216563	0.199226	0.216442	0.198331	0.198331
	NID, SAI and Drop			19	elg	5	0.158367	0.150531	0.155576	0.150771	0.150771
2411	Poles	30.25	-0.8998	15.92273	elg	5	0.164836	0.160569	0.161979	0.161015	0.161015
2421-m	Aerial Cable - Metallic	20.61	-0.2303	16.75201	elg	5	0.162748	0.15741	0.161353	0.157454	0.157454
2421-nm	Aerial Cable - Non-Metallic	26.14	-0.1753	22.24113	elg	5	0.154376	0.143657	0.152517	0.143524	0.143524
2422-m	Underground - Metallic	25	-0.1797	21.19183	elg	5	0.155438	0.145575	0.152417	0.145762	0.145762
2422-nm	Underground - Non-Metallic	26.45	-0.1458	23.08431	elg	5	0.153648	0.142287	0.150465	0.142432	0.142432
2423-m	Buried - Metallic	21.57	-0.0839	19.90036	elg	5	0.157033	0.14832	0.155345	0.148254	0.148254
2423-nm	Buried - Non-Metallic	25.91	-0.0691	24.23534	elg	5	0.152816	0.140631	0.150839	0.140448	0.140448
2426-m	Intrabuilding - Metallic	18.18	-0.1569	15.71441	elg	5	0.165416	0.161426	0.185288	0.156518	0.156518
2426-nm	Intrabuilding - Non-Metallic	26.11	-0.1043	23.64394	elg	5	0.153224	0.141453	0.167453	0.137457	0.137457
2441	Conduit Systems	56.19	-0.0995	51.10505	elg	5	0.151339	0.128939	0.150529	0.127937	0.127937

Account	USOA Category	Economic Lives	Net Salvag Percent	Adjusted Projection Lives (years)	IRS Deprec Category	Regulatory Deprec Method (SL/ELG)	ELG Curve Parameters c	Log g	Log s
2112	Motor Vehicles	8.24	0.1038	9.194376	2	elg	1.262139	-0.0396	0.008554
2115	Garage Work Equipment	12.22	-0.0558	11.57416	3	elg	1.027665	-5.710313	0.145524
2116	Other Work Equipment	13.04	0.0169	13.26416	2	elg	0	0	-0.043441
2121	Buildings	46.93	0.0164	47.71248	6	elg	1.499068	-0.00491	0.001774
2122	Furniture	15.92	0.0402	16.58679	3	elg	1.019541	-4.48722	0.058591
2123.1	Office Support Equipment	10.78	0.0412	11.24322	3	elg	1.020103	-8.97444	0.163161
2123.2	Company Comm Equipme	7.4	0.0252	7.591301	2	elg	1.262139	-0.0396	0.008554
2124	Computers	6.12	0.0229	6.263433	2	elg	1.027665	-5.710313	0.145524
2212	Digital Switching	16.17	0.0157	16.42792	2	elg	1.133397	-0.217455	0.023969
2220	Operator Systems	9.41	-0.0041	9.371577	2	elg	1.133397	-0.217455	0.023969
2232.2	Digital Circuit Equipment	10.24	-0.0062	10.1769	2	elg	1.020103	-8.97444	0.163161
2351	Public Telephone	7.6	0.0512	8.010118	2	elg	1.102494	-0.3341	0.024012
	NID, SAI and Drop			19	5	elg	1.027665	-5.710313	0.145524
2411	Poles	30.25	-0.8998	15.92273	5	elg	1.020103	-8.97444	0.163161
2421-m	Aerial Cable - Metallic	20.61	-0.2303	16.75201	5	elg	1.133397	-0.217455	0.023969
2421-nm	Aerial Cable - Non-Metalli	26.14	-0.1753	22.24113	5	elg	1.133397	-0.217455	0.023969
2422-m	Underground - Metallic	25	-0.1797	21.19183	5	elg	1.027665	-5.710313	0.145524
2422-nm	Underground - Non-Metall	26.45	-0.1458	23.08431	5	elg	1.027665	-5.710313	0.145524
2423-m	Buried - Metallic	21.57	-0.0839	19.90036	5	elg	1.133397	-0.217455	0.023969
2423-nm	Buried - Non-Metallic	25.91	-0.0691	24.23534	5	elg	1.133397	-0.217455	0.023969
2426-m	Intrabuilding - Metallic	18.18	-0.1569	15.71441	5	elg	0.96	-0.194886	-0.011252
2426-nm	Intrabuilding - Non-Metalli	26.11	-0.1043	23.64394	5	elg	0.96	-0.194886	-0.011252
2441	Conduit Systems	56.19	-0.0995	51.10505	5	elg	1.499068	-0.00491	0.001774

Account	USOA Category	GM Std. Curve Shape	ELG Curve Parameters c	Log g	Log s
2112	Motor Vehicles	GM 3.5	1.2621388	-3.96000900E+02	8.5537158E-03
2115	Garage Work Equipment	GM 1.5	1.0276647	-5.71031270E+00	1.45524080E-01
2116	Other Work Equipment	GM 0.0	0	0.00000000E+00	-4.34411150E-02
2121	Buildings	GM 4.5	1.4990682	-4.91004630E-03	1.77395090E-03
2122	Furniture	GM 0.5	1.0195406	-4.48721900E+00	5.8590832E-02
2123.1	Office Support Equipment	GM 1.0	1.0201029	-8.97443950E+00	1.6316108E-01
2123.2	Company Comm Equipment	GM 3.5	1.2621388	-3.9600900E+02	8.5537158E-03
2124	Computers	GM 1.5	1.0276647	-5.71031270E+00	1.45524080E-01
2212	Digital Switching	GM 2.5	1.1333974	-2.17455120E-01	2.39688400E-02
2220	Operator Systems	GM 3.5	1.2621388	-3.96000900E+02	8.5537158E-03
2232.2	Digital Circuit Equipment	GM 1.0	1.0201029	-8.97443950E+00	1.6316108E-01
2351	Public Telephone	GM 2.0	1.102494	-3.34100410E-01	2.40118790E-02
	NID, SAI and Drop	GM 1.5	1.0276647	-5.71031270E+00	1.45524080E-01
2411	Poles	GM 1.0	1.0201029	-8.97443950E+00	1.6316108E-01
2421-m	Aerial Cable-Metallic	GM 2.5	1.1333974	-2.17455120E-01	2.39688400E-02
2421-nm	Aerial Cable-Non-Metallic	GM 2.5	1.1333974	-2.17455120E-01	2.39688400E-02
2422-m	Underground-Metallic	GM 1.5	1.0276647	-5.71031270E+00	1.45524080E-01
2422-nm	Underground-Non-Metallic	GM 1.5	1.0276647	-5.71031270E+00	1.45524080E-01
2423-m	Buried-Metallic	GM 2.5	1.1333974	-2.17455120E-01	2.39688400E-02
2423-nm	Buried-Non-Metallic	GM 2.5	1.1333974	-2.17455120E-01	2.39688400E-02
2441	Conduit Systems	GM 4.5	1.4990682	-4.91004630E-03	1.77395090E-03

Actuals for 1996 ($000s)

		Investments	Expenses	Calculated Factor			
Plant-Specific Operations Expenses							
TPIS - General Support							
2111	Land	0.000001	2.76E-08	0.0276			0.0276
2112	Motor Vehi	0.000001	2.76E-08	0.0276			0.0276
2113	Aircraft	0.000001	2.76E-08	0.0276			0.0276
2114	Special Pu	0.000001	2.76E-08	0.0276			0.0276
2115	Garage Wo	0.000001	2.76E-08	0.0276			0.0276
2116	Other Worl	0.000001	2.76E-08	0.0276			0.0276
2121	Buildings	0.000001	9.06E-08	0.0906	Land & Bldg Exp Appli		0.0906
2122	Furniture	0.000001	9.06E-08	0.0906			0.0906
2123	Office Equi	0.000001	9.06E-08	0.0906			0.0906
2124	General Pu	0.000001	9.06E-08	0.0906			0.0906
2110	Total Land	0.00001	5.28E-07	0.0528			0
TPIS - Central Office Switching							
2211	Analog Ele	0	0	0.000001			0.0558
2212	Digital Elec	0	0	0.000001	0.0558	NET CO S	0.0558
2210	Total Centr	0	0	0.000001			
2220	Operator S	0	0	0.000001			
TPIS - Central Office Transmission							
2231	Satellite & Earth Station Facilities						0.0204
2231	Other Radio Facilities						0.0171
2231	Radio Systems						0.013
2232	Circuit Equ	0	0	0.000001	0.02	alternative	0.02
2230	Total Centr	0	0	0.000001			0.02
TPIS - Information Orig/Term							
2311	Station App	0	0	0.000001			
2321	Customer I	0	0	0.000001			
2341	Large Priva	0	0	0.000001			
2351	Public Tele	0	0	0.000001			
2362	Other Term	0	0	0.000001			
2310	Total Inforr	0	0	0.000001			
					Alternative Cable		
TPIS - Cable & Wire Facilities					Maintenance Factors		
2411	Poles	0	0	0.000001	Fiber	Copper	0.0219
2421	Aerial Cabl	0	0	0.000001	0.0073	0.0669	0.0669
2422	Undergrou	0	0	0.000001	0.0084	0.021	0.021
2423	Buried Cab	0	0	0.000001	0.0061	0.0446	0.0446
2424	Submarine Cable			0.000001			
2425	Deep Sea Cable			0.000001			
2426	Intrabuilding Network Cable			0.000001			
2431	Aerial Wire			0.000001			
2441	Conduit Sy	0	0	0.000001			0.0058
2410	Total Cable	0	0	0.000001			
240	Total TPIS	0	5.28E-07	0.000001			
710	Total Corp	0	1	0	0		
720	Total Opera	5.38E-07	1		0.3231	Total Operations General Support Allocator	
	note: does not include dep/amort				0.6769	"Office Worker" General Support Alllocator	

APPENDIX B

METHODOLOGY FOR ESTIMATING OUTSIDE PLANT COSTS

I. Introduction

1. Section II in this appendix explains in specific detail the regression equations and the adjustments to these equations for estimating the input values adopted in this Order for structure and cable costs. These regression equations and these adjustments are set forth in this appendix on the following tables: Table I., labeled "Regression Equations Derived From RUS Data For Estimating Cable And Structure Costs;" Table II., labeled "Adjustments To Regression Equations Derived From RUS Data For Estimating Cable And Structure Costs;" and Table III., labeled "Regression Equations Derived From Non-Rural LEC Data For Estimating Cable Costs."

2. Section III illustrates use of the Huber methodology to derive reasonable estimates for 24-gauge aerial copper cable costs.[1] This illustration uses the diagram in this appendix labeled "Scatter Diagram Of 24-Gauge Aerial Copper Cable Cost And Size With The Huber Regression Line." This diagram shows RUS cable cost observations for 24-gauge aerial copper cable and the regression line fit to these observations by using the Huber methodology. It also uses the frequency distribution in this appendix set forth on Table IV., labeled "Frequency Distribution Of Huber Weights For 24-gauge Aerial Copper Cable Cost." This frequency distribution shows the number of aerial copper cable observations to which the Huber methodology assigns particular weights.

3. Section IV demonstrates that the Huber methodology generally does not have a statistically significant impact on the level of the material costs reflected in the cable cost estimates adopted in this Order. This finding provides support for the large LEC buying power adjustment reflected in these estimates. This finding is supported by the statistical information set forth in this appendix on Table V., labeled "Analysis Of Coefficient For Cable Size Variable In The Huber Regression Equations."

II. Regression Equations For Estimating Outside Plant Structure Costs

A. Regression Equations Derived From RUS Data For Estimating Cable And Structure Costs

4. Table I, labeled "Regression Equations Derived From RUS Data For Estimating Cable And Structure Costs," sets forth the regression equations adopted in this Order for estimating the cost of:

[1] We used Stata Statistical Software: Release 5 (Stata) to perform the calculations needed to estimate the regression equations adopted in this Order for cable and structure costs. Stata has a robust regression methodology that uses formulas developed by P. J. Huber, R. D. Cook, A. E. Beaton and J. W. Tukey. We used this methodology to estimate the regression equations for cable and structure costs. We refer to this regression methodology as the Huber methodology. *See* StataCorp., *Stata Reference Manual, Release 5*, vol. 3, P-Z, 168-173 (College Station, TX: Stata Press, 1997).

(1) 24-gauge aerial copper cable; (2) 24-gauge underground copper cable; (3) 24-gauge buried copper cable and structure; (4) aerial fiber cable; (5) underground fiber cable; (6) buried fiber cable and structure; (7) poles; and (8) underground structure. These regression equations, other than the equations for poles and underground structure, are developed by revising the regression equations for cable and structure costs developed by Gabel and Kennedy in the NRRI Study.[2] The regression equations adopted in this Order, other than the equation for poles, are estimated by using the Huber methodology with RUS data. The regression equations in the NRRI Study[3] are developed by using ordinary least squares (OLS) with RUS data.[4] The regression equation for poles adopted in this Order is the regression equation for poles in the NRRI Study. The regression equation adopted in this Order for poles is not estimated by using the Huber methodology because the Huber regression for poles is not statistically significant at the five percent level.

5. Column A identifies, by type of cost, the regression equations adopted in this Order. Set forth in columns B, D, F, H, J, L, and N are the intercepts and the slope coefficients reflected in these regression equations. The coefficients set forth in these columns for these regression equations are for the variables that indicate the size of a cable,[5] density zone,[6] soil surface texture,[7] bedrock type,[8] combined

---

[2] There is no regression equation for underground structure in the NRRI Study. The regression equation for underground structure adopted in this Order was developed after the NRRI Study was published.

[3] These regression equations are set forth in the NRRI Study at 58, Table 2-16 (24-gauge aerial copper cable cost); 60, Table 2-19 (24-gauge underground copper cable cost); 41, Table 2-7 (24-gauge buried copper cable and structure cost); 59, Table 2-18 (aerial fiber cable cost); 61, Table 2-20 (underground fiber cable cost); 49, Table 2-10 (buried fiber cable and structure cost); 52, Table 2-12 (pole cost).

[4] None of the regression equations adopted in this Order has a variable that indicates the presence of a second cable at the same location. The regression equations in the NRRI Study, other than the equation for poles, have a variable that indicates the presence of a second cable at the same location. The regression equations adopted in this Order for poles, underground structure, buried copper cable and structure, and buried fiber cable and structure have a variable that indicates the presence of a high water table. The regression equation in the NRRI Study for poles and buried fiber cable and structure have a variable that indicates the presence of a high water table. The regression equation in the NRRI Study for buried copper cable and structure does not have this variable.

[5] The cable size variable is used in the regression equations for estimating the cost of 24-gauge aerial copper cable, 24-gauge underground copper cable, 24-gauge buried copper cable and structure, aerial fiber cable, underground fiber cable, and buried fiber cable and structure. It has values that equal the number of copper cable pairs in the 24-gauge copper cable regression equations and the number of fiber cable strands in the fiber cable regression equations.

[6] The density zone variable is used in the regression equations for 24-gauge buried copper cable and structure cost and buried fiber cable and structure cost. It has a value of 1 if a buried cable is installed in density zone 2; 0 if a buried cable is installed in density zone 1.

[7] The variable that indicates soil surface texture is used in the regression equation for pole cost. It has values that range from 0 for normal soil, to 1 for soft soil, to 3 for hard soil. *See* NRRI Study at 16 and 46, Table 2-8.

[8] The variable that indicates bedrock type is used in the regression equation for pole cost. It has values that range from 0 for normal rock, to 1 for soft rock, to 2 for hard rock. These bedrock types are at a depth of 48 inches. *See*

bedrock and soil type,[9] and the presence of a high water table.[10] Columns C, E, G, I, K, M, and O display the t-statistics used to measure the statistical significance of these intercepts and coefficients. Column P displays the F-statistics used to measure the statistical significance of these regression equations. Column O displays the number of observations in the data used to estimate these equations.

6. The coefficients for the variable that indicates the size of the cable in the regression equations for 24-gauge copper cable cost and fiber cable cost do not reflect the adjustments adopted in this Order for large LEC buying power. The intercepts and the coefficients in these equations do not reflect splicing and LEC engineering costs because these costs are not reflected in the RUS data from which these equations are derived. The intercepts and the coefficients for the water, soil, and bedrock indicator variables in the regression equations for structure costs do not reflect LEC engineering costs because these costs are not reflected in the RUS data from which these equations are derived. The intercept and the coefficients for the water, soil, and bedrock indicator variables in the regression equation for pole costs do not reflect costs for anchors, guys, and other pole-related items because these costs are not reflected in the RUS data from which this equation is derived.

B. Adjustments To Regression Equations Derived From RUS Data For Estimating Cable And Structure Costs

7. Table II, labeled "Adjustments To Regression Equations Derived From RUS Data For Estimating Cable And Structure Costs," sets forth adjustments to the regression equations adopted in this Order for estimating costs for 24-gauge copper cable, fiber cable, and structure. The equations that reflect these adjustments, *i.e.*, the adjusted equations, are used for estimating the cost of: (1) 24-gauge aerial copper cable; (2) 24-gauge underground copper cable; (3) 24-gauge buried copper cable; (4) aerial fiber cable; (5) underground fiber cable; (6) buried fiber cable; (7) aerial structure; (8) underground structure; and (9) buried structure.

8. Column A identifies, by type of cost, the adjusted equations used to derive the cable and

---

NRRI Study at 16 and 44, Table 2-8.

[9] The combined bedrock and soil type variable is used in the regression equations for 24-gauge buried copper cable and structure cost, buried fiber cable and structure cost, and underground structure cost. It is the sum of separate variables for surface soil texture and bedrock type at a depth of 36 inches. *See* NRRI Study at 45, Table 2-8. The value of the variable that indicates surface soil texture ranges from 0 for normal soil, to 1 for soft soil, to 3 for hard soil. *See* NRRI Study at 16 and 46, Table 2-8. The value of the variable that indicates bedrock type ranges from 0 for normal rock, to 1 for soft rock, to 2 for hard rock at a depth of 36 inches. *See* NRRI Study at 16 and 44, Table 2-8. Accordingly, the value of the variable for the combined bedrock and soil type indicator ranges from 0 where there are normal surface soil texture and normal bedrock at a depth of 36 inches to 5 where there are hard surface soil texture and hard bedrock at a depth of 36 inches.

[10] The variable that indicates the presence of a high water table is used in the regression equations for 24-gauge buried copper cable and structure cost, buried fiber cable and structure cost, pole cost, and underground structure cost. It has values that range from 0 for the absence of a high water table, to 1 for the presence of a high water table. This variable assumes that a high water table has a depth of five feet or fewer. *See* NRRI Study at 12, 16 and 46, Table 2-8.

structure costs adopted as input values in this Order.

9. Column B displays the intercepts in the adjusted equations. In the adjusted equations for the cost of aerial and underground 24-gauge copper cable, fiber cable, and structure, the intercepts are those in the regression equations for these costs. The intercepts in the adjusted equations for 24-gauge buried copper cable and buried fiber cable represent the fixed cost of buried copper cable and the fixed cost of buried fiber cable, respectively. The intercepts in the regression equations for 24-gauge buried copper cable and structure and buried fiber cable and structure represent the fixed cost of buried copper cable and structure and the fixed cost of buried fiber cable and structure, respectively, in density zone 1. The fixed cost of 24-gauge buried copper cable used as the intercept in the adjusted equation for 24-gauge buried copper cable, approximately $.46 per foot, is derived by subtracting from the intercept in the regression equation for 24-gauge buried copper cable and structure, approximately $1.16 per foot, the value of the fixed cost for buried structure in density zone 1 adopted in this Order, $.70 per foot. The fixed cost of fiber cable used as the intercept in the adjusted equation for fiber cable, approximately $.47 per foot, is derived by subtracting from the intercept in the regression equation for buried fiber cable and structure, approximately $1.17 per foot, the $.70 per foot fixed cost adopted for buried structure in density zone 1. The intercept in the adjusted equation for buried structure represents the fixed cost of buried structure in density zone 1. The fixed cost of buried structure in density zone 1 used as the intercept in the adjusted equation for buried structure is the $.70 per foot fixed cost adopted for buried structure in density zone 1.

10. Column C displays the coefficients for the cable size variable in the adjusted 24-gauge copper and fiber cable equations. In the adjusted equations for the cost of aerial and underground 24-gauge copper cable and fiber cable, the coefficients for the cable size variable are those for this variable in the regression equations for these costs. In the adjusted 24-gauge copper cable equation, the coefficient for the cable size variable is the coefficient for this variable in the 24-gauge buried cable and structure regression equation. In the adjusted 24-gauge fiber cable equation, the coefficient for the cable size variable is the coefficient for this variable in the buried fiber cable and structure regression equation.

11. Column D displays the large LEC buying power adjustment factors. These factors are applied to the coefficients for the cable size variable in the adjusted copper and fiber cable equations. Column E displays the values of the coefficients for these cable size variables in these equations, as adjusted to reflect large LEC buying power.

12. Columns F, G, and H display the coefficients for the density zone, bedrock indicator, and combined soil and bedrock indicator variables in the adjusted structure equations. In the adjusted equations for the cost of aerial and underground structure, these coefficients are those for these variables in the regression equations for these costs. In the adjusted buried structure equation, these coefficients are those for these variables in the 24-gauge buried copper cable and structure regression equation. The coefficients for the water and soil indicator variables in the structure regression equations are not reflected in the adjusted equations because the value for these variables is set equal to zero to estimate structure costs used as input values.

13. Column I displays the loading factors used to reflect splicing costs in the cable cost estimates for 24-gauge copper cable and fiber cable.

14. Column J displays the loading factor used to reflect LEC engineering costs in the structure cost estimates.

15. Column K displays the flat dollar loading used to reflect LEC engineering costs in the cable cost estimates for 24-gauge copper cable and fiber cable.

16. Column L displays the adjusted equations used to estimate costs for aerial, underground, and buried 24-gauge copper and fiber cable, buried and underground structure, and poles.

17. Columns M-O display adjustments to the adjusted pole equation. These adjustments add to the cost of poles the costs for anchors, guys, and other pole-related items, including LEC engineering costs associated with these additional items, and convert per pole costs, inclusive of costs for anchors, guys, and other pole-related items, *i.e.*, aerial structure costs, to per foot costs. Column M displays the costs for anchors, guys, and other pole-related items for density zones 1 and 2 ($32.98 per pole), density zones 3-7 ($49.96 per pole), and density zones 8 and 9 ($60.47 per pole).[11] Column N displays the loading factor used to reflect LEC engineering costs in the costs for anchors, guys, and other pole-related items. Column O displays the distance between poles used to calculate aerial structure cost per foot for density zones 1 and 2 (250 feet per pole), density zones 3 and 4 (200 feet per pole), density zones 5 and 6 (175 feet per pole), and density zones 7-9 (150 feet per pole).

18. Column P displays the adjusted equation used to estimate aerial structure cost per foot, including poles, anchors, guys, and other pole-related items.

19. We illustrate how the adjusted equations are used to develop the input values adopted in this Order by calculating the cost for a 100-pair 24-gauge aerial copper cable. Column L sets forth the adjusted equation used to develop the input values adopted in this Order for 24-gauge aerial copper cable. The adjusted equation set forth in column L for 24-gauge aerial copper cable is as follows:[12]

$$A1 = (B1 + (E1)(\#\text{ of Prs.}))(1 + I1) + K1$$

where:

A1 = 24-gauge aerial copper cable cost per foot;
B1 = the intercept for 24-gauge aerial copper cable in dollars per foot;
E1 = the coefficient, adjusted for buying power, in dollars per pair per foot, for the variable that represents the number of 24-gauge aerial copper cable pairs;
I1 = the splicing loading for 24-gauge aerial copper cable expressed as a percentage;

---

[11] These costs for anchors, guys, and other pole-related items are based on the costs for these items in rural, suburban, and urban areas derived by Gabel and Kennedy in the NRRI Study. *See* NRRI Study at 51, Table 2-11.

[12] Set forth on Table II in specific columns and on specific rows are the values for the intercepts, coefficients (including the adjusted coefficients for the cable size variable), splicing loadings, and LEC engineering loadings reflected in the adjusted equations used to estimate structure and cable costs. The specific column is identified by a letter. The specific row is identified by a number. B1, for example, refers to the value set forth in column B on row 1.

K1 = the LEC engineering loading for 24-gauge aerial copper cable in dollars per foot.

20. By substituting into the above equation for 24-gauge aerial copper cable the values from Table II for the intercept, adjusted coefficient for the cable size variable, splicing loading, and LEC engineering loading, and the number of cable pairs in this example, 100, we obtain the following estimate for the cost of a 100-pair 24-gauge aerial copper cable:

$$A1 = (1.014907 + (.008329)(100))(1 + .094) + .19$$

$$= (1.014907 + .8329)(1.094) + .19$$

$$= (1.847807)(1.094) + .19$$

$$= 2.021501 + .19$$

$$= \$2.21 \text{ per foot.}$$

We adopt this estimate as the input in the model for the cost of a 100-pair 24-gauge aerial copper cable.

C. Regression Equations Derived From Non-Rural LEC Data For Estimating Cable Costs

21. We adopt in this Order a methodology to derive estimates of 26-gauge copper cable costs from 24-gauge copper cable costs. We first estimate by using the Huber methodology with RUS data the cost for 24-gauge copper cable for each cable size.[13] We then obtain by using the Huber methodology with certain non-rural LEC data estimates of the cost for 24-gauge copper cable and 26-gauge copper cable for each cable size.[14] We next divide the 24-gauge copper cable cost estimate derived from the non-rural LEC data into the estimate for 26-gauge copper cable cost derived from these data for each cable size. The result is a ratio of 26-gauge copper cable cost to 24-gauge copper cable cost for each cable size.[15] Finally, we multiply this ratio by the estimate of the cost for 24-gauge copper cable derived from the RUS data to obtain the cost for 26-gauge copper cable for each cable size.[16] We adopt these estimates as inputs for 26-gauge copper cable costs in the SM.

22. Table III, labeled "Regression Equations Derived From Non-Rural LEC Data For Estimating Cable Costs," sets forth regression equations derived from the non-rural LEC data for: (1) 24-

[13] More technically, we obtain from these RUS data an estimate of the expected value of the cost for 24-gauge copper cable for each cable size.

[14] More technically, we obtain from these non-rural LEC data estimates of the expected value of the cost for 24-gauge copper cable and 26-gauge copper cable for each cable size.

[15] More technically, we obtain from these non-rural LEC data a ratio of an estimate of the expected value for 26-gauge copper cable cost to an estimate of the expected value for 24-gauge cable cost for each cable size.

[16] More technically, we obtain an estimate of the expected value for 26-gauge copper cable cost.

gauge aerial copper cable; (2) 24-gauge underground copper cable; (3) 24-gauge buried copper cable; (4) 26-gauge aerial copper cable; (5) 26-gauge underground copper cable; and (6) 26-gauge buried copper cable. We use these regression equations to develop the ratios of 26-gauge copper cable costs to 24-gauge copper cable costs used to derive the cost for 26-gauge copper cable. Column A identifies these regression equations by type of copper cable cost. Set forth in columns B and D are the intercepts and the slope coefficients reflected in these regression equations. Columns C and E display the t-statistics used to measure the statistical significance of these intercepts and coefficients. Column F displays the F-statistics used to measure the statistical significance of these regression equations. Column G displays the number of observations in the data used to estimate these equations. Column H shows the regression equations derived from the non-rural LEC data for estimating costs for 24-gauge and 26-gauge copper cable.

23. These regression equations are derived from *ex parte* data on 24-gauge and 26-gauge copper cable costs submitted by Sprint and Aliant, data on these cable costs submitted by BellSouth with its comments,[17] and the BCPM default values for these cable costs. These regression equations are developed by using the Huber methodology. Using the Huber methodology with non-rural LEC data to estimate cable costs for 24- and 26-gauge copper cable costs is consistent with use of this methodology to estimate 24-gauge copper cable costs from the RUS data. The regression equations derived from non-rural LEC data use the number of copper cable pairs as the sole independent variable. Using the number of copper cable pairs as the sole independent variable in these regression equations is consistent with using this variable as the sole independent variable in the regression equations for 24-gauge copper cable costs estimated from the RUS data.

24. In this Order, we find it reasonable to rely on the non-rural LEC data for calculating the ratio of the cost for 24-gauge copper cable to that for 26-gauge copper cable but not for calculating the absolute cost for 24-gauge copper cable and 26-gauge copper cable.[18] As discussed in this Order, we find that the non-rural LEC data is not a reliable measure of absolute costs. Notwithstanding this finding, we conclude that it is reasonable to use the non-rural LEC data to determine the relative value of the cost for 24-gauge copper cable to that for 26-gauge copper cable. We find that it is reasonable to conclude that each LEC used the same methodology to develop both 24-gauge and 26-gauge copper cable costs. Accordingly, any bias in the costs for 24-gauge and 26-gauge copper cable that results from using a given

---

[17] *See* BellSouth *Inputs Further Notice* comments, Exhibit 1. BellSouth submitted separate copper cable costs for nine study areas. We calculate the weighted average of these copper cable costs for each cable size based on the number of access lines in each study area. We include this weighted average cable cost for BellSouth for each cable size in the non-rural LEC data from which we derive 24-gauge and 26-gauge copper cable costs. By using a weighted average, the regression equations derived from the non-rural LEC data do not reflect a disproportionate number of observations for BellSouth compared to the number of observations for the other non-rural LECs for which costs are reflected in these data. The cable costs reflected in the data for these other LECs are either company-wide costs or an average for multiple study areas. In either case, there is a single observation for each of these companies for a given cable size for 24-gauge and 26-gauge copper cable cost. By reflecting the weighted average cost for BellSouth in the data, there is only one observation for BellSouth for a given cable size for 24-gauge and 26-gauge copper cable cost.

[18] We discuss the rationale for using non-rural LEC data to calculate relative copper cable costs, but not absolute copper cable costs, in this Order, section V.C.4.b.

methodology is likely to be in the same direction and of a similar magnitude. As a consequence, cost estimates for 24-gauge and 26-gauge copper cable for each cable size developed from non-rural LEC data by using the Huber methodology are likely to be biased by approximately the same factor. The ratios of these estimates are not likely to be affected significantly because the bias in one estimate approximately cancels the bias in the other estimate when the ratio is calculated.

25. We illustrate how we calculate the costs that we adopt in this Order for 26-gauge copper cable by calculating the cost for a 100-pair 26-gauge aerial copper cable. As explained above, we derive a ratio of 26-gauge copper cable cost to 24-gauge copper cable cost from non-rural LEC data to obtain costs for 26-gauge copper cable. To calculate this ratio for a 100-pair aerial copper cable, we estimate separately from non-rural LEC data the cost for a 100-pair 24-gauge aerial copper cable and a 100-pair 26-gauge aerial copper cable. We first estimate the numerator of this ratio, *i.e.*, the cost for a 100-pair 24-gauge aerial copper cable. Column H shows the regression equation derived from non-rural LEC data for estimating the cost for 24-gauge aerial copper cable. The regression equation set forth in column H for 24-gauge aerial copper cable is as follows:

$$A1 = B1 + (D1)(\# \text{ of Pairs})$$

where:

A1 = 24-gauge aerial copper cable cost per foot;
B1 = the intercept for 24-gauge aerial copper cable in dollars per foot;
D1 = the coefficient in dollars per pair per foot for the variable that represents the number of 24-gauge aerial copper cable pairs.

26. By substituting into the above equation for 24-gauge aerial copper cable the values from Table III for the intercept and the coefficient for the cable size variable, and the number of cable pairs in this example, 100, we obtain the following result for the cost of a 100-pair 24-gauge aerial copper cable:

$$A1 = 2.1548 + (.012393)(100)$$

$$= 2.1548 + 1.2393$$

$$= \$3.39 \text{ per foot.}$$

27. We next estimate the denominator for the ratio of 26-gauge aerial copper cable cost to 24-gauge aerial copper cable cost for a 100-pair aerial copper cable, *i.e.*, the 26-gauge aerial copper cable cost for a 100-pair cable. Column H shows the regression equation derived from non-rural LEC data for estimating the cost for 26-gauge aerial copper cable. The regression equation set forth in column H for 26-gauge aerial copper cable is as follows:

$$A4 = B4 + (D4)(\# \text{ of Pairs})$$

where:

A4 = 26-gauge aerial copper cable cost per foot;
B4 = the intercept for 26-gauge aerial copper cable in dollars per foot;

D4 = the coefficient in dollars per pair per foot for the variable that represents the number of 26-gauge aerial copper cable pairs.

28. By substituting into the above equation for 26-gauge aerial copper cable the values from Table III for the intercept and the coefficient for the cable size variable, and the number of cable pairs in this example, 100, we obtain the following result for the cost of a 100-pair 26-gauge aerial copper cable:

A4 = 2.385108 + (.008721)(100)

= 2.385108 + .8721

= $3.26 per foot.

29. We next calculate the ratio of 26-gauge copper cable cost to 24-gauge copper cable cost for a 100-pair cable. The ratio of 26-gauge copper cable cost to 24-gauge copper cable cost for a 100-pair cable is .96 ($3.26 per foot divided by $3.39 per foot).

30. Finally, we multiply this ratio by the estimate of the 24-gauge copper cable cost for a 100-pair cable derived from the RUS data, $2.21 per foot, to obtain the cost for a 100-pair 26-gauge copper cable, $2.12 per foot. We adopt this estimate as the input in the SM for the cost of a 100-pair 26-gauge aerial copper cable.

III. Huber Methodology

31. We find in this Order that it is reasonable to use the Huber methodology to develop input values for cable and structure costs. The structure and cable cost inputs used in the SM should reflect those that are typical for cable and structure for a number of different density and terrain conditions. Otherwise, the model may substantially overestimate or underestimate the cost of building a network. The Huber methodology produces estimates of costs that are typical for cable and structure by assigning zero or less than full weight to cable and structure cost observations that have extremely high or extremely low values. At the same time, it assigns full or nearly full weight to closely clustered cable and structure cost observations.

32. Use of the Huber methodology to derive reasonable estimates from RUS data is illustrated for aerial copper cable cost on the diagram labeled "Scatter Diagram Of 24-Gauge Aerial Copper Cable Cost And Size With The Huber Regression Line" and on the frequency distribution set forth on Table IV, labeled "Frequency Distribution Of Huber Weights For 24-Gauge Aerial Copper Cable Cost." The scatter diagram shows RUS cable cost data points representing combinations of aerial copper cable costs (measured on the vertical axis in dollars per foot) and cable size (measured on the horizontal axis by number of pairs). It also shows the regression line that the Huber methodology fits to these data points. The algebraic expression of this line explains or predicts the effects on aerial copper cable costs of changes in cable size.[19] The observations to which Huber assigns a weight that is less than .47 are

[19] The algebraic expression of the regression line for 24-gauge aerial copper cable estimated from RUS data by using the Huber methodology is as follows:

identified with an “o”; those to which it assigns a weight that is greater than .47 are identified with an “*”. The frequency distribution shows the number of aerial copper cable observations to which the Huber methodology assigns particular weights.

33. The scatter diagram and the frequency distribution demonstrate that the aerial copper cable estimates derived by using the Huber methodology with RUS data reflect most of the information contained in nearly all of the observations. As depicted on the scatter diagram, the majority of the aerial copper cable observations are clustered closely around the regression line. These are the observations to which Huber assigns the greatest weight when fitting the regression line to the data. As the frequency distribution shows, approximately 82 percent of the aerial copper cable observations is assigned a weight of at least .8. This large majority of closely clustered observations clearly represents typical cable costs. The minority of the aerial copper cable observations lies a considerable distance from the regression line. These are the observations to which Huber assigns the least weight when fitting the regression line to the data. As the frequency distribution shows, approximately 18 percent of the observations is assigned a weight of at less than .8. This small minority of observations comprises extremely high and extremely low values that do not represent typical cable costs. The scatter diagram also shows that some of the observations that receive a relatively small weight lie a substantial distance above the regression line while others that receive such weight lie a substantial distance below this line. This demonstrates that the Huber methodology excludes or assigns less than full weight to data outliers without regard to whether these are high or low cost observations.

IV. Analysis Of Coefficient For Cable Size Variable In The Huber Regression Equations

34. In this Order, we derive equations to estimate the non-rural LECs' labor and material cost for cable. We derive these equations by: (1) deriving regression equations by using the Huber methodology with RUS cable cost data that reflect labor and material costs; and (2) adjusting downward the coefficient for the variable that represents cable size in these regression equations to reflect the buying power of large LECs in comparison to RUS companies. The coefficient for the variable that represents cable size represents the additional cost for an additional pair of cable and therefore represents cable material costs. The adjustment to this coefficient is based on the difference between the average cable material prices that Bell Atlantic and the RUS companies pay for different cable sizes. The RUS companies' average cable material prices are calculated by using unweighted RUS data. Conversely, the Huber methodology used to estimate the regression equations assigns zero or less than full weight to data points that have extremely high or extremely low values. Below we demonstrate that the Huber methodology generally does not have a statistically significant impact on the level of material costs reflected in the cable cost estimates. That is, in general, there is not a statistically significant difference

---

24-gauge aerial copper cable cost per foot = 1.014907 + (.009822)(number of pairs).

In this regression equation, 24-gauge aerial copper cable cost is the dependent variable for which a value is measured along the vertical axis. The number of pairs is the independent variable for which a value is measured along the horizontal axis. The value 1.014907 is the intercept of the regression line. It is the point at which the regression line hits the vertical axis. It measures the fixed cost for 24-gauge aerial copper cable. The value .009822 is the slope coefficient of the regression line. It is the slope of the regression line. It measures the additional cost for one additional pair of 24-gauge aerial copper cable.

between the value of the coefficient for the cable size variable in the regression equations estimated by using the Huber methodology and the value of this coefficient in the regression equations developed in the NRRI Study by using OLS. Accordingly, the buying power adjustment for material is based on averages of RUS companies' cable material prices calculated by using unweighted RUS data.

35. Table V, labeled "Analysis Of Coefficient For Cable Size Variable In The Huber Regression Equations," displays the values of the coefficient for the cable size variable in the regression equations estimated from RUS data by using the Huber methodology in this Order and the 95 percent confidence interval surrounding the value of this coefficient in these equations in the NRRI Study estimated from these data by using OLS. Except for 24-gauge buried copper cable, the value of the this coefficient estimated by using the Huber methodology lies inside the 95 percent confidence interval surrounding the value of this coefficient in these equations in the NRRI Study estimated from these data by using OLS. That is, except for 24-gauge buried copper cable, the value of the cable size coefficient estimated by using the Huber methodology lies within an interval that contains with 95 percent certainty the true value of the OLS cable size coefficient.[20] This statistical evidence supports a finding that the Huber methodology does not have a statistically significant impact on the level of the material costs reflected in the cable cost estimates derived by using this methodology.[21] The cable size coefficient obtained by using the Huber methodology for buried copper cable lies outside the 95 percent confidence interval associated with the cable size coefficient obtained by using OLS for buried copper cable. This supports a finding that the Huber methodology does have a statistically significant impact on the level of the material costs reflected in the buried copper cable cost estimates.[22]

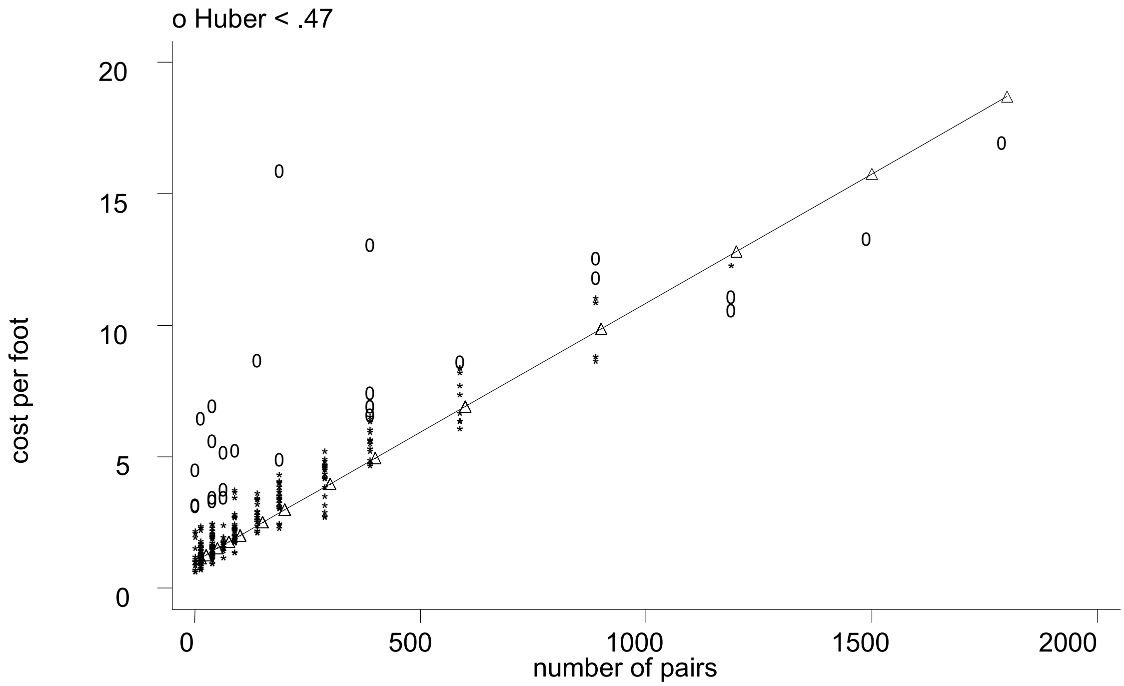
---

[20] Strictly speaking, over a large number of different samples, 95 percent of the confidence intervals associated with different OLS estimates of the cable size coefficient are expected to contain the true value of the OLS cable size coefficient.

[21] In this Order, we affirm the tentative decision in the *Inputs Further Notice* to use conservatively the lower of the buying power adjustments for aerial and underground copper cable material costs as the adjustment for buried copper cable material costs because the Huber methodology does have a statistically significant impact on the buried copper cable material costs reflected in the buried copper cable cost estimates. *See* this Order, section V.C.4.b.

[22] The specifications for the copper and fiber cable regression equations in the NRRI Study differ slightly from the copper and fiber cable regression equations adopted in this Order. The difference in the specifications does not alter the statistical conclusions regarding the impact of the Huber methodology on the level of cable material costs reflected in the cable cost estimates. We estimated by using OLS copper and fiber cable regression equations for which the specifications matched identically those for the copper and fiber cable regression equations estimated by using the Huber methodology. Again, with one exception, the cable size coefficient in the regression equations estimated by using the Huber methodology lies inside the 95 percent confidence interval associated with the cable size coefficient in the regression equations with the identical specifications estimated by using OLS. The one exception is that the value of the cable size coefficient in the buried copper cable and structure regression equation estimated by using the Huber methodology lies outside the 95 percent confidence interval associated with the cable size coefficient in the buried copper cable and structure regression equation with the identical specification estimated by using OLS. Again, we conclude that the Huber methodology does not have a statistically significant impact on the level of the cable material costs reflected in the cable cost estimates other than the buried cable cost estimates.

Scatter Diagram Of 24-Gauge Aerial Copper Cable Cost And Size With The Huber Regression Line



APPENDIX C

DESCRIPTION OF METHODOLOGY FOR ESTIMATING SWITCHING COSTS

1. Switch Cost Data. The depreciation rate reports filed by LECs contain information on Bell Operating Companies' (BOCs') digital switches that were reported as installed between 1983 and 1995 in the states specified, with certain exceptions. A small number of switches associated with apparent inconsistencies in the studies were not included in the set. In particular, for several locations in California, switches that were at the same location, but had different capacities, types, and year of installation, were reported as having the same per-line costs. These anomalies were judged to be the results of averaging by the respondent, and the switches in these locations were excluded from the data set. The following switches are also excluded from the data set: (1) switches for which there were no lines of capacity, such as those functioning solely as tandem switches; and (2) switches with fewer than 1,000 lines of capacity.

2. The sample was restricted to the period following the divestiture of AT&T, and to those switch types that could clearly be identified as either host or remote switches. These included the DMS-100, DMS-100 remote, DMS-10, 5ESS, 5ESS remote, and EWSD switch types. In total these restrictions removed about 500 observations from a data set of nearly 3,600 observations. Thus, after exclusions, the data set compiled by the Commission in conjunction with Gabel and Kennedy and the Bureau of Economic Analysis (BEA) of the Department of Commerce consisted of approximately 3,100 switches. In order to estimate the costs associated with the purchase and installation of new switches, and exclude the costs associated with upgrading switches, we removed those switches installed more than three years prior to the reporting of their associated book-value costs. The three-year restriction resulted in the removal of nearly 70% of observations, which do measure the cost of new switches. The depreciation data included in the data set selected by the Commission includes the remaining 946 observations.

3. The reports made to RUS by rural telephone companies contain information on the 181 digital switches installed in 1995 and 1996. To increase the reliability of analysis using these data, we removed the following observations from the data set: (1) observations containing information on switching equipment classified as upgrades to existing equipment and (2) observations containing information on switches reported as having no attached lines. These exclusions result in the removal of 42 observations. The RUS data included in the data set we select includes the remaining 139 observations.

4. Combined, the data set we employ includes 1,085 observations, 946 from the depreciation information and 139 from the RUS information. The RUS information includes a variable identifying switches as either hosts or remotes. The depreciation information does not. Therefore, an additional variable uniquely identifying switches as host switches or remote switches was added to the data set. Where data classifications were deemed unreasonable, switch types were reclassified. For example, switches identified as DMS-100 and 5ESS

switches which terminated less than 2,000 customers and cost in the neighborhood of $500,000 were reclassified as remote switches. These classifications identified approximately 55% of the switches included in the combined data set as remotes.

5. Regression Formulation. The regression employed is of the form:

$$Cost = a_1 + a_2*Lines + a_3*Host + a_4*(1/Time) + a_5*Lines*(1/Time) + a_6*Host*(1/Time) + e$$

where time takes on the value of 1 in 1985, 2 in 1986...15 in 1999. Regression results, including estimated coefficient values (in 1997 dollars), are:

$$Cost = \underset{(105{,}100)}{11{,}110} + \underset{(41.52)}{10.32}*Lines - \underset{(635{,}700)}{402{,}400}*Host + \underset{(970{,}500)}{2{,}205{,}000}*(1/Time) + \underset{(352.6)}{1{,}121}*Lines*(1/Time) + \underset{(4{,}757{,}000)}{1{,}080{,}000}*Host*(1/Time)$$

Robust (heteroscedasticity adjusted) standard errors in parenthesis. Regression R-squared = 0.73.

Estimates, identified using the regression equation, for the fixed cost of host and remote switches and for the per-line cost of all switches (in 1997 dollars) are, respectively:

$$\text{Host Fixed Cost} = a_1 + a_3 + a_4*(1/Time) + a_6*(1/Time)$$
$$\text{Remote Fixed Cost} = a_1 + a_4*(1/Time)$$
$$\text{Per-line Cost} = a_2 + a_5*(1/Time)$$

In estimating switch costs for 1999, the regression results (with time defined as 15) were converted into 1999 values using actual inflation between 1997 and 1998 and projected inflation between 1998 and 1999. Estimates for 1999, in 1999 dollars, identified using the regression equation, for the fixed cost of host and remote switches and for the per-line cost of all switches are, respectively:

$$\text{Host Fixed cost} = (1+inflation_{1998})*(1+inflation_{1999})*(a_1 + a_3 + a_4*(1/15) + a_6*(1/15))$$
$$\text{Remote Fixed Cost} = (1+inflation_{1998})*(1+inflation_{1999})*(a_1 + a_4*(1/15))$$
$$\text{Per-line Cost} = (1+inflation_{1998})*(1+inflation_{1999})*(a_2 + a_5*(1/15))$$

The inflation rate for 1998 is measured by the gross-domestic-product chain-type price index as published monthly by the Bureau of Economic Analysis of the U.S. Department of Commerce in the Survey of Current Business. The projected inflation rate for 1999 is reported in The Economic and Budget Outlook: An Update, published by the Congressional Budget Office on July 1, 1999. Inserting these inflation rates, the fixed cost of a host switch, the fixed cost of a remote switch, and the per-line cost for host or remote switches (in 1999 dollars) are, respectively:

$$\text{Host Fixed cost} = (1.01)*(1.013)*(a_1 + a_3 + a_4*(1/15) + a_6*(1/15))$$
$$\text{Remote Fixed Cost} = (1.01)*(1.013)*(a_1 + a_4*(1/15))$$
$$\text{Per-line Cost} = (1.01)*(1.013)*(a_2 + a_5*(1/15))$$

Inserting the coefficients from the regression analysis, the fixed cost of a host switch, the fixed cost of a remote switch, and the per-line cost for host or remote switches (in 1999 dollars) are, respectively:

Host Fixed cost = (1.01)*(1.013)*(11,110 - 402,400 + 2,205,000*(1/15) + 1,080,000*(1/15))= 486,700
Remote Fixed Cost = (1.01)*(1.013)*(11,110 + 2,205,000*(1/15)) = 161,800
Per-line Cost = (1.01)*(1.013)*(10.32 + 1,121*(1/15)) = 87

6. In response to the *Inputs Further Notice*, Sprint contends the following:[1]

> Sprint conducted regression analysis on the two data sets (depreciation and RUS) individually and arrived at the following conclusions:
>
> 1. No RUS variables are significant (5% level of significance).
> 2. Only the 'lines*1/time' variable in the depreciation data set is significant (5% level of significance).
> 3. Severe multicollinearity was found in the proposed regression equation (VIF>55).

Based upon this evidence Sprint suggests that the data in the Commission's proposed data set or the proposed regression equation appears to be "severely tainted" and recommends "dismissing all conclusions suggested as a result of this tainted data set and mis-specified regression model."

7. We reject Sprint's argument. While we acknowledge that there is collinearity amongst the explanatory variables, we note that this is typically the case in multiple regression models. Anderson, Sweeney, and Williams note that "…most independent variables in a multiple regression problem are correlated to some degree with one another."[2] Similarly Fomby, Hill, and Johnson note, "[f]requently in nonexperimental situations, some explanatory variables exhibit little variation, or the variation they do exhibit is systematically related to variation in other explanatory variables."[3]

Muliticollinearity does not as Sprint implies indicate that the regression model is mis-specified.[4]

---

[1] *Sprint Input Further Notice Comments* Attachment 6.

[2] *See* David Anderson, Dennis Sweeney, and Thomas Williams (1996), *Statistics for Business and Economics*, Sixth Edition at page 597.

[3] *See* Thomas Fomby, R. Carter Hill, and Stanley Johnson (1988), *Advanced Econometric Methods* at page 283.

[4] *See* William Green (1990), *Econometric Analysis* at 278 (noting that "the case of near collinearity or high intercorrelation among the variables is … a statistical problem. The difficulty in estimation is not one of identification but of precision."), or Fomby, Hill, and Johnson at 284 (noting that "the primary statistical consequence of multicollinearity is that one or more of the estimated coefficients of the linear model may have large

Therefore, the issues of mis-specification and mutlticollinearity are independent, and Sprint provides no evidence that the regression model is mis-specified.

8. Even with multicollinearity the least squares estimate is the minimum variance linear unbiased estimator, its standard error is correct, and the conventional confidence interval and hypothesis tests are valid.[5] The least squares estimates and hence forecasts based upon them are also best linear unbiased estimates and maximum likelihood estimates and hence are unbiased, efficient, and consistent.[6] Furthermore Ramanthan notes that "Multicollinearity may not affect the forecasting performance of a model and may possibly even improve it."[7]

9. Sprint also raises concerns in their comments regarding the lack of statistical significance of individual parameters in our estimates.[8] However as Golberger notes, while muliticollinearity may make the estimates of individual parameters less precise, it may "facilitate the precise estimation of particular combinations of elements."[9] For example Sprint expresses concern that the lines variable "by itself" should be more significant. Staff analysis indicates, however, that jointly the variables Lines and Lines/Time are statistically significant, indicating that switches increase significantly in cost when additional lines are purchased at installation.. Therefore, one would be in error to conclude that, based upon individual "t-statistics," switch costs do not vary with line size.

---

standard errors.")

[5] *See* Arthur Goldberger (1991), *A Course in Econometrics* at 246.

[6] *See* Ramu Ramanthan (1989), *Introductory Econometrics* at 232.

[7] *See* Ramu Ramanthan (1989), *Introductory Econometrics* at 233.

[8] *See Sprint Inputs Further Notice Comments* at 44.

[9] *See* Arthur Goldberger (1991), *A Course in Econometrics* at 250.

APPENDIX D

DESCRIPTION OF METHODOLOGY FOR ESTIMATING EXPENSES

1. Data Sources used in Regression Analysis. The use of multiple variables in the estimation process required that various data sources be used to determine the common support service expense model inputs. Because the reporting requirements and number of company study areas were different among the reports used, it was necessary to reconcile the data for 1998 expenses, access lines, and dial equipment minutes, as described below.

1998 Expenses
Data Source: ARMIS, 43-03 Report, "Total Regulated" Column.

Study Areas (SAs) reconciled:

Total SAs from ARMIS 43-03 Report:	125
Less:	
SAs combined to agree with access line data in ARMIS 43-08:	(8)

Study Area(s)	Combined with
MSID	PNID
COCA	GTCA
COTX	GTTX
PRCC	PRSA
COIL	GTIL
COIN	GTIN
COMO	GTMO
CONC	GTNC

SAs removed (not in NECA Tier I reporting): GTGO	(1)
SAs removed (certified rural): (GTAR, COAZ, GNCA, ALGC, COIA, COSI, GTIA, GTID, GLIL, GLIN, UTIN, COKY, GLMI, COCM, COEM, UTMO, ALNC, GTNE, UTNJ, CONM, GTNM, CONV, CTRH, CTUP, CTWC, ALWR, UTNW, ALPA, COPA, COQS, UTPA, COSC, UTTX, COVA, GTVA, COWA)	(36)
SAs used in analysis:	**80**

<u>Access Lines</u>

Data Source: ARMIS, 43-08 Report, Table III,
Column (dj) "Total Switched Access Lines", and
Column (dm) "Total Access Lines (Switched and Special)"

Study Areas (SAs) reconciled:

Total SAs from ARMIS 43-08 Report::	116
Less:	
SAs combined to agree with ARMIS expense data and NECA usage data:	(7)

<u>Study Area(s)</u>	<u>Combined with</u>
NYNY (Conn)	NYNY (New York)
CBTC (IN & KY)	CBTC (Ohio)
LTNE (IA & KS)	LTNE (Nebraska)
UTIM (VA)	UTIM (Tenn)
PRCC	PRPR

SAs removed (not in NECA Tier I reporting): (2)
(COTM, CWTC)

SAs removed (certified rural) (27)
[GTSW(Ar & Nm), GTGC(Az & Nv), GTNW (Ca & Id), ALGC, GTMD(Ia & Ne), GTSO(Il & Va), COSO (Mi & In), UTIN, UTMO(Ia, Ks & Mo), ALNC, UTNJ, COWW, CTNY, ALWR, UTNW(Or &Wa), ALPA, UTPA, UTTX]

SAs used in analysis: 80

<u>Dial Equipment Minutes</u>
Data Source: NECA filed statistics on network usage by carrier

Study Areas reconciled:

Total SAs per NECA data filing: 131

Less:

SAs combined to agree with access line data: (10)

Study Area(s)	Combined with:
COCA	GTCA
MSID	PNID
CBTC (KY)	CBTC (Ohio)
PRCC	PRPR
COTX	GTTX
COIL	GTIL
COIN	GTIN
COMO	GTMO
CONC	GTNC
UTIN(Va)	UTIN(Tn)

SAs removed (not in ARMIS reporting): (4)

(GA Alltel Telecom, Micronesian Tel, GTE No. Inc. - MN, Citizens Utilities DBA Citizens of Tennessee)

SAs removed (certified rural) (37)

[GTSW(Ar), COAZ, GNCA, COIA, COSI, GTIA, GTNW (Id), ALGC, GTSO(Il & Va), COKY, COCM, COEM, COSO (Mi & In), UTIN, UTMO, GTNE, CONM, GTNM, CONV, CTUP, CTWC, CTRH, ALNC, UTNJ, ALWR, ALPA, COPA, COQS, UTPA, COSC, UTNW(Or &Wa), UTTX, COVA, COWA]

SAs used in analysis: 80

Local Number Portability

(cents per month)

Ameritech	$0.28
BA/NYNEX	$0.23
BellSouth	$0.35
Pacific Bell	$0.34
Southwestern	$0.33
US West	$0.43
GTE	$0.36
Sprint LTCs	$0.48
Cincinnati Bell	$0.34
Nationwide Line-weighted Avg.	$0.32

General Support Facilities

Investment Calculation

$$\begin{pmatrix}\text{Office}\\ \text{Worker}\\ \text{GSA}\end{pmatrix} = \frac{\dfrac{\text{SW}}{\text{TOTAL}}\begin{bmatrix}\text{Loop}\\ \text{Main.}\end{bmatrix} + \dfrac{\text{SW}}{\text{TOTAL}}\begin{bmatrix}\text{Circuit}\\ \text{Main.}\end{bmatrix} + \dfrac{\text{Local DEM}}{\text{Total DEM}}\begin{bmatrix}\text{Switch}\\ \text{Main.}\end{bmatrix} + \text{USF Corp.}}{\left[\text{Loop Main.} + \text{Circuit Main.} + \text{Switch Main.} + \text{Total Corp.}\right]}$$

$$.6769 = \frac{.8225(2.99) + .8225(.45) + .7438(1.38) + 7.32}{2.99 + .45 + 1.38 + 11.69}$$

Office Worker GSA = .6769

Total Operation GSA = 1 - .6769 = .3231

GSA = General Support Allocation
SW = Switched Lines
TOTAL = Total Lines
Main. = Maintenance
Corp. = Expenses Related to Part 32 Accounts 6510, 6530, 6600, 6700