

DESIGN OF BURIED PLANT-PHYSICAL CONSIDERATIONS

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FIGURE 1

1. GENERAL

1.1 This section provides REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design, construction, and operation of REA borrowers' telephone systems. This section discusses in particular the design of buried plant using both nonfilled core and filled core cables and wires.

1.2 Buried plant as discussed in this section pertains to telephone plant in which the majority of cables and wires are placed directly in the ground by plowing and/or trenching.

1.3 Additional information for use in the design of buried plant can be found in other REA TE & CM Sections, REA PE Specifications, REA PC Standards, and the specifications contained in the REA Telephone System Construction Contract, Form 511.

2. APPLICATION

2.01 Buried plant inherently offers certain advantages over aerial and underground plant (in conduit), and is usually more economical on a first cost basis. Exceptions where this economic advantage may not be realized are in built-up urban areas or extensive rock formations. In these types of areas, a combination of buried and aerial plant may prove to be the most economical construction for the system. There are also certain advantages in using conduit in conjunction with buried plant. Refer to TE & CM 643 for these applications.

2.02 Whereas the repair of damage or faults in buried plant may be more expensive in individual situations, than in aerial plant, buried facilities are less exposed than aerial facilities to physical damage, and therefore the number of faults are fewer. Fewer failures mean longer periods of trouble-free operation; and consequently, greater subscriber satisfaction. Buried plant is particularly advisable in areas of frequent ice storms and high velocity winds. In addition, buried plant will satisfy the growing impetus from public pressures for the improvement and preservation of the natural aesthetic values of the country.

2.03 Right-of-Way - The burial of telephone plant is generally dependent on permission to bury facilities on public and private rights-of-way. In most instances cooperation can be expected when buried plant and construction techniques are fully explained along with the aesthetic improvements. Experience has shown that road work is more responsible than farm operations for damage and outages in buried plant. Therefore, primary consideration should be given to the use of private right-of-way. If public right-of-way is to be used for the placement of cable, a comprehensive investigation should be made as to possible highway improvements, such as widening or changing grade elevations, since they may necessitate costly future rearrangements and rerouting. The need for permits in other situations such as railroad crossings, crossings of navigable streams, and crossings of the facilities of other utilities should be thoroughly investigated.

2.04 Rock Considerations - In portions of a project area where there is more than incidental rock, consideration should be given to reduced depth with protection as described in Paragraph 2.071 and Paragraph 3.3, or preripping. Note: The preripping operation is normally very expensive and warrants special consideration by the Engineer prior to approval. The most economical plowing rates will be obtained when the area is relatively free of rock and one tractor is able to move the plow through the earth. There will be situations where localized rock conditions will economically restrict plowing-in of cable and/or wire through a particular area, in which case the Engineer must consider the rerouting of facilities, trenching, blasting, reduced depth with mechanical protection, or using aerial inserts. This condition normally will be resolved during the construction period. Provisions are made in the Construction Contract for the Contractor to determine the extent of rock, when encountered, and demonstrate that plowing cannot be accomplished; and on this basis, the Engineer will decide the most economical solution based not only on the bid prices in the contract, but also on the long run advantages and disadvantages.

2.05 Other Underground Utilities - In some urban and suburban areas, other underground facilities such as water lines, gas lines, sewer lines, power and/or telephone lines will present obstacles to

plowing or trenching. The existing underground utilities and the possibility of future buried utilities must be considered. The Engineer should obtain detailed information from other utilities on present and proposed underground facilities. Where it is known that obstacles will be encountered during construction, the Engineer should designate such areas at the time plans and specifications are prepared. The buried cable and wire units for these areas will be listed in the plans and specifications with a "T" suffix. This will distinguish the units from the regular BJ units in order that the higher cost associated with plowing in these congested areas will not be reflected in the bid prices for the major portions of the system.

2.06 Physical Location

2.061 The exact location for buried cable or wire should be determined in conjunction with federal, state, county, and local authorities, and private interests as applicable. Special attention should be given to the size of equipment that will be required for installation.

2.062 Some of the considerations that affect the decision of physical locations are:

- a. Width of road shoulders
- b. Type of terrain
- c. Type of road
- d. Easement
- e. Fence locations
- f. Required number of housings
- g. Public right-of-way
- h. Private right-of-way
- i. Type of drainage ditch
- j. Road and drainage ditch
- k. Soil conditions

2.063 With the continuing emphasis of placing telephone wire and cable facilities below ground the Engineer should give greater consideration to the problems that the borrower will encounter in the operation and maintenance of his plant. Investigation, coordination and thorough planning in the routing of buried plant is of paramount importance. In addition, the depth of plant placement, the physical plant protection when required, adequate route marking and detailed plant in-place records are an absolute necessity. Detailed information is provided in TE & CM Section 116 "Plant Engineering and Record System" and TE & CM Section 642 "Staking of Buried Plant."

2.064 In addition to considering the physical location of the plant and terrain characteristics, the Engineer should consider methods for providing protection to the buried facilities.

2.065 Special attention to protect cable which is to be placed on public rights-of-way, should be discussed and coordinated in detail with the particular regulatory authorities by emphasizing exact location, exact depths and the placement of warning and route signs to eliminate damage caused by road maintenance equipment regarding resurfacing, etc. In addition, the road authorities should be informed that the borrower will provide any assistance necessary through identification, location, etc. of existing telephone plant.

2.066 The Engineer should contact each property owner when private rights-of-way are to be used and emphasize the need to provide protection to any buried plant to be installed therein. Here again, the selection of the exact cable route and the depth that the cable should be placed is of utmost importance. Buried cable warning and route signs should be discussed and a route drawing should be provided to each property owner indicating the exact location of all below-ground plant on his property. In addition, the property owner should be informed that the telephone company will provide assistance with reference to identification, location, etc. of in-place plant as the needs arise.

2.067 The Engineer should follow the same procedures as outlined above in coordination with town and development areas where below-ground plant is to be placed (buried or in conduit and manholes). Special assistance should be given to the town planning authorities, land, industrial, and commercial developers by either identifying on existing plans and maps or in the preparation of new plans or maps, the exact locations of all below-ground plant. Here again, these organizations should be informed of the voluntary participation by the telephone companies in providing identification and location of its plant as the need arises.

2.068 The Engineer also should coordinate all proposed underground plant placement with other utilities. This is necessary not only for coordinated joint construction, but also to properly develop a working relationship between the various utilities on future planning of all underground utility plant. Plant-in-place records of telephone plant to be placed should be provided to each of the utility companies whose plant is, or may be placed within the area of the telephone companies plant facilities.

2.07 Terrain - The minimum depth of buried cable and wire either plowed or trenched is detailed in the applicable specifications of the REA Construction Contract, Form 511. The Engineer will determine the local condition which would affect the requirement for increased depths. In areas where crop plowing or subsoil operations are being carried out, increased depths may be necessary, especially if the wire or cable is to be buried on private right-of-way. The Engineer should check with county agents, the U. S. Soil Conservation Service, and

others in regard to any existing and/or proposed land development programs which would require special design considerations.

2.08 Frost Conditions - Cable and wire should be buried below the frost level, if possible, in those areas where frost heave can be expected. Damage to conductors has been experienced due to movement of above ground housings. It is, therefore, recommended that stub poles for mounting housings be used in these areas. Poles should be set below the frost line and in accordance with the requirements set forth in REA Form 511.

2.09 Flood Conditions - In many areas of the United States a problem of general flooding must be considered. Flooding can also be a problem within specific areas of a system not included in the general flood areas. Particular attention should be given in respect to the routing and depth of placement of buried cable or wire in those areas of flooding to prevent exposure due to soil erosion. Another consideration is to utilize existing or new poles to mount housings above flood water levels. In non-flood as well as flood areas, moisture blocks or pressure blocks, if the cable is to be pressurized, should be placed on all non-filled cables appearing in above-ground housings to prevent the entrance of moisture into the cables.

2.10 Gopher Protection - Large areas of the United States are infested with gophers or other rodents which can damage buried facilities and cause outages unless the wire and/or cables are adequately protected. Wire and cable specifically designed for burial in rodent infested areas are included in REA Specifications PE-23, PE-39, PE-44, PE-50, and PE-54. Figure 1 reflects areas with significant gopher infestation; however, the Engineer should thoroughly investigate the project area and should contact the local agent of the U. S. Department of the Interior, Fish and Wildlife Service, prior to selection of the gopher or nongopher type shields.

2.11 Cable Route Markings - The Engineer should consider one of the more important responsibilities associated with the design of underground and buried plant by providing prominent above-ground identification that the plant exists. It is necessary that information be provided as to identification and proper instructions in order to avoid service interruptions. The term normally associated with a service interruption is "Dig-In". A "Dig-In" is usually the result of a lack of instruction or unawareness as to the exact location of underground or buried facilities. With reference to the coordination activities as indicated in paragraph 2.063, the Engineer should detail the placement of signs along a below-ground cable route with a sufficient number and proper spacing so that the location of the route is clearly defined to the telephone company personnel and to the public. In general, signs should be located adjacent to the cable along roads, railroads, pipe lines, streams, irrigation and drainage ditches as well as at other locations where it is likely that excavation work may occur. In addition, signs should be placed at each change in route direction, at buried splice locations, on both sides of streets, roads,

channels, pipe lines, buried power cable, etc. Where practicable, the signs should be placed in fence lines or at other locations where they will not inconvenience the owner of the property. Type of signs and typical warning sign layout drawings are included in the appropriate specifications of the REA Construction Contract, Form 511.

3. MATERIALS AND SPECIFICATIONS

3.1 Housings are essential in buried plant to accommodate above-ground appearances of buried cables and wires. Housings of fiberglass, and galvanized painted steel are available in sizes to accommodate variations in splicing, terminations, loading coils, bridged tap isolators, etc. Above-ground housings will normally appear in buried plant at the following locations:

- a. Subscriber distribution points.
- b. Junctions with lateral runs of cable and wire including future known extensions.
- c. Loading points
- d. Aerial inserts when necessary for splices.

3.11 Serious consideration should be given by the Engineer to the use of the direct burial filled splice enclosures in lieu of housings at the following locations:

- a. Connections between buried wire or cable and buried service wire.
- b. Reel end splices

3.12 Buried splice enclosures and splice encapsulations shall conform to REA Specification PE-70.

3.13 Buried plant housings shall conform to REA Specification PE-35.

3.14 The objective in the selection of housings is to have them as small and inconspicuous as possible so as to preserve the natural beauty of the countryside. There are, however, instances where it may be desirable to have attention called to their presence. This may be done by mounting housings on tall stub poles or using brightly colored steel or fiberglass housings.

3.2 Terminal Blocks - Moisture inside buried plant housings should not be a problem if filled splicing connectors are used for connecting service wire. Every effort should be made to seal buried plant by using filled cable and wire and/or non-filled cable or wire with moisture blocks, and using only moisture resistant splicing connectors on both types of cables or wires. Buried plant terminal blocks should not be used.

3.3 Cable and Wire Guard - Where sufficient depth of cable cannot be obtained as indicated in paragraph 2.071, consideration should be given for mechanical protection as follows:

1. Cable and Wire Guards

- a. Road and street crossings
- b. Open drainage canal crossings
- c. Stream and river crossings

2. Creosote Planking

- a. Parallel runs within highway right-of-way if so required by regulations.
- b. Within railroad right-of-way if so required by regulations.
- c. In exposed areas susceptible to hand or mechanical digging, buried cable warning signs should be placed near these exposed areas.

3.4 Rodent Control - Substantial damage to cable conductors within above-ground housings from mice, ants, termites, etc., has been experienced. It is recommended that protective action be taken in accordance with REA Contract Form 511.

3.5 Loading - Design considerations and requirements for the various types of loading are defined in detail in other REA TE & CM sections. The Engineer must coordinate the actual location of loading points during construction due to possible buried cable route deviations, additional reel end splices, and/or subscriber terminals.

3.6 Buried Cable and Wire - Refer to REA Specifications PE-23, PE-39, PE-44, PE-50, and PE-54.

3.7 Other Materials Used in Buried Plant

3.71 Building-out Capacitors - Refer to REA Specification PE-30.

3.72 Junction Impedance Compensators - Refer to REA Specification PE-31.

3.73 Buried Cable Warning Sign - Refer to REA Contract Form 511.

4. DESIGN CONSIDERATIONS

4.01 Major improvements in techniques for the placement of buried cable and wire stimulate consideration of these facilities for use in serving urban areas. Properly engineered buried construction may result in plant which is equal to or lower in first cost to aerial construction and is likely to be lower in annual costs.

4.02 In view of these advantages and the major improvements in materials, experience, and construction techniques, the Engineer should re-consider carefully those places where it may have previously been assumed that the facility could not be buried economically.

4.03 Joint burial of electric and telephone cables by plowing or trenching is being increasingly emphasized. The most favorable conditions for the construction of joint buried plant will usually occur in relatively small areas of high residential concentration such as sub-divisions and new housing developments. The Engineer should give special consideration to this method of installation as described in REA Bulletin 61-3 "Design and Construction of Joint Buried Plant - Electric and Telephone" publication dated June 1967 which should be filed with this TE & CM. Joint burial should not be considered when the parallel exposure exceeds 1/2 mile. Due to local, State, and Federal ordinances and regulations which are under continuous review and subject to changes, the Engineer should coordinate plant design carefully in compliance with the regulations in effect at the time of design. The most stringent regulations should be used.

4.04 In determining the outside plant buried facility requirements the Engineer should evaluate very thoroughly the circuit requirements needed to provide sufficient margin in the sizing of both the distribution and backbone or feeder buried cables. When existing aerial wire, non-jacketed distribution wire or parallel line wire requires reinforcing, it frequently may be economical to install buried facilities of such capacity that the existing facilities can be economically retired. This should be worked out on initial and annual cost bases.

4.05 Serving additional subscribers not anticipated at the time of construction may be more of a problem in buried plant than in aerial plant. Thorough planning is therefore of utmost importance. Long range subscriber estimates by grade of service should be made prior to preparation of the design. The estimate should take into account the likelihood of upgrading new services and additional subscribers.

4.06 Local characteristics of the project area should be thoroughly studied so that it is known whether normal or extraordinary plowing or other construction conditions exist before comparative cost studies are undertaken. In addition, the determination should be made as to whether special cable shielding or other protection methods will be required for rodent control so that the increase in incremental cost associated with it can be evaluated.

4.07 The design should provide for the optimum use of fine gauge cable (24 and 26 gauge). Care must be exercised in the design to ensure that current transmission requirements are met, and that high lightning areas are considered.

4.08 Choice of proper gauge conductors will depend on transmission and signaling requirements. Care should be exercised in selecting the cables since initial cost differentials between the various cable sizes and conductor gauges can be appreciable. Transmission and signaling requirements sometimes require the use of some

heavy gauge cable but do not demand that the entire length be of the same gauge. In addition, the Engineer should consider the possible future use of carrier and perhaps other types of electronic equipment and this may alter the initial economic gauge selection.

4.09 Economic and/or operating advantages may often be realized by extending or reducing cable lengths to eliminate splices and housings which may provide savings in cable reel length purchases.

4.10 In the case of buried plant, the procedure explained in TE & CM Section 210 is recommended for use in sizing cables and the procedures explained in TE & CM 629 are recommended for use in assigning cable pairs.

5. ECONOMIC CONSIDERATIONS

5.1 Buried plant in general provides a lower incidence rate of trouble than does aerial plant. While it may be more expensive to repair an individual buried plant trouble, buried facilities are so much less exposed to physical damage that failures are few and the total maintenance costs are usually less.

5.2 The alternatives for making an economic analysis are covered in REA TE & CM 204, "Telephone System Design." Annual cost factors are presented in REA TE & CM 218, "Plant Annual Cost Data for System Design Purposes."

5.3 Design comparisons between aerial, underground, or buried plant should be made on the basis of a five-year design. It is essential, however, that good engineering judgment govern the design process. Initial and annual cost data are intended as guidelines in economic selection studies to supplement and support engineering judgment and decisions. The objective is to choose the most suitable elements of new plant facilities.

5.4 It is strongly recommended that filled cables and wires be considered in buried plant construction in the size range from 1 pair through at least 50 pairs. In these cable and wire sizes there is now no practical method to provide protection from moisture entry through the jackets into the core of the non-filled type cables and wires. Insofar as the use of cable in the larger cable sizes (75 pair and above) is concerned, the Engineer must consider protection and stability of the cable electrical transmission values for the estimated service life for this type of cable. It is, therefore, necessary for the Engineer to consider the following factors in his selection of larger filled versus nonfilled cables:

Filled Cable (75 Pair and larger)

Advantages:

1. Moisture entry protection
2. Stabilized electrical transmission values
3. Corrosion of the shield is controlled
4. Moisture blocks are not required
5. Damage to the outer jacket should not affect performance of the cable because moisture entry is controlled and restricted from flow within the cable.
6. Cable plant maintenance is expected to be reduced considerably.
7. Less expensive splice enclosures may be used.

Disadvantages:

1. Possible higher initial cable cost
2. More difficult to work with in colder temperatures
3. Inconvenience to the workman in splicing and terminating.

Non-filled Cables (75 pair and larger)

Advantages:

1. Possible less initial cable cost
2. Easier to work with in colder temperatures
3. Less objection by workmen in splicing and terminating

Disadvantages:

1. Pressurization should be employed for moisture protection.
2. Pressure blocks and pressure tight splice enclosures should be installed.
3. Pressurization equipment and installation costs are high.
4. Maintenance of pressurization equipment and plant is continuous.
5. If the cable is not pressurized moisture blocks should be installed; any damage to the outer jacket as well as the inner jacket should be considered major due to possible moisture entry; water tight or pressure tight splice enclosures should be used; and permeation of moisture through the jackets is possible.

GOPHER INFESTED AREAS

AREAS REFLECT TYPE OF GOPHER OF GREATEST CONCERN IN CABLE DAMAGE. CONTACT SHOULD BE MADE WITH LOCAL AGENT OF THE BRANCH OF PREDATOR AND RODENT CONTROL U.S. FISH AND WILDLIFE SERVICE PRIOR TO SELECTION OF CABLE IN ALL AREAS.

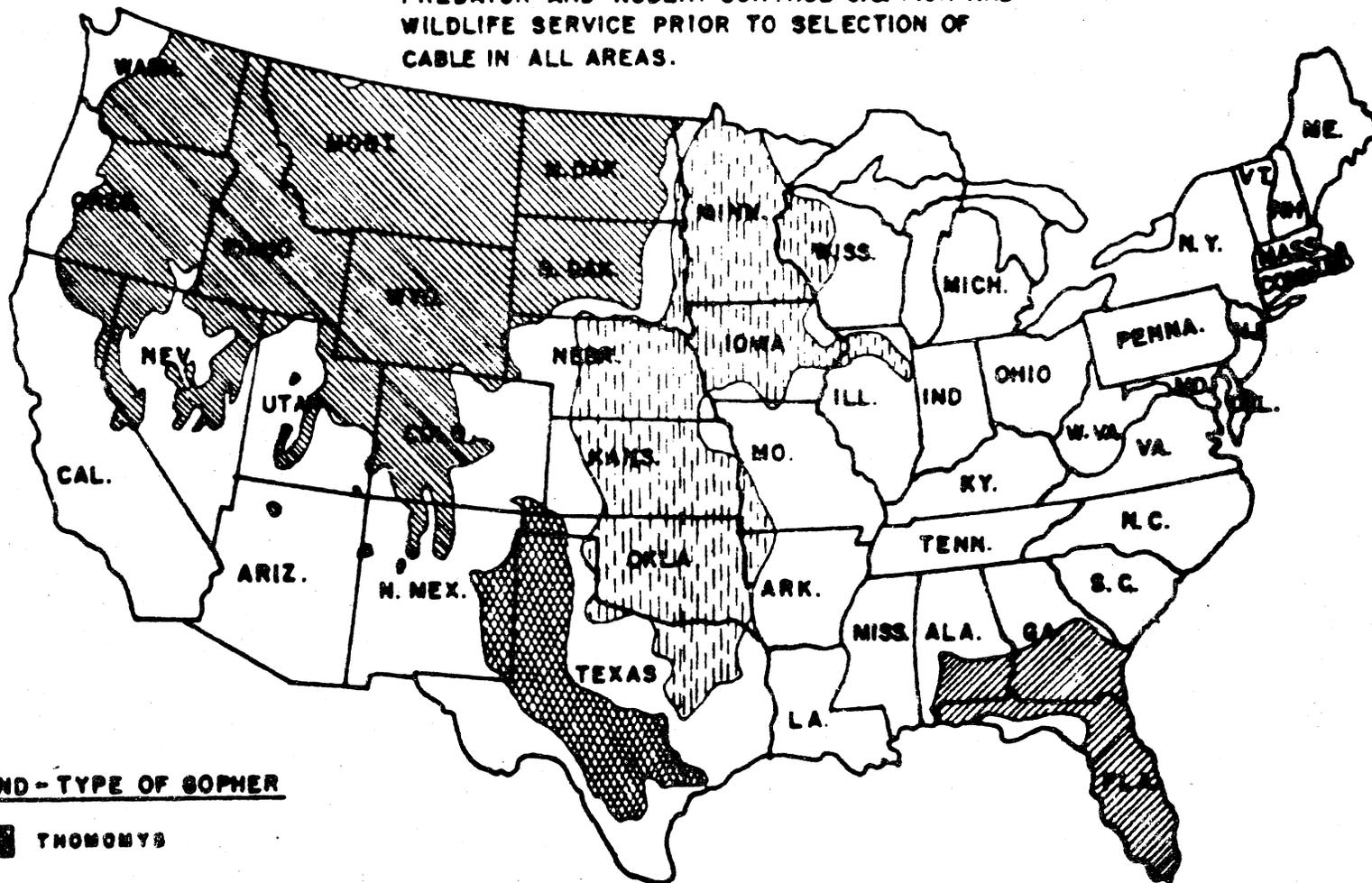


FIGURE 1

LEGEND - TYPE OF GOPHER

-  THOMOMYS
-  CRATOGEOMYS
-  GEOMYS-BURBARIUS & ARENARIUS
-  GEOMYS

FILE WITH TE&CM 640

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**DESIGN AND CONSTRUCTION OF JOINT BURIED PLANT
-ELECTRIC AND TELEPHONE-**

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This publication provides REA borrowers, consulting engineers, contractors and other interested parties with information for use in the design and construction of joint buried electric and telephone facilities. REA publications pertinent to the design and construction of separate buried electric distribution plant and buried telephone plant are as follows:

REA Bulletin 61-3, "Underground Rural Distribution"
REA Telephone Engineering and Construction Manual, Sections

- 640 - "Design of Buried Plant"
- 641 - "Construction of Buried Plant"
- 642 - "Staking of Buried Plant"
- 701 - "Station Installations"
- 805 - "Subscriber Station Protection"
- 816 - "Electrical Protection of Buried Plant"

REA Form 806, "Specifications and Drawings for Underground
Electric Distribution"
REA Form 511, "Telephone System Construction Contract"

DESIGN AND CONSTRUCTION OF JOINT BURIED PLANT -ELECTRIC AND TELEPHONE-

I. INTRODUCTION

The merits of buried plant have long been recognized by the telephone industry. Extensive construction of this type has been completed and efforts are continuing to improve the methods and materials associated with it. The use of underground distribution in the electric utility industry has been somewhat more selective in the past. However, increased public demand, improved technology, and better economies have resulted in an increasing number of underground installations. Buried plant fulfills the objectives of the telephone industry by increasing the reliability of service, providing longer plant life, reducing installation costs, reducing maintenance costs, providing increased safety and meeting the public demand for this type of plant. Even though the electric utility industry has had considerably less experience with underground, indications are that these same objectives will be furthered by putting electric lines underground.

Only during the past decade has buried construction been undertaken in this country to an appreciable extent. This is so mainly because it was only encouraged previously as an option to overhead construction. Now, the trend toward the improvement and preservation of the beauty of rural and urban areas of the United States should result in an increase in the use of buried plant.

Almost all of the underground construction by electric and telephone utilities until just recently has been of the separate rather than the joint type. The electric industry had not sufficiently developed the direct burial concept which has served the telephone industry so well. There has also been considerable concern of possible damage to telephone personnel and property in case of a power fault on the electric cable in a joint-use situation. Also, where random lay of cables has been prohibited, the cost of trenching and deliberate separation of cables has often made it more economical to plow in cables

separately. This is especially true of telephone cables since their placement depths have generally been less than those of electric conductors.

Considerable study and effort by both the electric and telephone utilities have done much to resolve most of the problems associated with underground joint use construction. However, each potential application for this type of construction must still be evaluated on the basis of its advantages and disadvantages as follows:

1. Reduction of installation cost is usually the first objective of buried joint use construction. If the plant is properly designed and construction is coordinated, considerable savings in construction cost can often be realized. Lack of coordination can be very costly.
2. Right-of-way can often be utilized more efficiently.
3. Where cables are placed jointly at the same time, there is less chance of one utility plowing, trenching, or digging into the other utility's cables.
4. Compromise in design may be necessary to reach agreement on the depth of burial in random lay installations.
5. Maintenance costs may be higher on joint-use installations if both utilities must be represented when digging is to be performed.

Negotiations with respect to coordination and division of construction costs for joint buried construction should not normally present any more of a problem than accompanied joint aerial construction. Therefore, as new techniques and materials are developed for the construction of joint buried plant, it should become commonplace rather than unique as the method of providing facilities for electric and telephone services.

II. DESCRIPTION

A.

- A. Joint burial of electric and telephone facilities pertains to the placement of these facilities in a common trench either by trenching or plowing. Dependent upon the separation which will exist between the facilities, joint buried plant is classified as fixed separation or random separation as shown in Figure 2.

1. Fixed separation requires that the electric and telephone cables be separated everywhere by a specific minimum distance. This is consistent with the Sixth Edition of the National Electrical Safety Code (NESC) requirement that buried communication and buried electric supply cables be separated by not less than 12 inches of well-tamped earth, 4 inches of brick or 3 inches of concrete. This rule should be followed unless a waiver to use random separation is obtained from the state or local regulatory authority, whichever is appropriate. (A revision of this portion of the NESC to allow random separation under specific conditions is now under consideration).
2. Random separation permits the facilities to be placed without the requirement for a minimum distance between them. Extensive tests and several years of experience show that buried construction using random separation should not impose problems of damage or hazard if properly designed, constructed, and maintained.

APPLICATION

- A. The most favorable conditions for the construction of joint buried plant will usually occur in relatively small areas of high residential concentration such as subdivisions and new housing developments. These conditions may also present themselves in cases where the electric utility decides to undertake a major replacement of aerial plant with buried plant in the process of rehabilitation or modification. Nevertheless, the application of joint buried plant in other rural areas should also be investigated thoroughly to determine whether economical advantages will result.
- B. The minimum separation distance requirement between the facilities should be a major factor influencing the decision to bury plant jointly. Under favorable conditions cables and wires can be plowed in separately at less cost than trenching. The fixed separation type of joint buried plant can usually be expected to demand trenching. Therefore, if a fixed separation is required by the state or local code, joint burial may not result in an economic advantage if cables may be separately plowed. If random separation is permitted, both electric and telephone cables may be plowed simultaneously.

C. Joint buried plant construction should be planned only if the electric distribution facilities have the following characteristics:

1. The system is the wye connected multi-grounded neutral type having a maximum voltage of 22,000 volts to ground.
2. The primary power cable will consist of a No. 2 AWG or larger conductor with suitable insulation and shield and having an outer covering of bare corrosion resistant low conductivity metal which forms the neutral conductor. The primary cable should be placed by direct earth burial so that the metallic neutral is in intimate contact with the earth. (Where a buried system passes through a short section of conduit, such as under a roadway, the contact with the earth may be omitted, provided the neutral conductor is continuous through the conduit.)
3. The buried secondary cable will be of ribbon, triplexed, or other cable construction which can be readily distinguished from telephone cable in the event the cables must be uncovered later.
4. Service cables will normally be of the same construction as the secondary cables.
5. The buried portion of the power distribution system should be protected by fault protection equipment capable of clearing the calculated maximum line-to-ground faults in not more than 12 cycles. The power company's use of fuses rated high enough to allow initial opening and reclosing of circuits to clear transient faults should be avoided for buried branch circuit protection.

IV. AGREEMENT BETWEEN UTILITIES

A. If the electric and telephone utilities decide to use joint buried construction, they must then agree on the conditions which shall govern the coordination and completion of the construction. These conditions should contain at least the following provisions:

1. The utilities shall locate cables, wires, transformers, pedestals, and equipment housings of their

main distribution systems as may be mutually agreed upon. Primary and secondary power cables should be readily identifiable to avoid confusing power cables with telephone cables and vice versa.

2. The utilities shall place their cables at a mutually agreed upon depth and decide on the use of separate or joint pedestal housings or vaults. Each utility is to lay its own cables, unless otherwise mutually agreed upon.
3. A mutually agreeable system of electrical bonds interconnecting the telephone shield and the power neutral should be installed and maintained. Equipment which is installed for the joint use of both utilities should be jointly owned.
4. Each utility should prepare and maintain accurate maps and records showing the location and nature of all its underground facilities. Equipment which can locate underground facilities should also be maintained by each utility.
5. The portion of the trenching or plowing cost each utility is expected to absorb, as well as who is to perform it, shall be agreed upon.
6. Each utility shall inform the other of plans for new construction, replacement, removal or repair of its facilities. In addition, it shall explain the nature and location of the proposed work so that full cooperation will be possible.
7. The utilities shall agree on which utility the warning signs shall designate to receive telephone calls concerning proposed digging. Agreement shall also be reached that the utility which receives the telephone call will inform all other appropriate utilities in this respect.

V. AGREEMENT BETWEEN BUILDER AND UTILITIES

- A. In situations where a builder (developer) is involved, the builder and utilities shall enter into a formal agreement which shall provide for the following:

1. Utilities will provide a plan showing the route along such lines and boundaries as required for placing all cables.
2. Utilities are to provide all material and installation, engineering and supervision for the installation of cables to be located on the utility easements.
3. Builder shall provide:
 - (a) Recorded easements of the widths which may be necessary;
 - (b) Semi-finished final grade for the entire length and width of easements;
 - (c) Semi-finished final grade in road or public right-of-way at cable crossing locations;
 - (d) Semi-finished final grade from the distribution pedestal to the consumer's house or foundation at such time as required to install service to the premises;
 - (e) Final grade at the location of all submersible transformer vaults.
4. Builder shall keep all easements and service routes free of debris and obstacles.
5. Builder shall reimburse the utilities for any expenses incurred for relocating its buried plant to accommodate changes in grade, relocation of easements, etc., after the initial installation.
6. Builder shall restrict all subsequent digging in the easement area to hand digging only and shall maintain stakes or adequate marking to show the location of the buried facilities for the duration of construction.

VI. DESIGN

- A. The design of telephone and power distribution systems intended for joint construction is similar to the design of separate buried systems. In joint plant, however, the location of distribution plant and distribution pedestals must meet the requirements of both utilities.

1. The proposed route should be planned so that it will be reasonably free from future excavations which might subject the cables within the trench to mechanical injury.
2. Ten foot easements will normally be adequate for joint buried plant construction. Locating the cable route within one-half of this easement normally results in sufficient space being provided for cable placement. Pedestals should be installed a minimum of 18 inches from lot lines in situations where fences may be erected later. Figure 3 shows the typical position of the main trench, transformer pad or vault and utility pedestal.

The design of joint buried plant requires that a decision be made on whether the distribution cables will be located along the front or rear of the lots. In the past, the rear lot line was selected for the location of underground power facilities because of the unsightly appearance of pad-mounted transformers and above-grade pedestals. Also, the rear lot line location is attractive as a means of reducing conflict with gas, water and sewer lines which customarily enter the lot from the front. On the other hand, the rear lot line location can present maintenance problems. Transformers must be accessible to vehicles with lifting equipment to permit transformer replacement or other operations. In many cases, this accessibility will not be convenient or practicable after houses are occupied, lots have been landscaped, and other construction such as fences and patios have been added. With the present availability of submersible transformers and below-grade pedestals and handholes, front lot line routing need not present an objectionable appearance. The selection of front or rear lot construction should be based upon ease of construction and maintenance, economy and appearance.

1. Service pedestals will normally be located at the same lot line for both electric and telephone services. Placement of a pedestal adjacent to every other lot line is considered to be the most efficient method of pedestal arrangement in meeting the requirements of the telephone company and the power company. Usually, this permits serving two lots on each side of the easement, or a total of four lots. Figures 4 through 7 illustrate some typical service arrangements. Other variations may be necessary depending upon the type and size of the subdivision, and the shape of the lots.

2. A combination type buried cable terminal housing (Figure 8) is very helpful in effecting close coordination and may be used where both electric and telephone services terminate at the same location. This combination type pedestal consists of a common stake with separate electric and telephone terminal compartments mounted back-to-back. The stake also serves as a common bonding point for the neutral of the electric service and the shield of the telephone cable. It should be placed by either the electric or telephone company; whichever installs the cable. The two terminal compartments should face perpendicular to the trench. For the sake of uniformity, a pattern for terminal facing should be established by the utilities.

C. Sizing

Sizing of telephone cables and wires for joint buried plant should be based on providing at least 1.5 pairs per lot for low and medium-priced homes. If high-priced homes will be served, 2 pairs for each lot should be considered.

D. Telephone Transmission

Joint buried plant should present no unusual transmission problems in areas where (1) the buried exposure length is $\frac{1}{2}$ mile or less, and/or (2) the waveform is relatively free of harmonics. Transmission design procedures followed in the design of separate buried plant are applicable to the design of joint buried plant and should be observed.

E. Protection

1. The shields of all telephone cables and service wires should be bonded to the pedestal frame or grounding connector at all pedestals.
2. The metallic shield of the telephone cable shall also be bonded to the power cable's multi-grounded neutral at every transformer location or every 1000 feet, whichever results in the greatest number of bonds. This may be accomplished on the common grounding stud at joint terminal housings. If separate pedestals are used, an insulated No. 6 AWG or larger copper conductor shall be buried between the telephone pedestal and the transformer housing to interconnect the telephone shield to the primary neutral.

3. At each transformer installation, all grounds shall be interconnected. These include primary neutral, secondary neutral and shield of the telephone cable. The telephone cable shield may be bonded to the primary neutral through the secondary neutral.
4. At each service entrance all neutral and ground conductors, the power ground electrode, and the metallic enclosures shall be interconnected. The power ground electrode shall comply with the requirements of the National Electrical Code (NEC) with respect to grounding to a metallic underground water piping system. The water system shall be included in the common ground system regardless of the length of the water pipe. If a water piping system having a buried metallic length of 10 or more feet is not available, one or more of the alternate grounding electrodes recognized by the NEC shall be utilized.
5. At each service entrance, the shield of the telephone cable or wire should be connected to the ground post of a fuseless station protector and the telephone protector grounding conductor should be interconnected with the power service grounding conductor or ground electrode. Other details of the station protector installation and method of grounding should be in accordance with TE & CM Sections 701 and 805.
6. At crossings, power facilities should be installed below telephone facilities.

VII. CONSTRUCTION

- A. In order to realize potential construction economies and to minimize future maintenance problems in random separation applications, complete coordination between the telephone utility, the power utility, and the developer is necessary. Therefore, the appropriate representatives of each of these parties should meet to establish a set of general rules and conditions to be used as a guide in coordinating the design and construction of the joint buried plant. Afterwards, these rules and conditions as well as any other arrangement and negotiations should be discussed with the builder and other pertinent parties. A thorough understanding of all factors concerning the proposed construction should be acknowledged by all parties before construction is started.

B. In all plowing and trenching operations it is always essential to obtain permits from the proper authorities before starting any plowing or trenching. In addition, property owners must be contacted for the required easements wherever the wire or cable crosses private property.

1. The company which will provide the trench shall make such field inspections, with the service date in mind, as are necessary to formulate plans for doing the work. In formulating these plans, the requirements of both companies, as indicated on work plans, must be considered. Where practicable, the work should be planned and timed so that all open trenches will be backfilled each day.

C. Final grades must be determined before the job is started. Therefore, several days prior to the cable installation date the construction forces providing the trenching should determine if the terrain is clear and reasonably close to the finished grade. If not, the person responsible for coordinating this work should make arrangements with the contractor or developer to bring the area involved to semi-finished final grade.

D. Unless otherwise specified by the companies involved and approved by the appropriate regulatory authority, the width of the main trenches and the service trenches shall be a minimum of four inches (4")* except where plowing is performed. The depths measured from final grade to the bottom of the trenches shall be as follows (refer to Figures 3 and 9):

Main trench	30" minimum**
Service trench	24" minimum**

*The necessity for backfilling the trench and compacting of the backfill should be considered in determining the width of the trench to be opened. Therefore, a trench wider than four inches (4") may be advisable.

**36" minimum for non-random vertical separation so that a 24" cover will be provided for the telephone cable.

E. The cost for burial of service wires can affect to a large degree the total cost of joint buried construction. Therefore, plowing in of services should be studied from a comparative cost standpoint even if trenching is necessary for the distribution and feeder cables (refer to Figure 10).

Note: Telephone construction costs have been used in the example because of the limited knowledge and experience with the costs for direct placement of power cables in separate or joint burial applications.

- F. The speed with which plowing or trenching is performed greatly affects the overall construction cost. Therefore, the plow or trencher which best meets the requirements for the proposed construction should be employed. Optimum construction conditions will prevail when maximum digging speed is obtained and cable placing and backfilling operations are kept abreast of the trenching progress with minimum lengths of open trench. The speed at which the cable can be placed is governed only by the speed of the trencher. A minimum of earth should be moved consistent with the trench width and depth requirements and it is important to use a trencher that will trench at maximum speed for the prevailing soil conditions.
- G. In measuring and placing cables in the trench, allowance should be made for loops, including the telephone company's bonding conductor, at pedestals, splice closures, transformers, and other locations.
- H. Augering and Pipe Pushing
 - 1. Augering and pipe pushing should be performed before the installation date for the cables and wires to avoid delaying placement of these facilities during construction.
 - 2. Cables and wires will normally be pulled through a single opening. It should be large enough to accommodate the facilities of both utilities without undue pressure being placed on the cables and wires. Otherwise, separate openings should be provided.

VIII. RECORDS

- A. Accurate, up-to-date records are very important for the maintenance and possible expansion of joint buried plant.
- B. The final location of buried cables and wires should be marked and recorded on the staking sheets and maps and each utility should have a complete copy. Maps should be prepared to show the location of all primary, secondary, and service circuits. The location of all splices and other buried utilities should also be indicated on the maps. In addition, the depth of all cable should be shown and joint-use trenches identified.

- C. A small plot plan should be prepared after the cable is placed and be made available to each property owner. The plan or map should show the exact location of the cables and carry a clear warning against digging nearby. A suitable warning tag should be attached to the service entrance equipment where possible. Some form of permanent marker, as shown in Figure 11, should be placed on a steel stake adjacent to the trench at appropriate points to agree with map data.

IX. MAINTENANCE

A. Routine Maintenance and Extensions

The utility performing the excavating (digging, trenching) shall give the other utility adequate advance notice to permit the undertaking of any necessary precautionary measures.

1. It shall be the responsibility of each utility to locate, identify and mark its own facilities. The facilities should also be indicated on the construction plans with such warnings as may be appropriate and mutually acceptable.
2. Except where 12" vertical separation is maintained, no digging to uncover existing facilities shall be done until the power cable has been de-energized. De-energizing the power cable shall be done by the power utility only.
3. If work is to be done on the telephone cable, the power cable may be re-energized (if mutually agreed upon) after the electric utility has exposed and separated the cables and such protection as the telephone company deems necessary has been provided. In such cases the electric utility will re-energize its cable only after clearance from the telephone representative in charge of the operation.
4. If 12" vertical separation is maintained and no power fault is involved, the telephone company may uncover its own cable.
5. No backfilling should be done until agreed upon by both utilities.

B. Unscheduled Outage or Emergency

1. Whichever utility experiences the outage should notify the other. If cable is to be uncovered, both utilities can

use the opportunity to inspect their cable regardless of which utility had the outage.

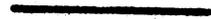
2. Except where 12" vertical separation is maintained, the power company shall de-energize and excavate the cable.
3. If a power cable fault is involved, the electric utility should repair its cable first.
4. After the electric cable has been repaired it may be re-energized (if mutually agreeable) and the electric utility will then be responsible for providing whatever separation and protection between the electric and telephone cables that the telephone company needs so that the telephone cable may be inspected or repaired.
5. No backfilling should be done until agreed upon by both utilities.

X. PRECAUTIONS

- A. Existing cables should be uncovered by hand digging. Hand digging tools should have handles made of wood or material of comparable insulating value. Extreme care should be used during digging in order to avoid penetrating or otherwise damaging the insulation of cables.
- B. Digging bars should never be used in the vicinity of buried cables. If digging conditions are encountered which require tools other than a shovel, a wooden handled pick or similar tool with comparable insulating value should be used.
- C. Power digging equipment should be used for extensions only in the direction away from buried cables.
- D. If existing facilities cannot be accurately identified by appearance after exposure, they should be identified electrically through the use of approved test sets.
- E. After the cables have been identified, the electric utility representatives on the job should place electrical and mechanical protection over the electric cables.

SYMBOLS

Telephone Distribution Cable
and Telephone Service Wire



Primary Power Cable



Secondary Power Cable



Telephone Pedestal



Power Pedestal



Joint (Telephone and Power) Pedestal



Power Transformer (Pad Mount or Submersible)



Power Transformer with Power
and Telephone Terminal Housings



Easement Line

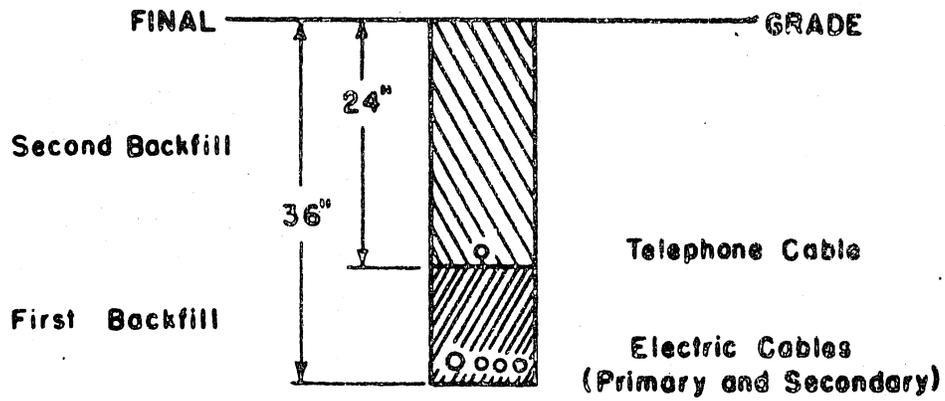


Lot Line

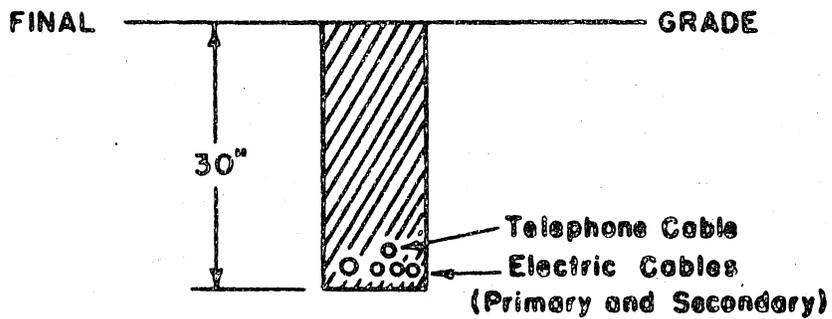


FIGURE 1

CABLE SPACING



FIXED SEPARATION



RANDOM SEPARATION

FIGURE 2

TRANSFORMER AND PEDESTAL LOCATION

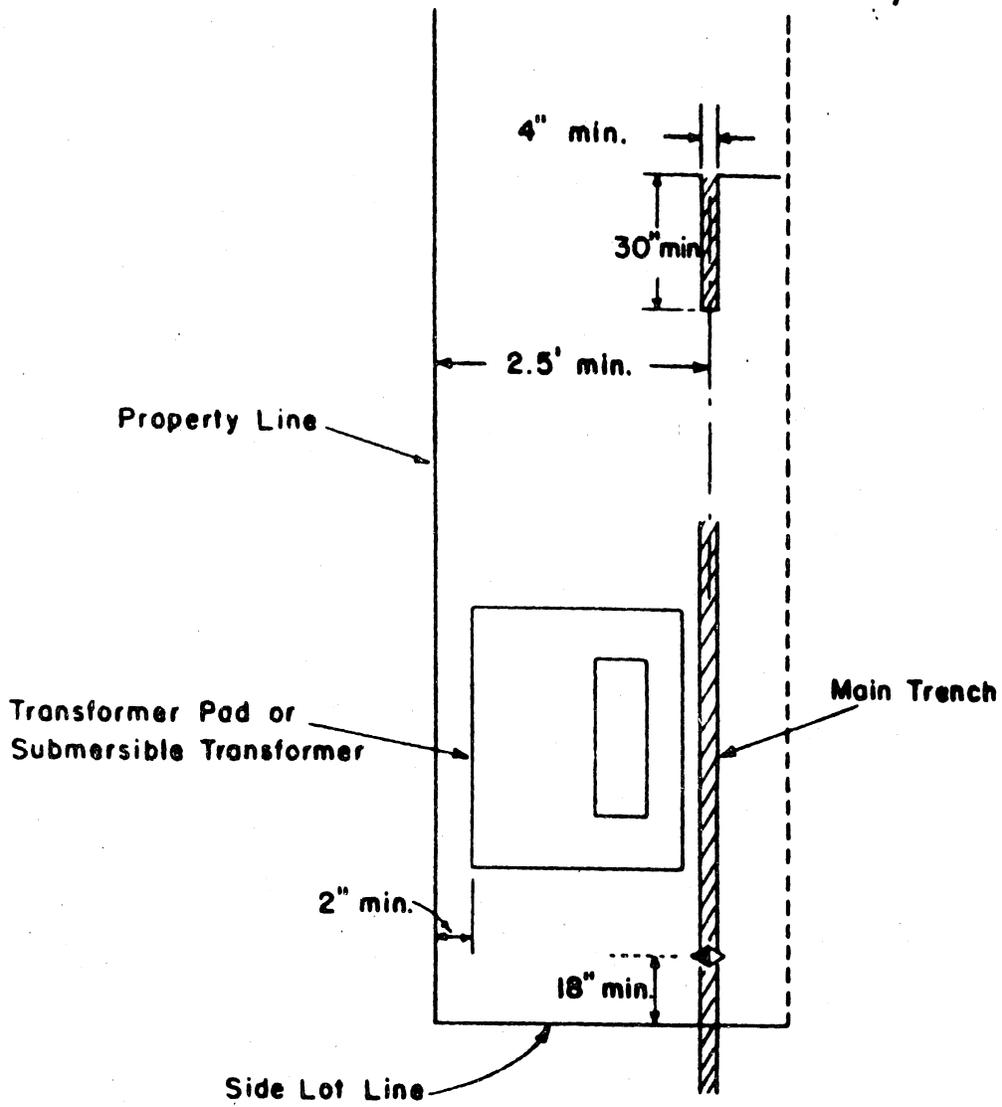
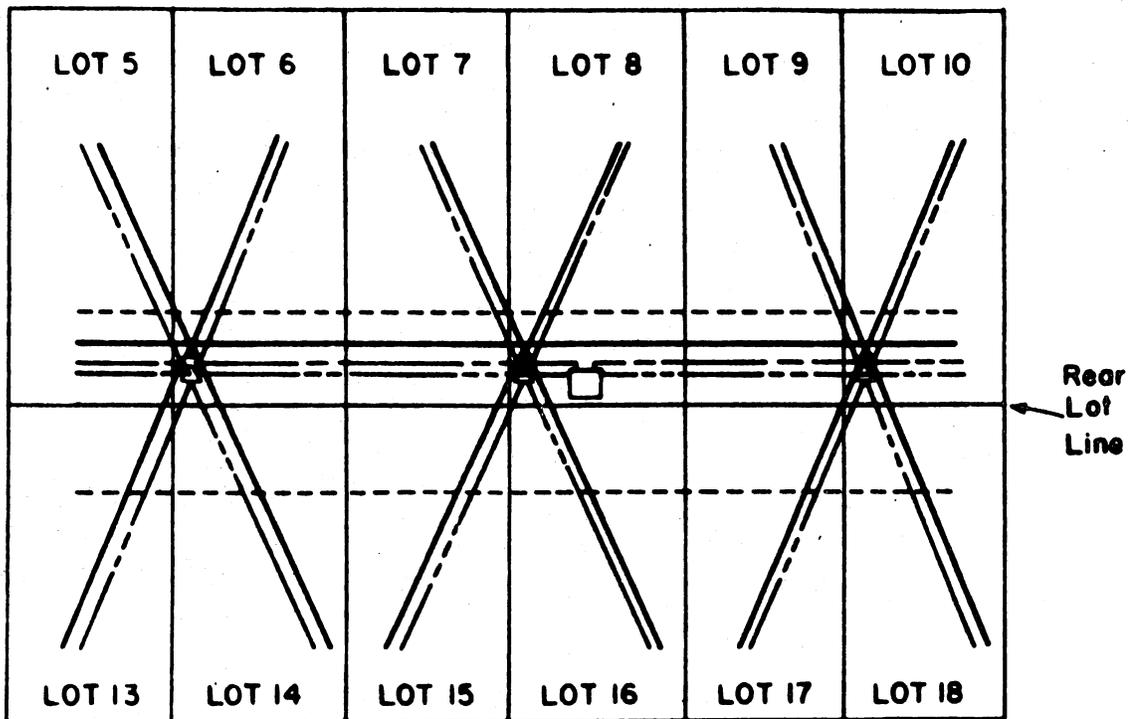


FIGURE 3

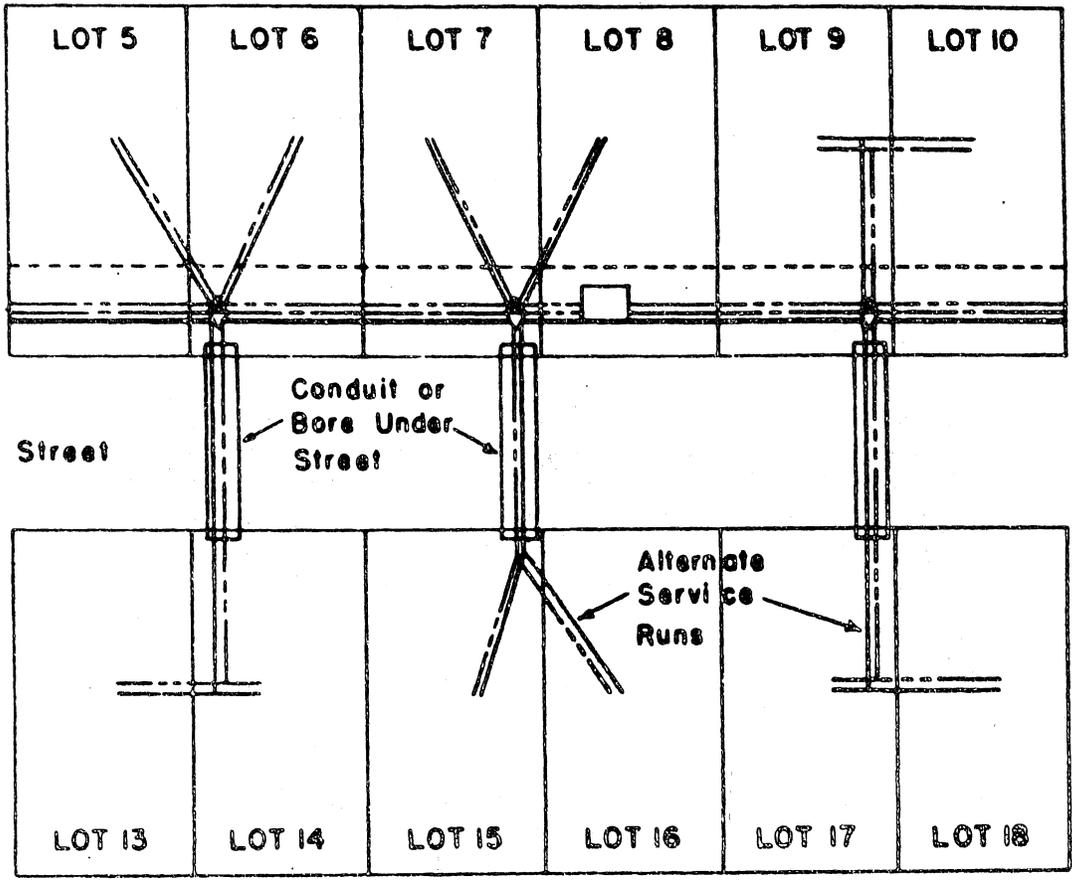
**PEDESTAL LOCATION
COMMON TRENCH
FIXED SEPARATION**



Service From Rear Lot Line

FIGURE 4

**PEDESTAL LOCATION
COMMON TRENCH
RANDOM SEPARATION**

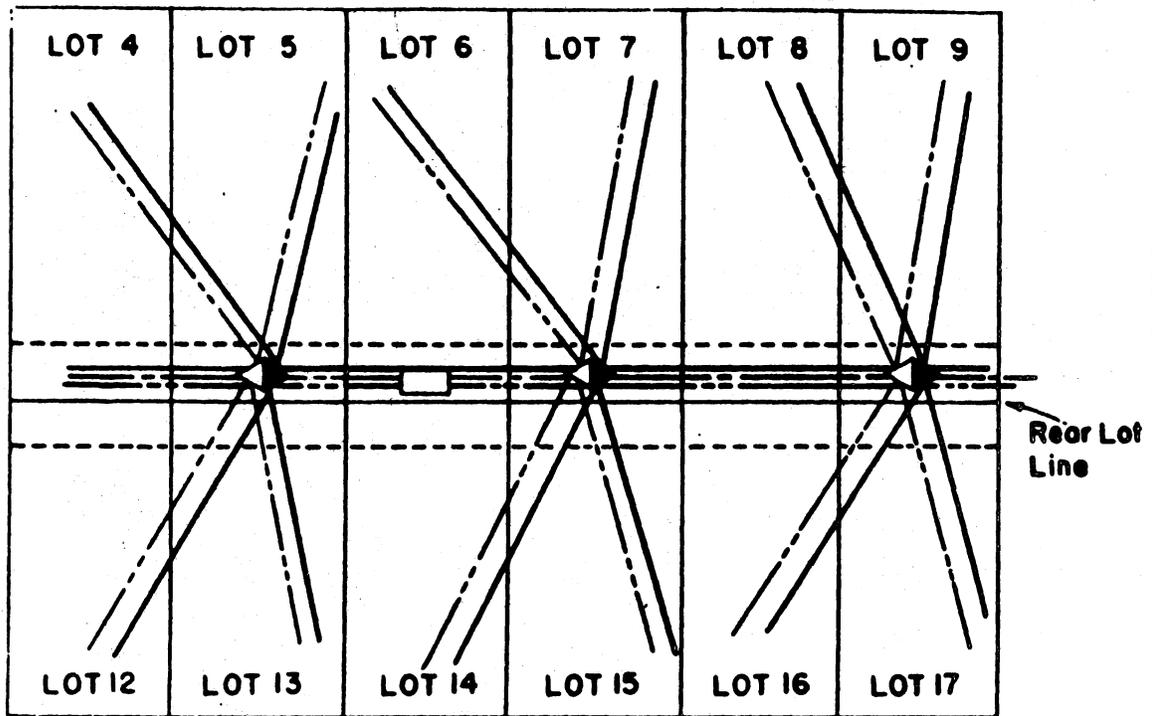


Service from Front Lot Line

Note: Pedestals would be separated for fixed separation.

FIGURE 5

**PEDESTAL LOCATION
RANDOM SEPARATION**



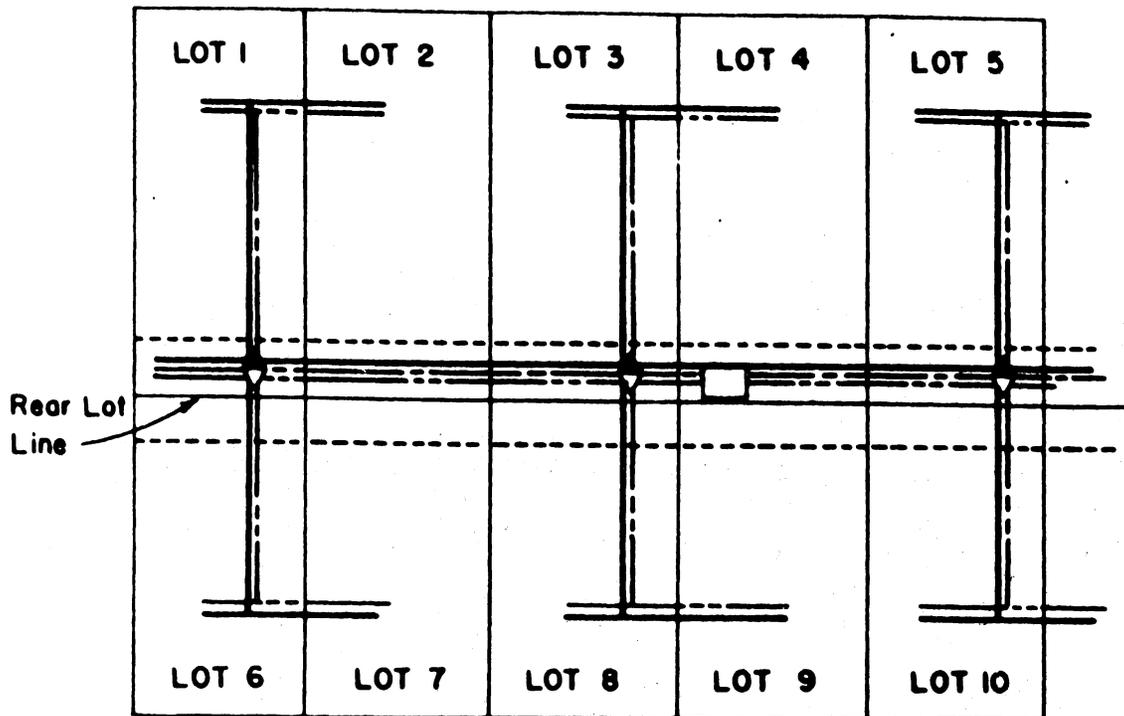
Service from Rear Lot Line

**Notes: Cables shown at separation for clarity.
Lot line crossings should occur within easements if possible.**

FIGURE 6

PEDESTAL LOCATION

RANDOM SEPARATION



Service From Side Lot Line

Note: Cables shown at separation
for clarity.

FIGURE 7

**COMMON PEDESTAL
RANDOM SEPARATION**

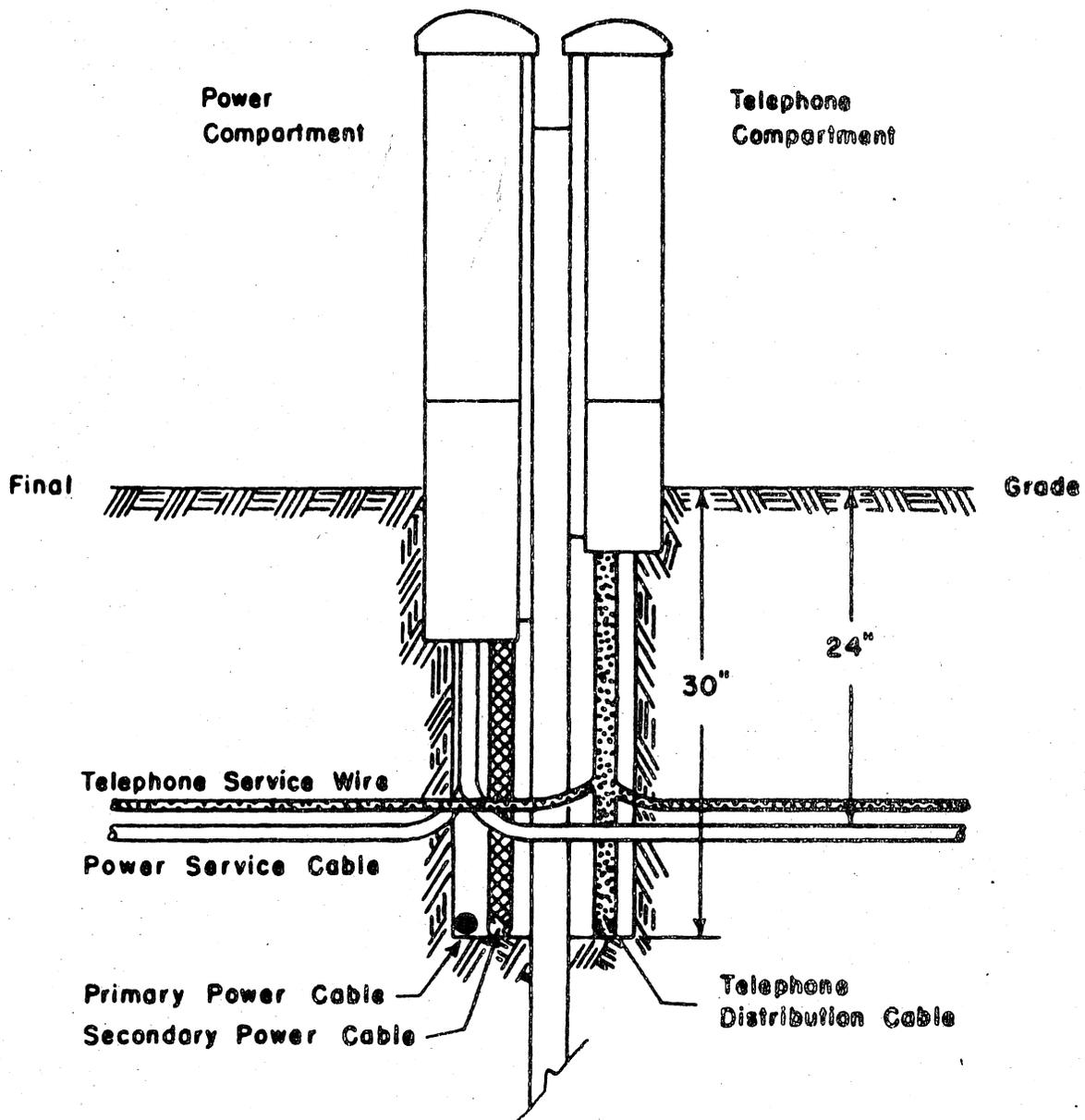


FIGURE 8

LOCATION OF SERVICE TRENCHES AND PEDESTALS

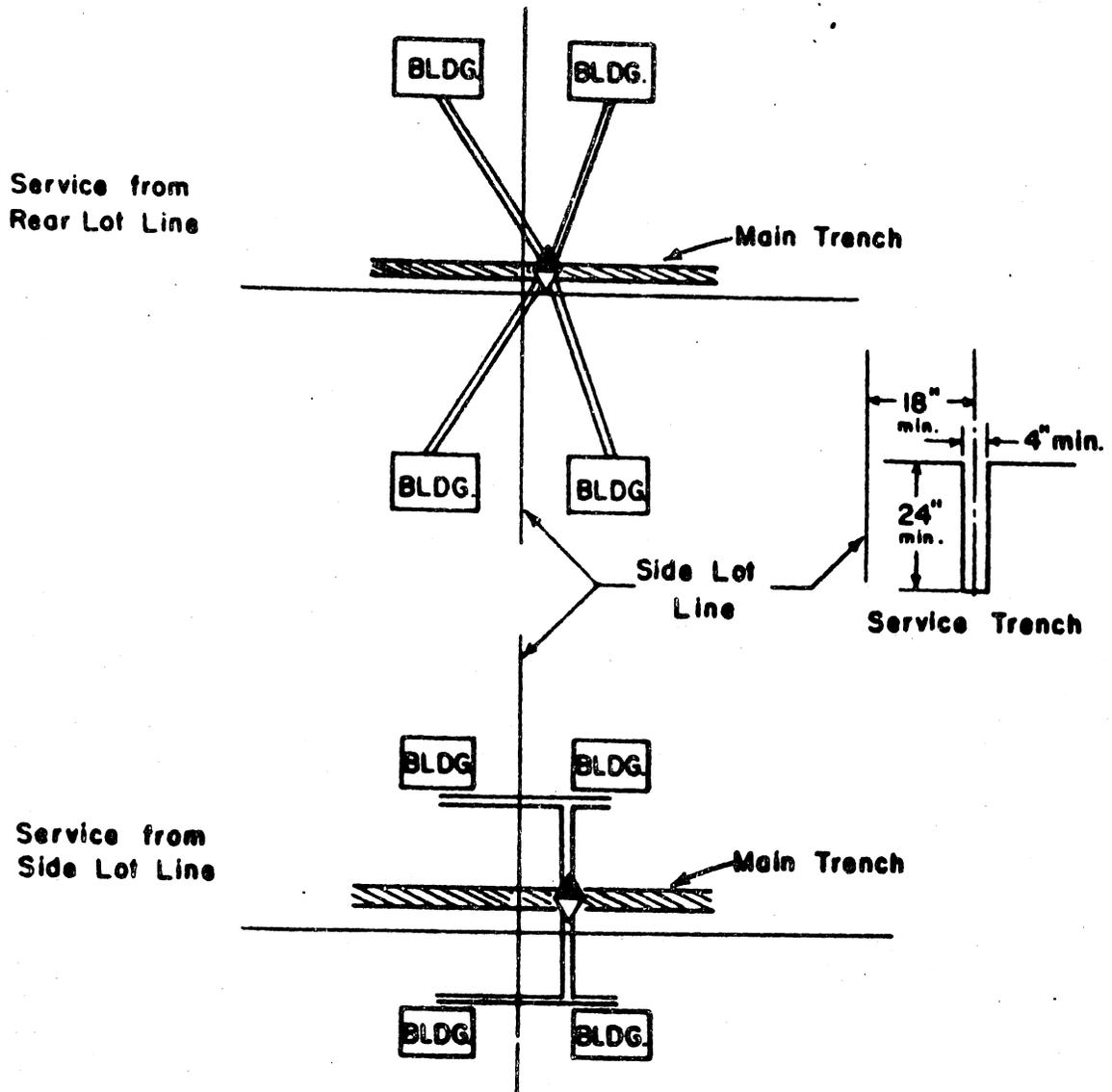
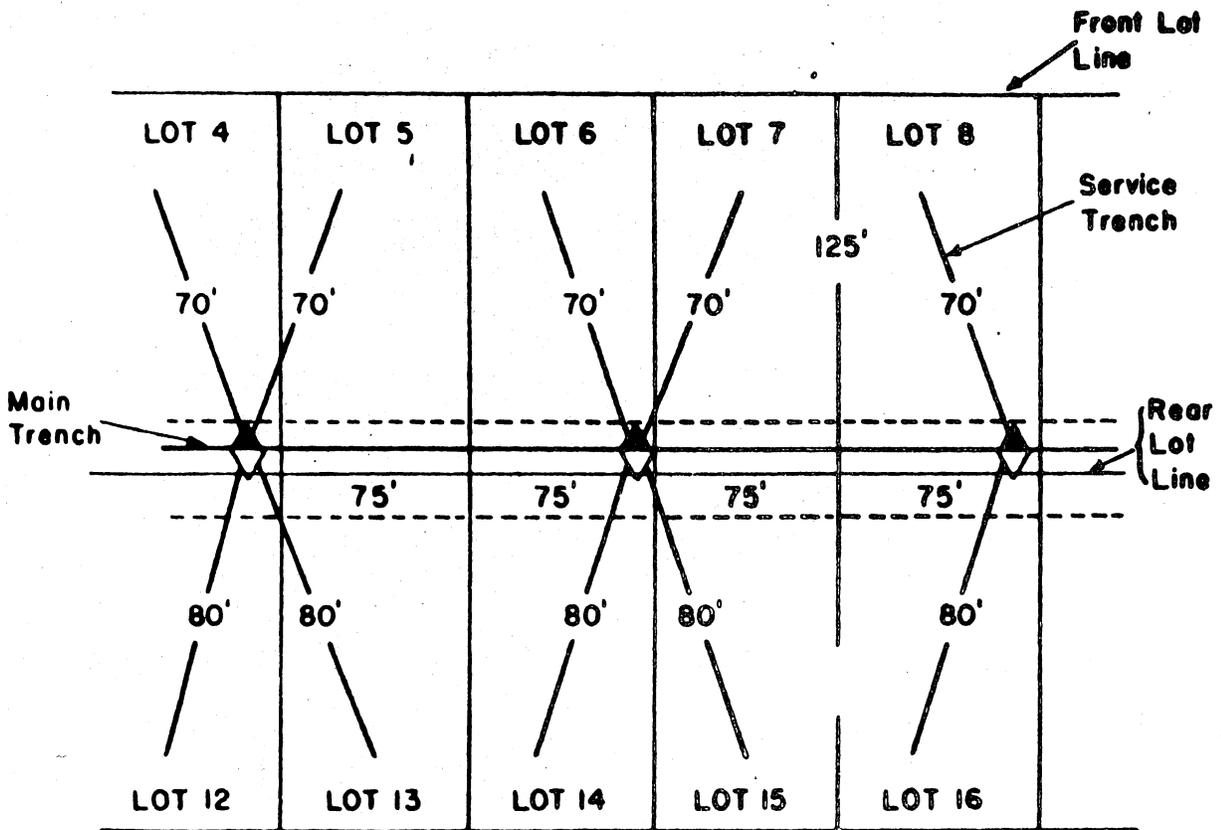


FIGURE 9

**PLOWING vs TRENCHING
COST COMPARISON**



EXAMPLE

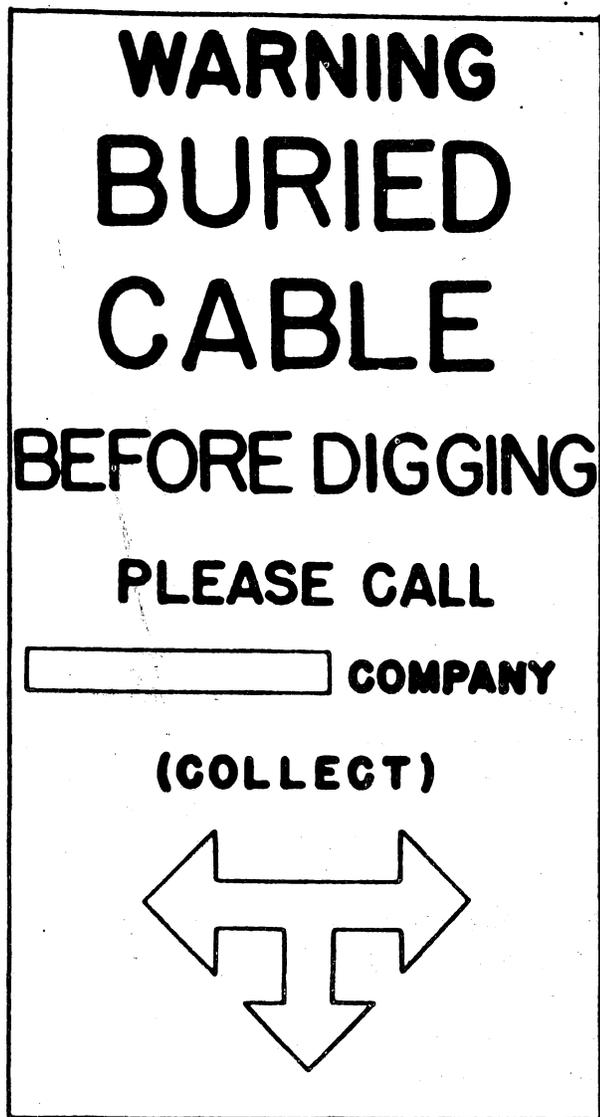
The above sketch is the result of adding arbitrary values to Figure 6, and will be assumed to typify part of a sub-division. Each of the ten lots shown is 125 feet by 75 feet.

The total length of main trench between the farthestmost pedestals is 300 feet, and the combined length of buried services is 750 feet.

Trenching (approximately 25 cents per foot) costs about six times as much as plowing (approximately 4 cents per foot).

A saving of 21 cents per foot of service or \$189.00 for the 10 lots can be realized by plowing - in the services.

FIGURE 10



**Note: Appropriate utility should be inserted before "COMPANY".
Telephone number may also be shown.**

FIGURE II