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Underground Cable Trenches – Construction Practices

The following memo has been prepared to document the methodology employed to install the electrical collection system at the Wild Horse Wind Project. It includes a description of the process, a graphic depiction of the typical installation and a photo array of current implementation of these procedures showing the outcome.

This memo serves to provide a series of practicable alternative approaches for the remaining trench system installation which will allow an acceptable schedule and cost outcome for the construction effort while meeting the project goals of minimizing negative impacts to the local environment. The soil conditions at the site are highly variable, ranging to solid basalt outcroppings to deep soil. The variability requires a flexible approach with a number of processes utilized to achieve the goal of a trench which can accommodate the design criteria. Accordingly, there is no single solution to the problem statement. By providing several processes which are individually suitable to achieve the desired ends in specific conditions, the trenching can be done in an efficient, workmanlike manner.

Two basic factors drive the chosen approach to trench installation, the capabilities and limitations of the trenching equipment and the soil conditions. The first, the equipment limitations are the result of the high center of gravity of the trencher and the inability to slew the toothed digging belt. That is, if the machine is tilted to the side, the resulting trench will also be tilted. The unacceptable trench configuration and the safety of the equipment means the operating trencher should have as level and smooth a surface as possible. If the surface is naturally level and reasonably even, the need to scrape the surface is unnecessary. However, if large cobbles or an inclined surface is encountered, it will be necessary to blade off the surface to provide a suitable workplace. The decision to level the surface with a blade is an ad hoc process based on the operator's expertise and the characteristics of the machine. The incentives to avoid the additional work and time will favor opting out of the blading process whenever possible.

The desired outcome of the trench installation and restoration is to provide a surface which appears as reasonably similar as possible to the undisturbed surface in the vicinity of the trench route. By following the process outlined in this document, the organic materials (compost, seeds, plant material, etc.) will be retained and placed on the surface of the completed installation to the greatest extent possible using good construction practice.

The following four scenarios cover most of the conditions encountered. The process of completing the trench installation, filling, cover and finish have been developed by reviewing the contract specifications, discussing the process with the various contractors involved and through personal observation. The various processes have been distilled to the following:

1. Single Trench at Roadside:

- a. Soft soil – the trenching operation will be as follows:
 - i. Surface evaluated as sufficiently level or bladed off 3-6 inches to provide secure, level surface for trencher to run on. Spoil from dozer is windrowed on side opposite to shoulder of road.
 - ii. Trencher runs down prepared surface, full depth, spoil on side opposite to shoulder of road in windrow.
 - iii. Thermo fill bedding, cables, thermo fill cover installed
 - iv. Windrowed topsoil and trench spoil bladed back into trench and compacted. Trench spoil precedes topsoil into trench.
 - v. Excess topsoil mix spread into low mound over trench.
- b. Rocky soil – the trenching operation will be as follows:
 - i. Surface evaluated as sufficiently level or bladed off 3-6 inches to provide secure, level surface for trencher to run on. Spoil from dozer is windrowed on side opposite to shoulder of road.
 - ii. Trencher runs down prepared surface, full depth, spoil on side opposite to shoulder of road in windrow.
 - iii. Thermo fill bedding, cables, thermo fill cover installed
 - iv. Windrowed topsoil and trench spoil bladed back into trench and compacted. Trench spoil precedes topsoil into trench.
 - v. Excess spoil spread on trench array in a low crown.
- c. Very rocky/solid rock - the trenching operation will be as follows:
 - i. Surface drilled for blasting process
 - ii. Trench line blasted
 - iii. Trench cleared with track hoe; spoil placed on side opposite to shoulder of road
 - iv. Trench completed as in 1.b.iii - iv (Above).
 - v. Excess large rock spoil hauled to disposal.

2. Multiple Trenches at Roadside

- a. Soft soil – the trenching operation will be as follows:
 - i. Surface evaluated as sufficiently level or bladed off 3-6 inches to provide secure, level surface for trencher to run on. Spoil from dozer is windrowed on side opposite to shoulder of road.
 - ii. 1st Trench: Trencher runs down surface, full depth, spoil windrowed on side opposite to shoulder of road.
 - iii. Trench completed as in 1a.iii. - v. (Above).
 - iv. 2nd Trench: Surface evaluated as sufficiently level of bladed off 3-6 inches as above. Spoil from dozer in windrow on side of previous trench.
 - v. Trencher runs down surface, full depth, spoil windrowed on side of 1st Trench.
 - vi. Trench completed as in 1a.iii. - v. (Above).
 - vii. 3rd Trench (and continuing): Surface evaluated as sufficiently level of bladed off 3-6 inches as above. Spoil from dozer in windrow on side of previous trench.
 - viii. Trencher runs down surface, full depth, spoil windrowed on side of previous trench.
 - ix. Trench completed as in 1a.iii. - v. (Above).

- x. Excess soil spread on trench array in a low crown.
 - b. Rocky soil – the trenching operation will be as follows:
 - i. Surface evaluated as sufficiently level or bladed off 3-6 inches to provide secure, level surface for trencher to run on. Spoil from dozer is windrowed on side opposite to shoulder of road.
 - ii. Trencher runs down surface, full depth, spoil in windrow on side opposite of shoulder of road.
 - iii. Trench completed as in 1b.iii. - v. (Above).
 - iv. 2nd Trench: Surface evaluated as sufficiently level or bladed off 3-6 inches to provide secure, level surface for trencher to run on. Spoil from dozer is windrowed on side of previous trench.
 - v. Trencher runs down surface, full depth, spoil on side of 1st Trench.
 - vi. Trench completed as in 1b.iii. - v. (Above). Note: excess spoil disposal deferred until array complete.
 - vii. 3rd Trench (and continuing): Surface evaluated as sufficiently level or bladed off 3-6 inches to provide secure, level surface for trencher to run on. Spoil from dozer is windrowed on side of previous trench.
 - viii. Trencher runs down surface, full depth, spoil on top of previous trench.
 - ix. Trench completed as in 1b.iii. - v. (Above).
 - x. Excess spoil spread on trench array in a low crown.
 - c. Very rocky/solid rock - the trenching operation will be as follows:
 - i. 1st Trench: Surface drilled for blasting process
 - ii. Trench line blasted
 - iii. Trench cleared with track hoe; spoil placed on side opposite shoulder of road.
 - iv. Trench array completed as in 2.b.iii - .ix (Above).
 - v. After trench array covered, excess large rock spoil hauled to disposal.
- 3. Single Trench in field**
- a. Soft soil - the trenching operation will be as follows:
 - i. Trenching operation will be as in 1a (Above) with the exception that since there is no adjacent road, access and spoil pile handling will be closely monitored to minimize disturbance.
 - b. Rocky soil - the trenching operation will be as follows:
 - i. Trenching operation will be as in 1b (Above) with the exception that since there is no adjacent road, surface preparation, access and spoil pile handling will be closely monitored to minimize disturbance.
 - c. Very rocky/solid rock - the trenching operation will be as follows:
 - i. Trenching operation will be as in 1c (Above) with the exception that since there is no adjacent road, surface preparation, access and spoil pile handling will be closely monitored to minimize disturbance.
- 4. Multiple Trenches in Field**
- a. Soft soil - the trenching operation will be as follows:
 - i. Trenching operation will be as in 2a (Above) with the exception that since there is no adjacent road, access and spoil pile handling will be closely monitored to minimize disturbance.

- b. Rocky soil - the trenching operation will be as follows:
 - i. Trenching operation will be as in 2b (Above) with the exception that since there is no adjacent road, surface preparation, access and spoil pile handling will be closely monitored to minimize disturbance.
- c. Very rocky/solid rock - the trenching operation will be as follows:
 - i. Trenching operation will be as in 2c (Above) with the exception that since there is no adjacent road, surface preparation, access and spoil pile handling will be closely monitored to minimize disturbance.

At the conclusion of the various trench installation alternatives, the surface should be as follows:

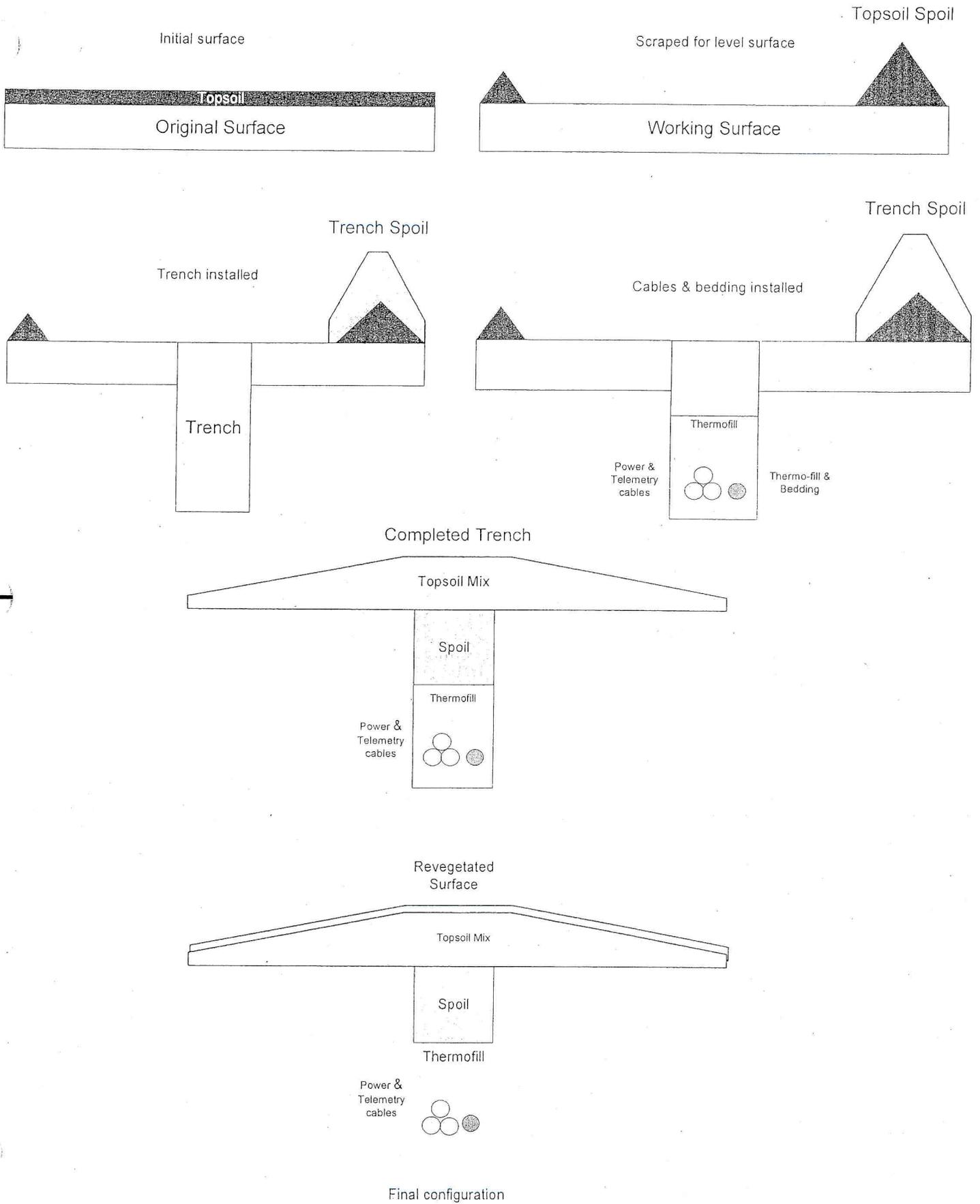
1. Soft soil: The surface should be relatively smooth and slightly crowned. The surface should be ready for direct application of revegetation.
2. Rocky Soil: The surface should be relatively smooth and crowned with surface rocks similar to the undisturbed terrain. It should be ready for direct application of revegetation in most places. If rocky surface deemed to have too little topsoil, the application of stockpiled topsoil will be instituted.
3. Very rocky/solid rock: The surface should be relatively even with no apparent residual rock piles. It should be ready for application of layer of topsoil to facilitate revegetation in a pattern which replicates natural surface appearance.

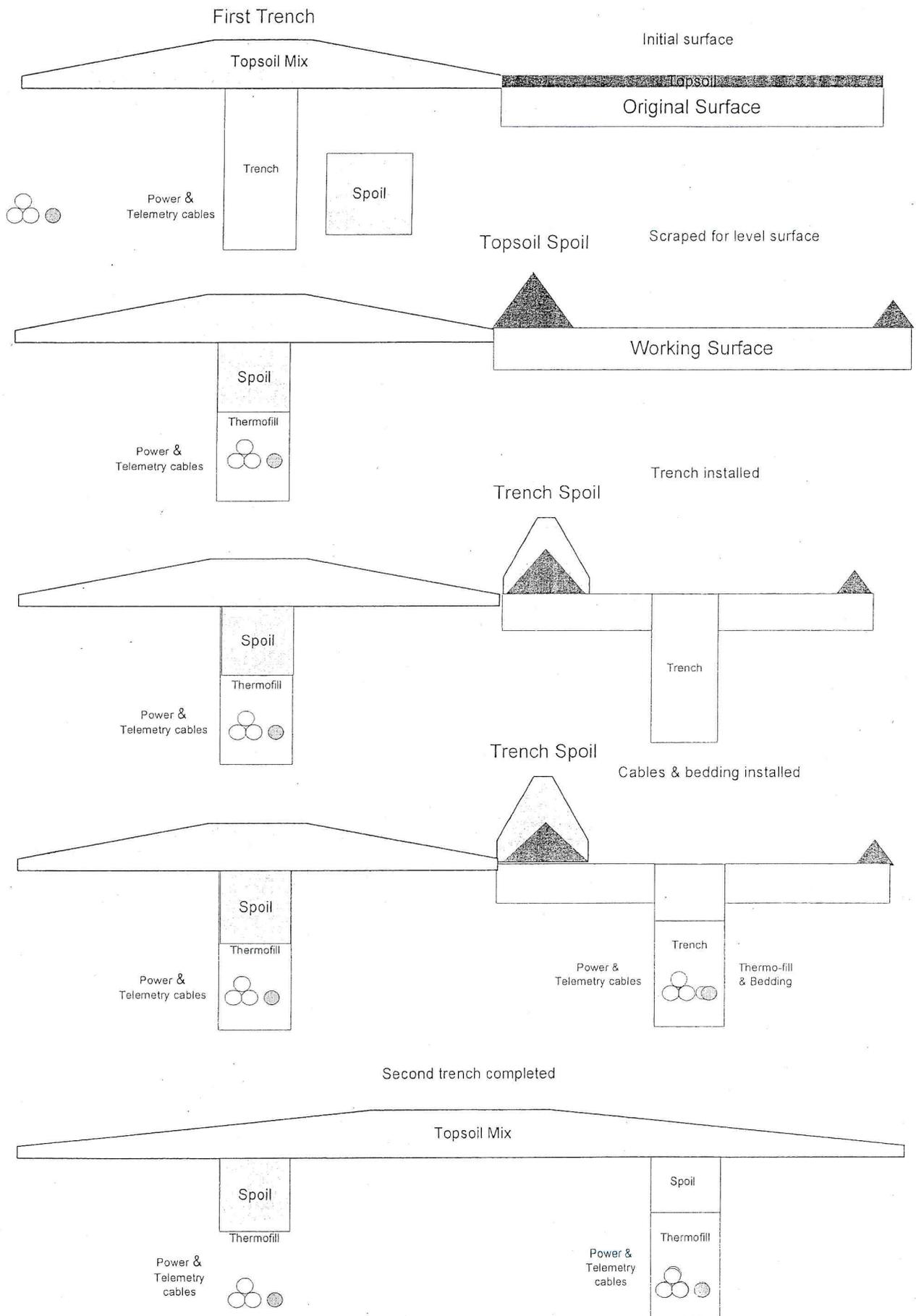
To further illustrate and document this process, please refer to the attached sketches and photo array.

This effort has endeavored to provide information defining the process which accomplishes the goal of a natural appearance completed within the existing contractor's specifications, equipment and expertise. As in standard, accepted construction practice any abnormal or otherwise unexpected conditions encountered will be dealt with utilizing these procedures as a guideline to achieve the desired outcome.

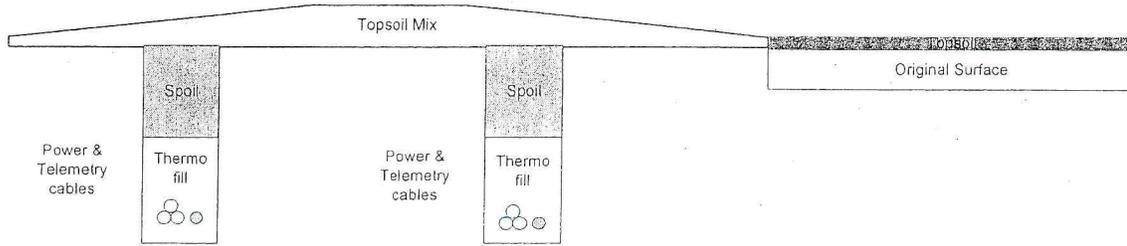
Trenching

Basic Trench Installation Sequence

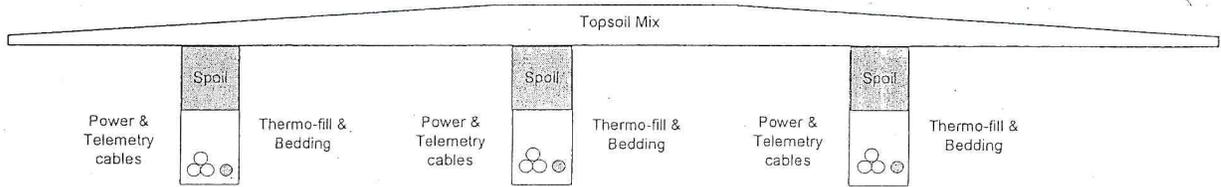




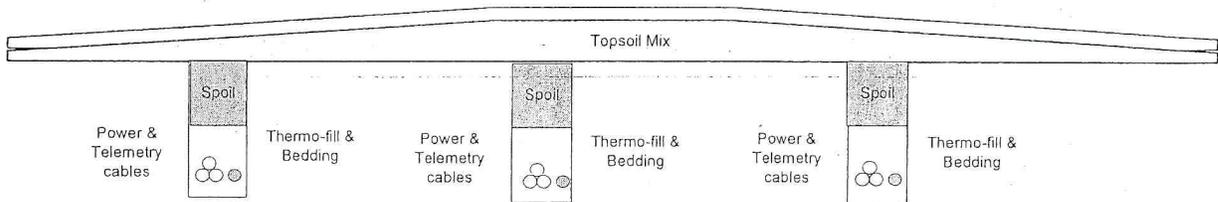
Preparation for Third (and continuing) Trench



Third Trench Completed

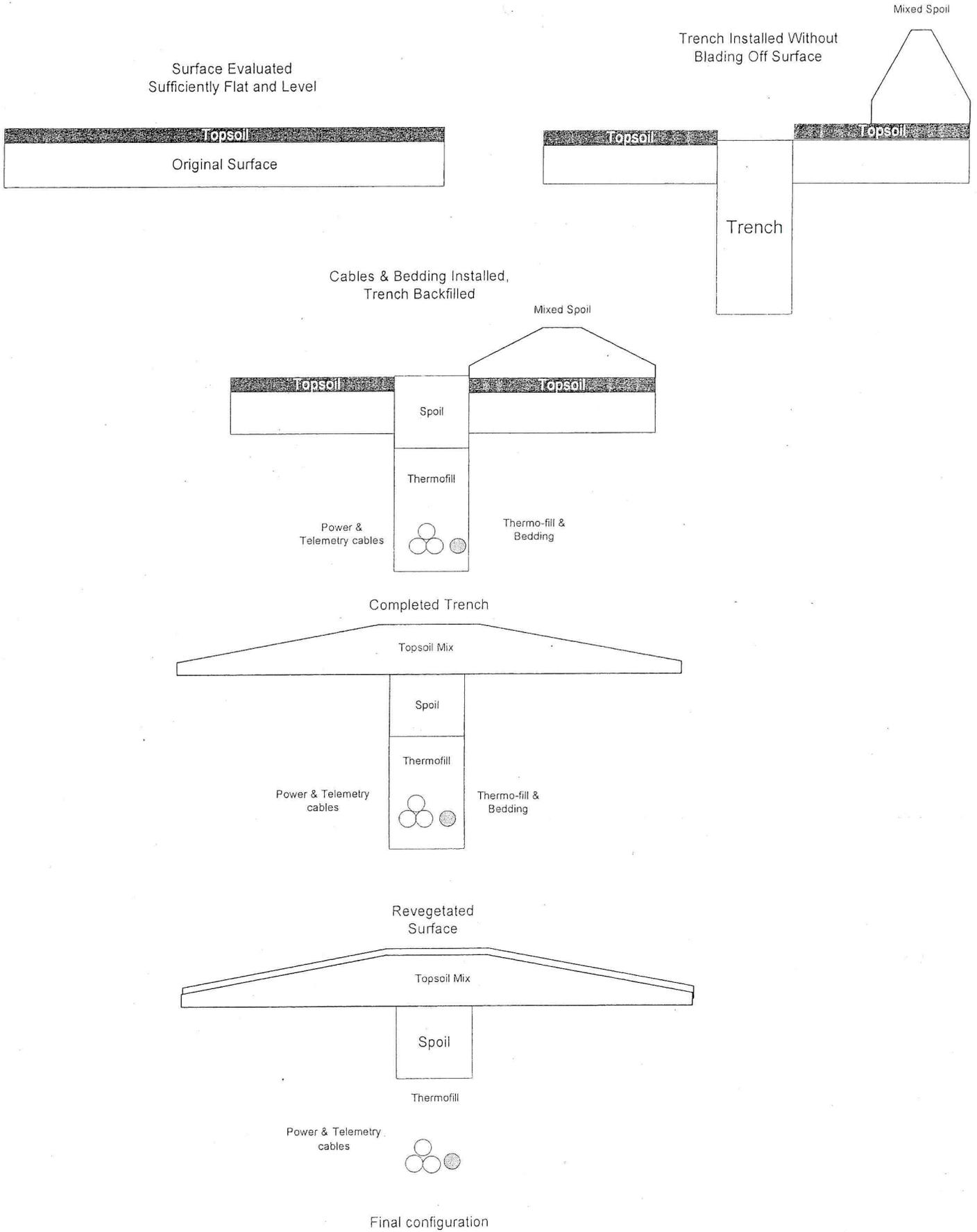


Vegetation Completed



Trenching

Trench installation Process where Surface is Evaluated to be Sufficiently Flat & Level



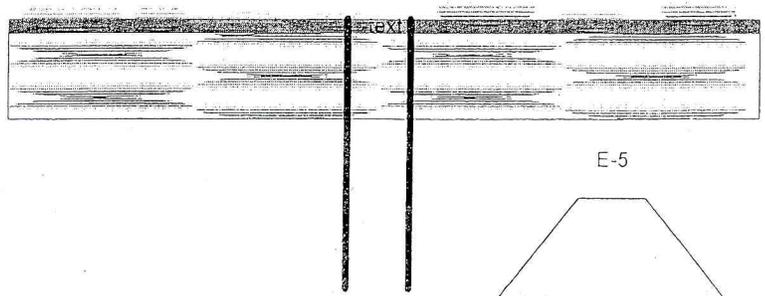
Trench Installation Process with Rocky Soil Requiring Blasting

Trenching

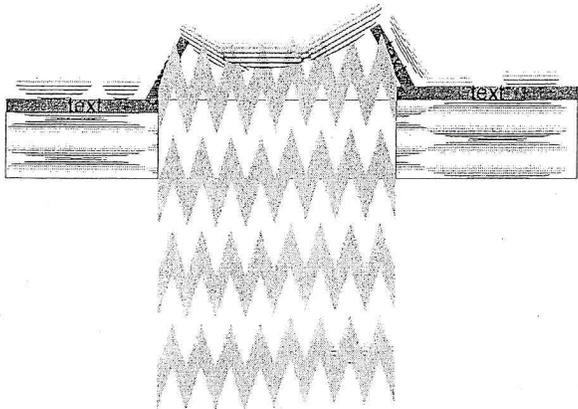
Original Surface



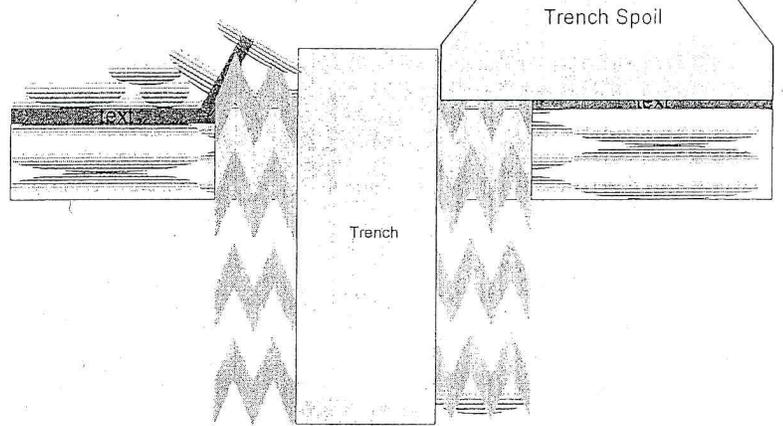
Drilled For Blasting



Blast Fractured Rock

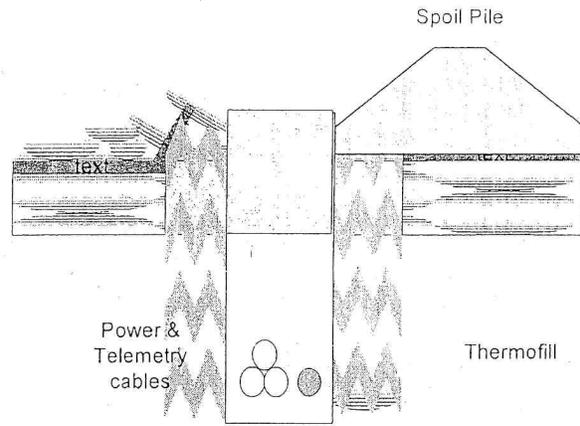
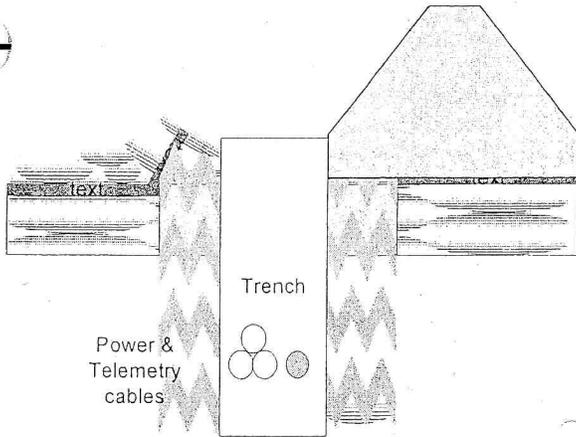


E-5



Spoil Pile

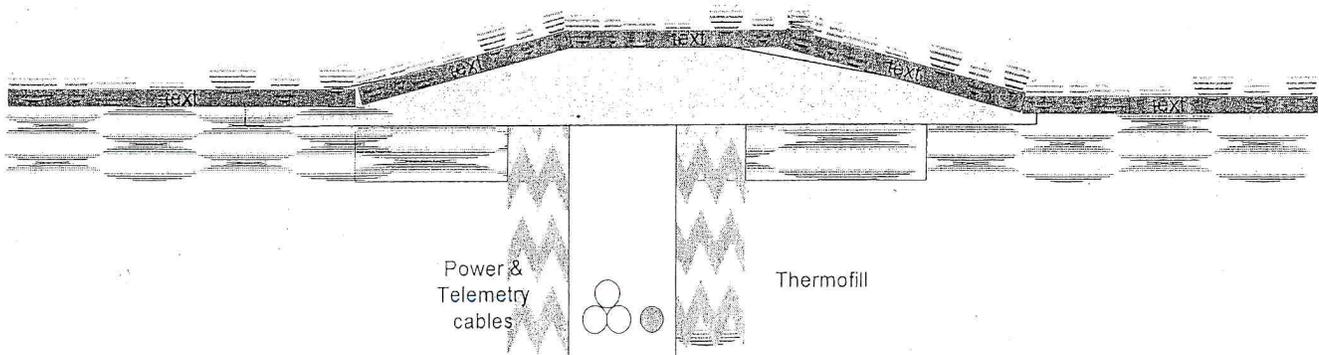
Trench Excavated



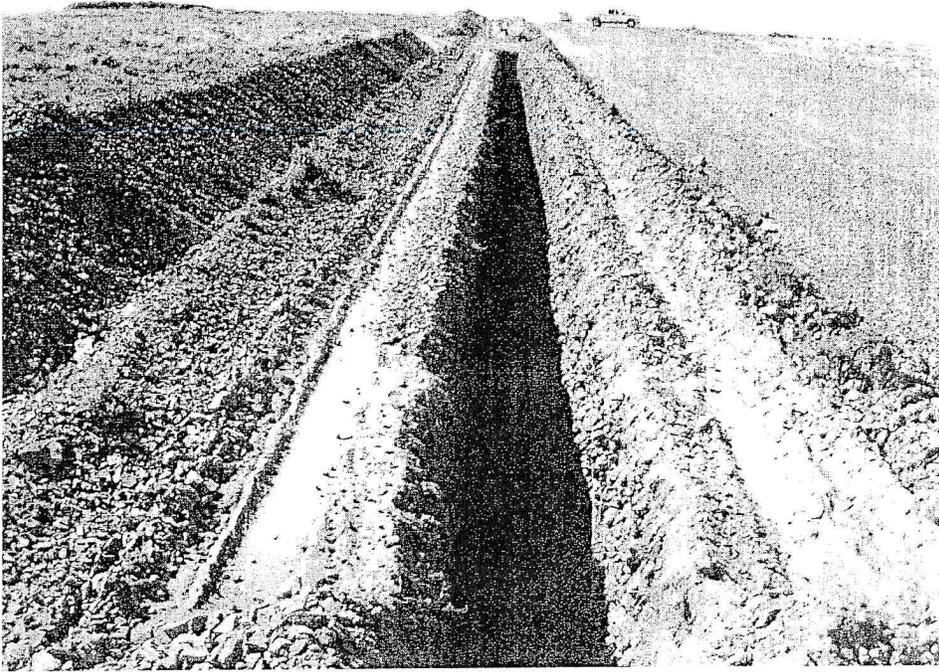
Cables Installed

Trench Backfilled

Completed Trench

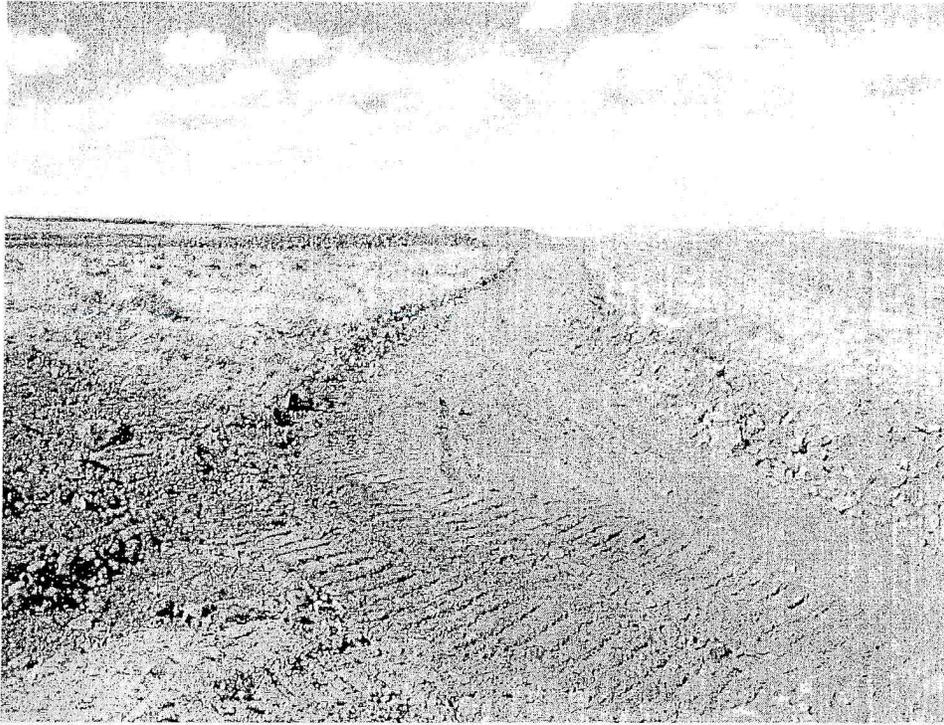


Trench Installation Process
Photo Documentation



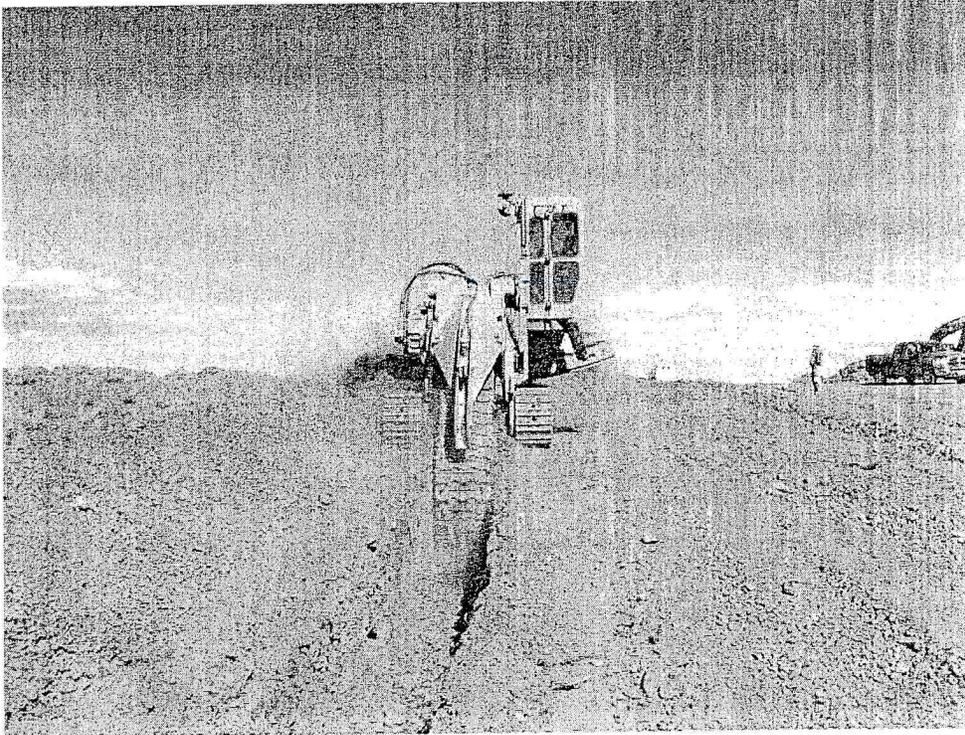
Trench on side of road with trench spoil on top of topsoil

Trench Installation Process
Photo Documentation



Trench in field showing clearance spoil preferentially on RH side of area

Trench Installation Process
Photo Documentation

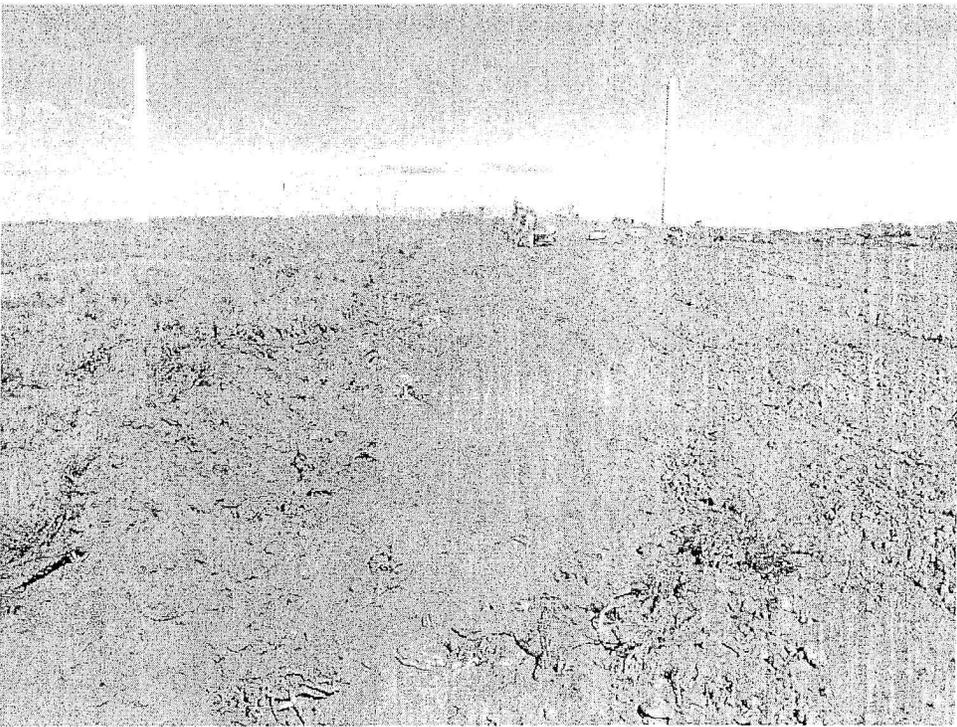
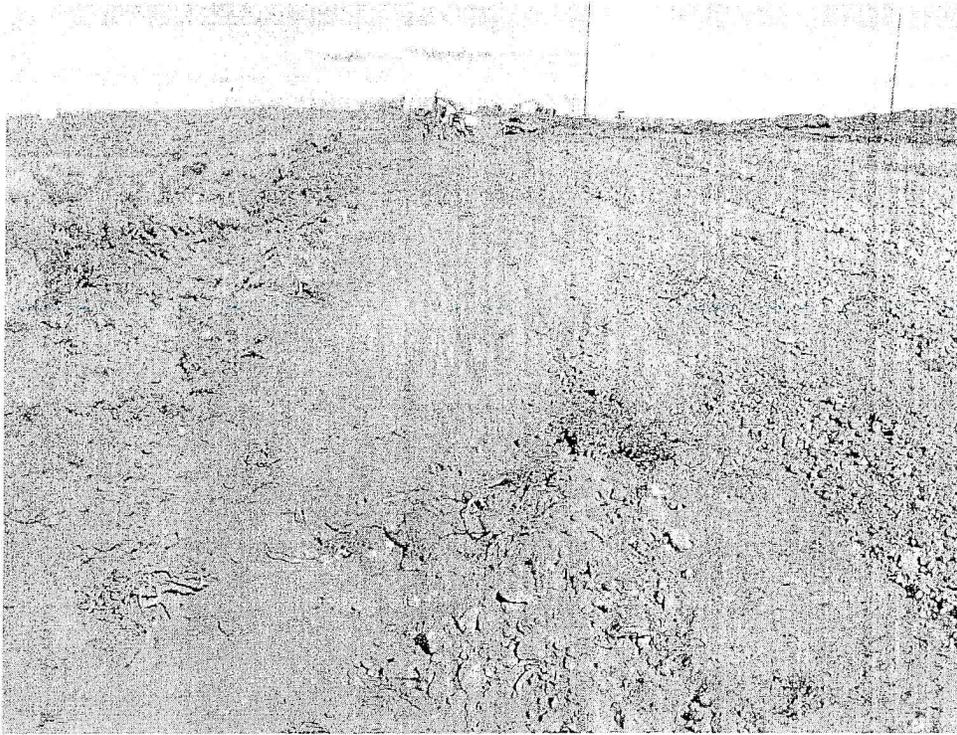


Multiple trench array with trencher piling spoil on top of topsoil windrow from clearing pass



Cable installed on top of bedding in same trench as above

Trench Installation Process
Photo Documentation

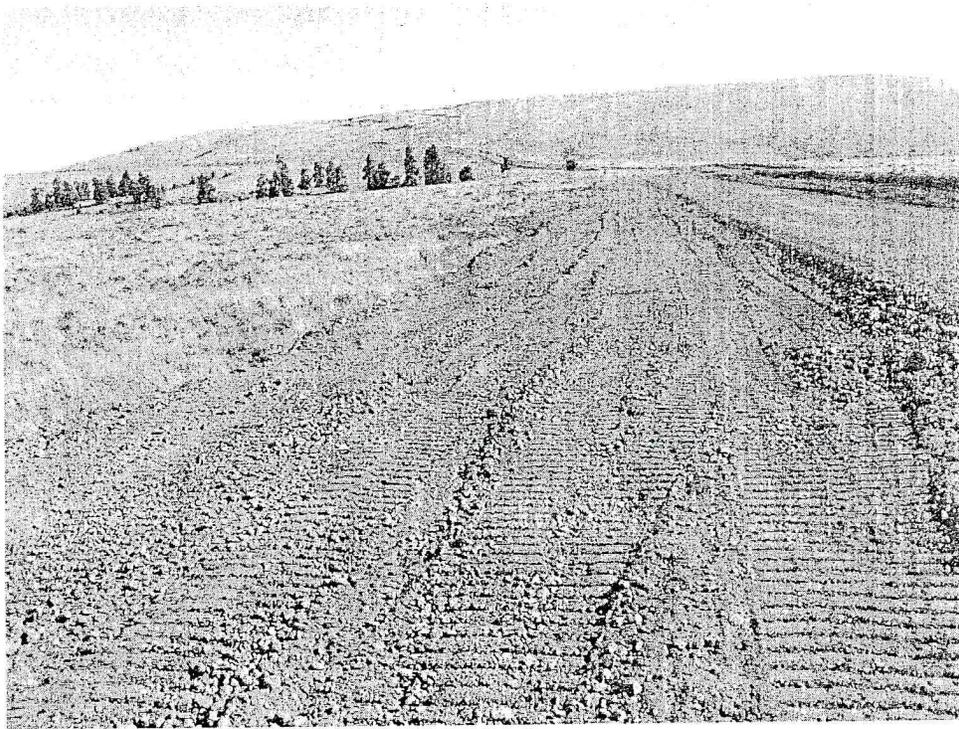


Trench closed with organics on top of same trench as above

Trench Installation Process
Photo Documentation

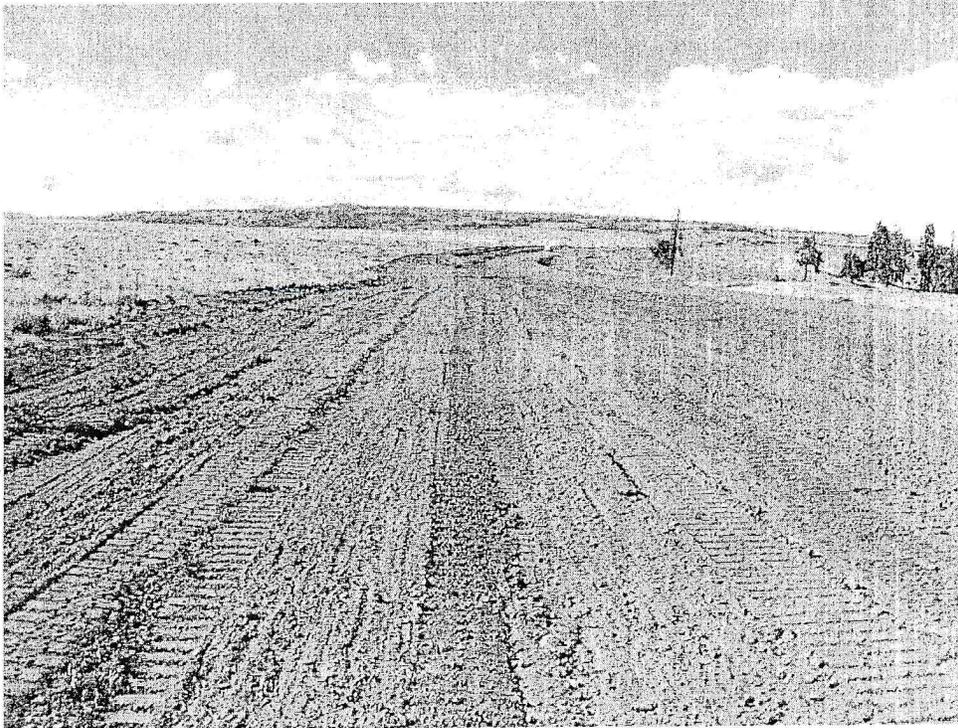


Dozer with angled blade to preferentially move spoil to LH side



Multiple trench array with organics on top of closure (E side of Jeep Rd)

Trench Installation Process
Photo Documentation



Multiple trench array with organics on top of closure (W side of Jeep Rd)