Attachment 2

Center for Nuclear Waste Regulatory Analyses

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Contract No. NRC-02-88-005
Account No. 20-3702-002

U.S. NUCLEAR REGULATORY COMMISSION
ATTN: Mr. David Brooks
1 White Flint North (4-H-3)
11555 Rockville Pike
Rockville, MD 20852

Subject: Letter Report: "Prototype Drilling Inspection near Superior, Arizona and Inspection of Sample Management Facility (SMF) at the Nevada Test Site (NTS), Mercury, Nevada" (as compiled by Richard W. Galster)

Dear Mr. Brooks:

Enclosed is the report relating to the above assignment authorized by you in a Technical Directive dated March 16, 1990. The authorized trip included a two-day inspection of prototype drilling at the Apache Leap test site, near Superior, Arizona, a day of travel from the site to Las Vegas, Nevada and a day inspecting the SMF on the NTS at Mercury, Nevada. The last day included a brief visit to Yucca Mountain on the periphery of the NTS.

The field operations and SMF staffs should be commended on their efforts to establish standard procedures for core/sample handling and documentation. They are a most dedicated group.

The following items are critical observations and comments:

1. The use of a triple-tube core barrel would materially enhance the recovery of core in as close to an in-situ condition as possible. It would probably eliminate the problems presently experienced with occasional blocking of the split-inner tube and with the lexan tubing currently in use.

2. Present procedure does not include on-site maintenance of an appropriate field log. A running, annotated, graphic field log, standard in the industry of geotechnical investigation, should be kept. Such a log should contain all lithologic, structural, hydrologic and drilling mechanics data in a single document. Such field logs should be a requirement for boring acceptance in the licensing process.

3. The present practice of removing samples from the core string prior to logging should be discontinued. The field log is the most important document in the entire geotechnical process. Its completeness should not be compromised by removal of samples prior to core logging.

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4. Apparently, it is presently the function of U.S.G.S. personnel, not necessarily directly involved with the drilling activity, to compile the final log of each boring. A revised procedure assigning this function to the field operations geologist is preferable. The field operations geologist's work should be reviewed by higher authority (DOE, USGS, or other) to assure consistency of notation and conformity with standards, but the field operations geologist is uniquely qualified to compile the final log by virtue of his/her close association with the boring and core retrieval during the drilling and field logging process.

5. Considering the importance of data completeness in the licensing process, it would be prudent for the NRC to review and advise the DOE regarding the appropriateness of the format used for field and final logs.

6. The perception of the CNWRA observer is that project investigations are oriented more toward scientific research than engineering, licensing and construction of a project. The CNWRA is not privy to the activities of the Sample Overview Committee (SOC), its staffing, or any documentation of its activities. The NRC may wish to closely monitor the activities of the SOC and to advise and consult with the SOC regarding data required for licensing to ensure that all goals are met.

Please contact me or Mike Miklas if you have any questions regarding this matter.

Sincerely yours,

Allen R. Whiting for

John L. Russell
Manager - Geologic Setting

/yl

Enclosure

cc: S. Mearse
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REPORT OF VISIT TO PROTOTYPE DRILLING INSPECTION
NEAR SUPERIOR, ARIZONA, AND
INSPECTION OF SAMPLE MANAGEMENT FACILITY (SMF),
ON THE NEVADA TEST SITE (NTS), MERCURY, NEVADA

1.0 Authority and Purpose

Pursuant to a Technical Directive from Dr. David Brooks and a subsequent verbal request from Tom Cardone in early March 1990, Richard Galster, CNWRA consultant, visited a DOE prototype drilling operation located on the University of Arizona Apache Leap test site near Superior, Arizona on 19 and 20 March. The purpose of this trip was to observe and comment on drilling methods and core sample handling and logging procedures. This was followed by a visit to the DOE Sample Management Facility (SMF) at NTS on 22 March. The purpose of this segment of the trip was to observe sample handling and management procedures at the facility as it relates to licensing for a high-level nuclear waste repository at Yucca Mountain, NTS, Nevada.

During these visits Mr. Galster was accompanied by Kenneth Hooks, NRC-HLPD, William Belke, NRC-HLPD, Tom Cardone, NRC-HLGP, Paul Prestholt, NRC, Nevada on-site representative.

Prior to the visit, Mr. Cardone furnished Mr. Galster with draft copies of 12 separate written procedures relating to handling, logging, documenting, transport, and usage of borehole samples, both at the field site and at the SMF. In addition, a copy of the directive relating to the activities of the prototype drilling program was furnished.

2.0 Apache Leap Site Description

2.1 Location

The prototype drilling site lies in the Pinal Mountains, on Oak Flat, about 6 miles east of Superior, Arizona. Topography is a gently westward-sloping irregular bedrock surface between Devils Canyon and Oak Flat Campground (U.S.G.S. Superior, Arizona Quadrangle. 1:24,000) in SE 1/4, Section 28, T 1 S, R 13 E, G & SRM. The site area exhibits open scrub vegetation characteristic of the high desert. Elevation is about 4,076 ft. The site is underlain by Tertiary rhyolitic tuffs, local breccia which vary in lithic-crystal ratio and exhibit vesiculated zones, especially near unit tops. The rock is moderately hard and exhibits both horizontal and high-angle cooling fractures.

2.2 General Discussion

The prototype drilling program* (Enclosure 1) is being conducted by DOE to determine acceptable procedures for obtaining borehole core samples in tuff without the introduction of drilling fluids that might contaminate the samples or the adjacent formation. The program includes establishment of acceptable procedures in the handling, logging, documentation, verification, use, and storage of borehole samples. These methods and procedures are being established so that when drilling begins at the Yucca Mountain site the borehole sample results will be acceptable to the NRC as appropriate for licensing purposes. There are indications that some earlier drilling accomplished at the Yucca Mountain site in Nevada was inappropriately inspected, samples inadequately logged and documented from either a technical or quality assurance standpoint, or both. The earlier work and documentation was not investigated during this visit.

Numerous persons were at the prototype drilling site in addition to the basic five-man drilling crew from Lang Exploratory Drilling Company. These persons represented DOE, DOE contractors, and sub-contractors from the following organizations: Reynolds Electrical & Engineering Co. (REECO), Fenix & Scisson of Nevada (F&S), Harza Engineering Co., and Science Applications International Corp. (SAIC). Principal contacts for information from these organizations are listed on Enclosure 2. *

3.0 Drilling

3.1 Description

The prototype drilling is being accomplished using a Schram drill modified by Lang. It is a combination hydraulic feed/chain pull-down configuration with a floating rotary drive head. The machine is referred to as LM-120 (meaning it can develop 120 kips of drilling force). The drilling machine was situated on boring USW UZP-4 during the time of the visit (19-20 March) and during this period the boring was advanced from 62.6 ft. to 105.2 ft. Using air circulation (capacity 1500 cfm) at pressures varying from 115 to below ground level 130 psi, the drilling procedure advanced a PQ wireline double-tube core barrel (5.5 inches O.D., 3.27 inches I.D.) through an open-centered (6-inch passage) roller-cone bit which cuts a 12.25 inch hole and carries 12-inch O.D. dual-wall drill casing as it advanced. After the core barrel was advanced about 40 ft. the boring was reamed to the same depth by activating the 12.25-inch bit, and the boring simultaneously cased. The dual-wall casing served two purposes in addition to maintaining the integrity of the boring; it provided a separate annular space for air and cuttings return to the surface, and prevented any potential caving zones present around the boring periphery from contaminating the sampling or disturbing sampling procedures. Cuttings returning to the surface were collected in a dual cyclone system from which cutting samples may be drawn at any time during the drilling or reaming process. A vacuum system to be attached to the air return side of the unit is planned but was not operating at the time of the visit. Implementation of such a system will reduce the effective air circulation pressure downhole and probably improve cutting removal.

During the drilling process continuous recordings of air pressure and temperature were made on a recoverable time basis. Efforts were being made to adjust air volume and pressure so that air temperature would be kept at about 60 degrees F. In addition the driller manually recorded air pressure, penetration rate (in minutes/ft) and torque being developed by the floating head on the rotating drill column (recorded at 1 ft. intervals). All tool and stick-up measurements were made by the driller without any obvious verification. During core drilling the speed of rotation was on the order of 60 rpm. A 10 ft. core barrel (total length 11.2 ft.) utilizing a single split-tube-type inner tube was employed. The inner tube was bound at several circumferential locations by filament tape. For several core runs the interior of the inner tube was lined with lexan tubing in which the core was received. This was apparently done to help retain the natural moisture content of the core.

3.2 Comments

The design of the drilling machine and related equipment makes handling drill pipe difficult. The rig is not equipped with either a tower platform or a pipe rack for storage of active drilling pipe in a near vertical mode. All drill pipe must be stored horizontally on the drill deck (which is spacious). When the wireline procedure is going well this is a minor problem (theoretically at least) as the drill rods do not have to be removed except when changing core bits or reaming dual-wall casing. However, lack of a tower platform and pipe rack substantially slows any pipe handling required and produces personnel safety questions.

Major problems of coring equipment relate to use of an unconfined split inner tube. When the core barrel becomes blocked, usually because fractured rock moves differentially as the core enters the core barrel, the core becomes jammed and the filament tape becomes inadequate to secure the split-tube properly. Depending on the extent to which the inner tube is expanded, the tube may also be jammed against the outer tube. As fractured zones are encountered in boring this problem with the single split inner tube can become acute.

The jamming problem can be eliminated by the use of a triple-tube core barrel which features a solid inner tube that houses a split-tube steel liner inside the inner tube. Lubrication between the two inner tubes is required for successful removal.

The use of lexan tubing in the core barrel appears to create problems with core recovery. Because the lexan tubing has no rigidity it tends to easily deform from any minor abnormalities as the core moves into the core barrel during the drilling process. In one observed instance the lexan tubing was crumpled so badly that further drilling progress was slowed and core was lost. If closely fractured rock is encountered the core recovery problem can become chronic if use of lexan tubing is continued.

The responsibility for measuring tools and measuring drill tool stick-up is apparently trusted to the driller only. None of the field operations (FO) staff were seen to verify measurements taken. Without any intent to question the integrity of the driller, a more appropriate procedure would be for the field operations drill-site geologist or his designee to physically verify all measurements.

The axial wavy character of the solid core suggests that drilling pressures (tool weights) may be excessively high. This is not surprising given the design of the equipment. It is possible that recovery of core from more fractured zones and rock of poor quality may be difficult owing to lack of control of the drill string as shown by the wavy character of the solid core.

4.0 Core Handling/Logging (Field)

4.1 Description

The latest draft (March 8, 1990) of field logging, handling and documenting borehole samples (Enclosure 3) was being followed in-so-far as possible by the field operations (FO) staff. The procedure is summarized as follows:

The FO staff took possession of the split inner tube while it remained in a jig on the drilling deck. It was labeled and manually carried to the portable logging facility (PLF) at the drill site. The inner tube was placed on a logging rack in the PLF where the split inner tube was opened and the top half of the tube was removed to expose the core.

The segmented pieces of the core were appropriately fitted together and the length was measured. Though the run stub from the previous run was not labeled, the point was immediately used as a measuring point for marking whole foot intervals directly on the core. Red and blue "quasi" orientation lines were marked axially on the core immediately after fitting the pieces together. A polyfoam block labeled with basic information was placed at the top of the run to identify the core sample.

The core was then videophotographed by slow automated passage of a video camera over the re-fitted and marked core in the lower half of the split-tube.

A "natural-state" sample was taken by breaking the core at specified intervals (two samples per 10 ft.) with a rock hammer. The brittleness of the rock caused chips to fly away along with small pieces of core, some of which were not recovered. These "natural-state" samples were immediately placed in sealed tubes. (The DOE later advised us that the purpose of these samples was not so much for determination of moisture content but for recovering natural moisture for hydrochemical studies.) A polyfoam block was cut to the length of the removed sample and placed in the run string where the sample was removed.

After the core was photographed and the "natural-state" sample taken, the lithology of the core was determined and noted on one form (Figure 9, Enclosure 3) and the natural fractures and man- or drilling-induced breaks were listed on a separate form (Figure 5, Enclosure 3). No single, running field log containing all pertinent boring data was maintained.

Upon completion of logging, the core was placed in two-row, 36-inch-long cardboard boxes with detachable lids. Core was placed with the top of the core string at the lower left corner of the box and the bottom at the upper right. This is opposite the conventional manner of placement. The DOE advised us that the manner of placement was dictated by the configuration of SMF logging and handling room. The core boxes were appropriately marked on the end of the lid, the core was photographed in the box and the lid secured with filament tape.

4.2 Comments

The FO staff appeared to be most dedicated to following the draft written procedures and processing the core and samples in a workmanlike manner as expeditiously as possible. The speed with which this is done may result in occasional errors in measurement and marking, especially when the drillers measurements are not verified by the FO staff. The core is marked prior to the recovery of the succeeding run, an action that may complicate the resolution of runs and losses. Unless the bottom of the run is actually pulled (undrilled rock showing at run bottom) it would be prudent to wait for final run resolution and core marking until the succeeding run is removed.

The removal of samples from the core string for any reason prior to total resolution of run depths, complete logging of the core, and core photography should not be considered as appropriate procedure so far as licensing is concerned. The most important result of drilling is providing an accurate log of the boring. The inspection of all recovered core should be required as this log is made by the FO staff. If it is necessary to preserve moisture content in the core, the sample zone can be temporarily wrapped in kitchen plastic wrap or some similar product. If loss of moisture is a problem, an appropriate field laboratory should be set up at the drill site to process the samples immediately following logging and photography. The manner in which "natural state" samples were taken was unnecessarily damaging to the core. Chips of core were often lost on the floor and never recovered.

When core was received in lexan tubing, "natural state" samples were removed by cutting the tubing with pipe cutters, the core broken and the sample capped. The remainder of the core was removed from the tubing by tilting the tubing and allowing the core to slide into the half-round of the split inner tube. This handling method counters the use of a split tube. Although intact core survives such handling fairly well, badly fractured core will not survive such treatment and thus be impossible to re-fit and log with any accuracy. Here again, the use of a triple-tube core barrel will provide an appropriate solution. The major purpose of core drilling is to recover core in order to examine and document it in as close to its in-situ condition as possible. Use of the lexan tubing as employed by the FO staff is not conducive to such an effort.

Present procedures do not require compilation of an on-site, annotated, graphic, field log. This type of log is standard for the industry and should be a required for data used in licensing. The FO staff appear to be aware of this deficiency but a field log of this type does not appear necessary to either the DOE or the USGS. Appropriate geotechnical practice requires maintenance of a detailed graphic field log, generally at a scale of 1 inch equals 1 ft. An annotated graphic log would contain all data on lithology, fractures and other defects in the rock mass being drilled in addition to drilling mechanics and borehole hydrologic data. It is completed by the drill site geologist as the boring is advanced and provides the only complete history of the boring in a single document. The present system of logging places data regarding lithology, structure, drilling mechanics and borehole hydrology in separate documents with a "final" log to be prepared by USGS personnel at some unspecified future date. By virtue of his involvement in this coring and initial logging process, the on-site geologist is the only truly qualified individual capable of compiling a field log, and hence, should also be responsible for the final log subject to higher authority review. This activity, with the documentation, should be required for data used in licensing.

5.0 Transport of Core

5.1 Description

The driver charged with transporting the core to the SMF confirms the listing provided by the FO staff with the labels on the containers to be transported. The containers are loaded into a pick-up truck and sandwiched between polyfoam pads; the load is covered and lashed down. The core samples are secure in cardboard containers as the container lids are bound (with filament tape) tightly against the core; the whole core samples being maintained in constant compression inside the container. Upon arrival of the load at the SMF on 22 March, 1990 only one core box had moved and was lying on its side in a vacant area of the vehicle bed.

5.2 Comment

Procedures for securing and transporting of core are well formulated and generally well-executed. Care should be taken to fill up spaces on the vehicle bed so that any shifting of containers during transit is minimal and does not induce damage to the more fractured zones of the core which are most susceptible to handling induced damage.

6.0 Sample Management Facility (SMF)

6.1 Description

The SMF is located on the NTS at Jackass Flats about 10 miles east of the proposed repository site at Yucca Mountain. The SMF is a permanent single-story building containing office space, logging space, laboratory space (diamond saws, lapidary equipment) and core container storage racks. The core containers are placed in juxtaposition on roller tables, the containers opened and the structural and lithologic logs verified. Any discrepancies between the written log and observations are resolved and any required relogging of the core is accomplished at this time. The individual containers are resecured, permanently labeled, a record entered into the SMF data system, and the boxes stored in a secure enclosure.

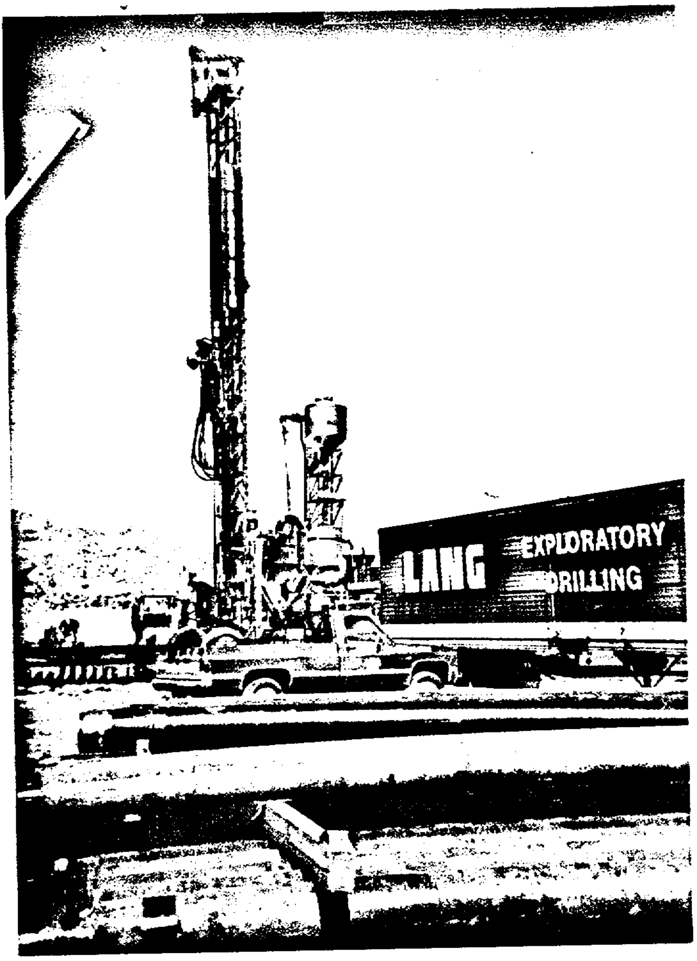
6.2 Comments

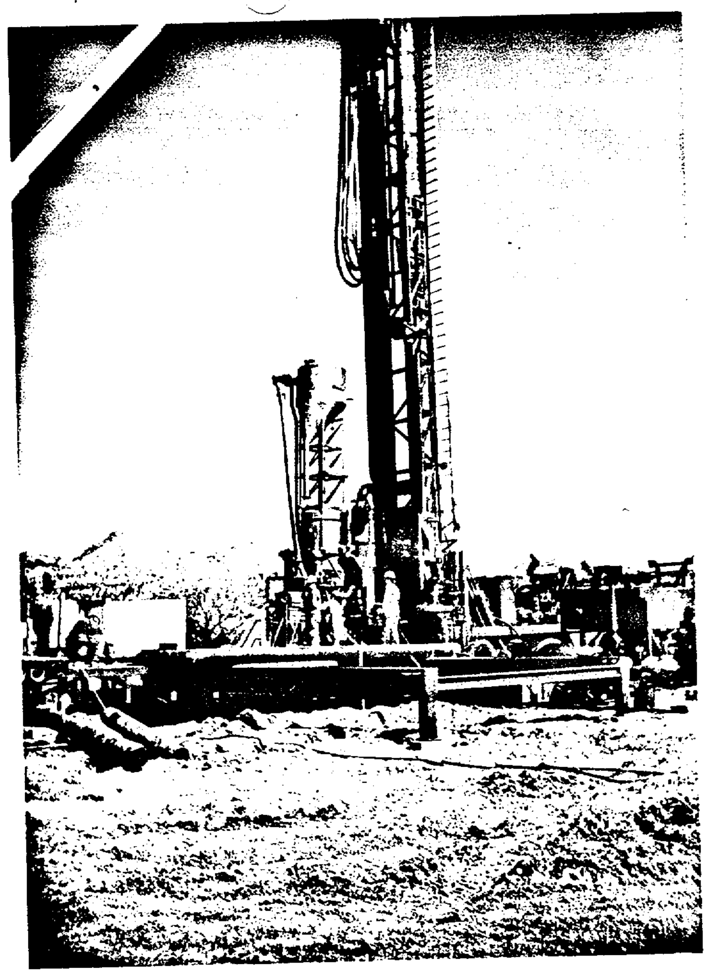
The SMF appears adequate for the purpose intended and the staff appear dedicated. The verification of the structure and lithologic logs appears to be unnecessarily time consuming and would be greatly enhanced by the availability of copies of an appropriate field log. The facility appears destined to maintain the limited purpose of curating the samples and limited sample preparation. The staff appears overly concerned about over-stepping their authority with respect to obtaining data from or testing of samples. For example; such simple tests as specific gravity and absorption could easily be routinely conducted at the facility together with certain other nondestructive engineering property tests. Some of these tests would enable the staff to enhance their capabilities in verifying the rock quality and its variety.

7.0 Yucca Mountain Site

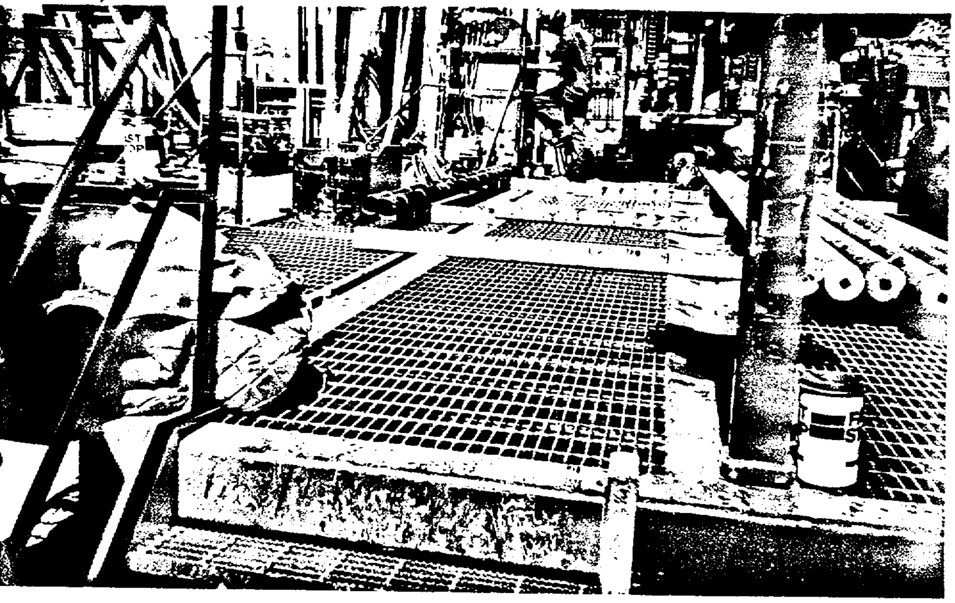
Following the inspection of the SMF, a brief visit was made to the repository site are at Yucca Mountain in the company of Paul Prestholt (who conducted the tour) and Tom Cardone. The tour included stops at trench 16 across the Paintbrush Canyon fault, site of proposed surface facilities, and along the crest of Yucca Mountain. The tour served as an excellent quick orientation.

* W/O ENCLOSURES 1, 2 & 3



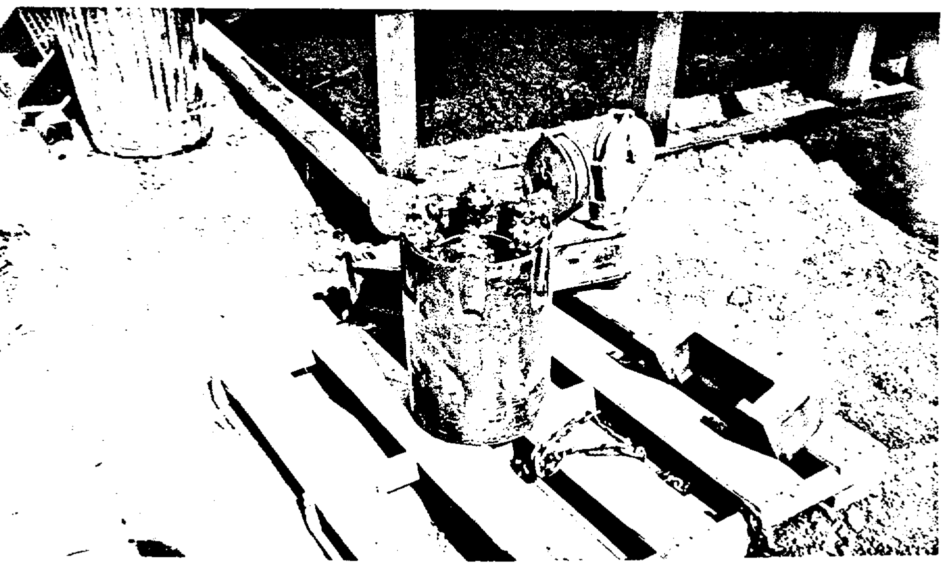


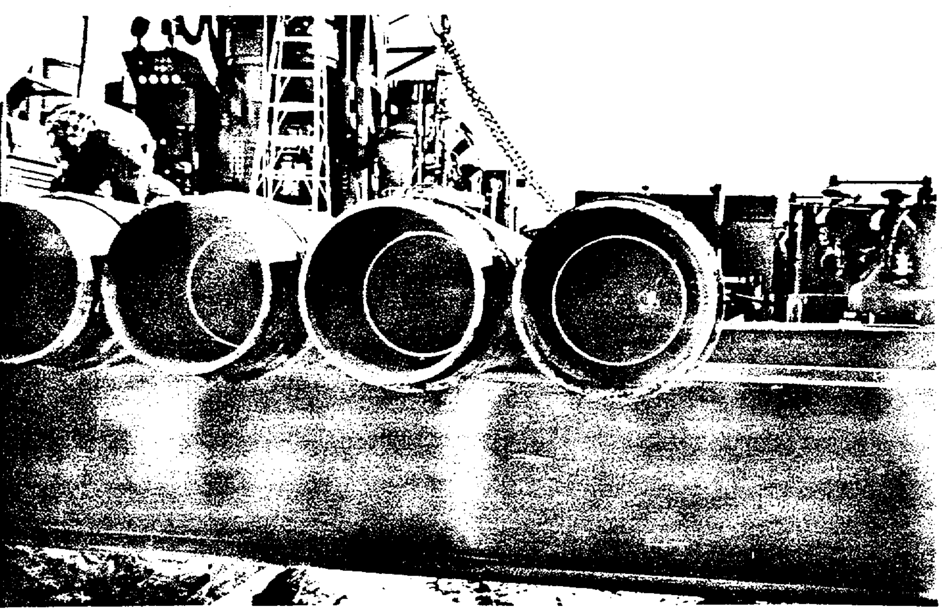
Lang Drilling Rig With Small And
Large Cutting Collectors



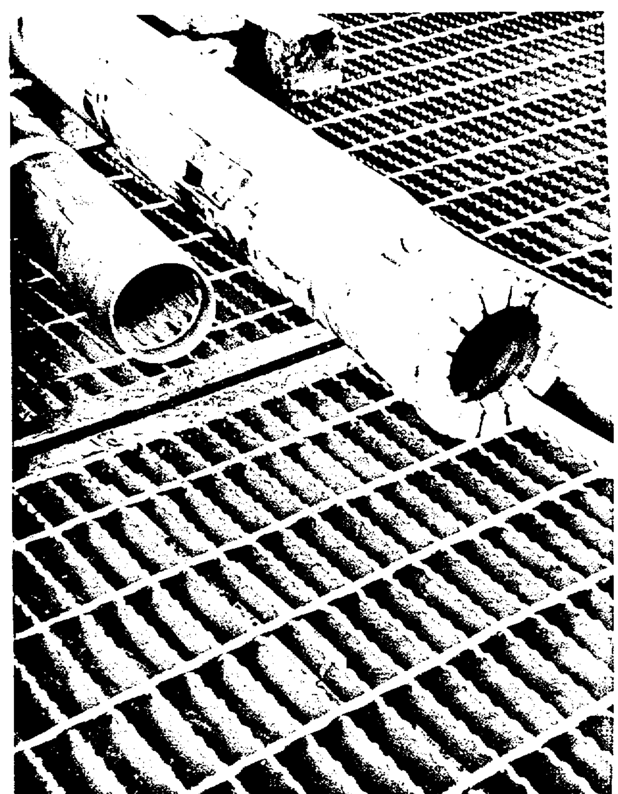
Lang Drilling Rig

12 1/4 " X 6" Open-Centered Roller-Cone Bit

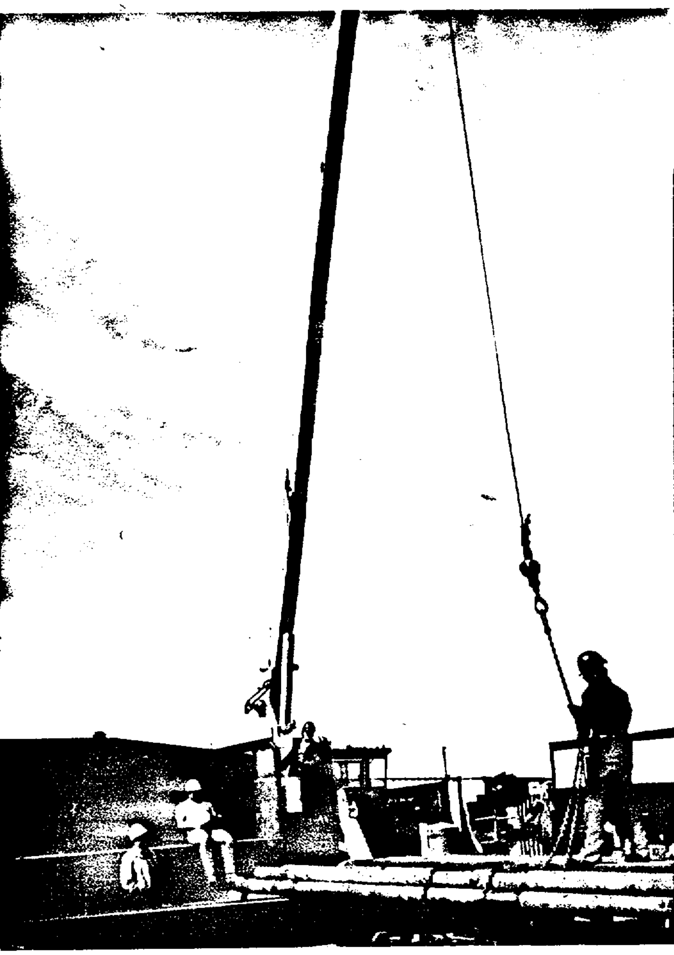


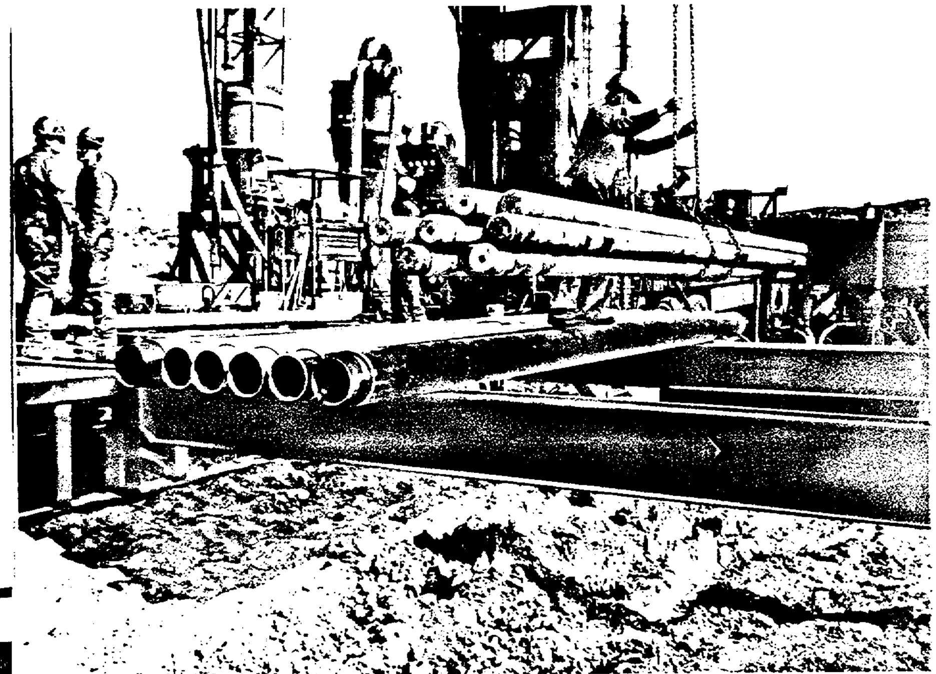


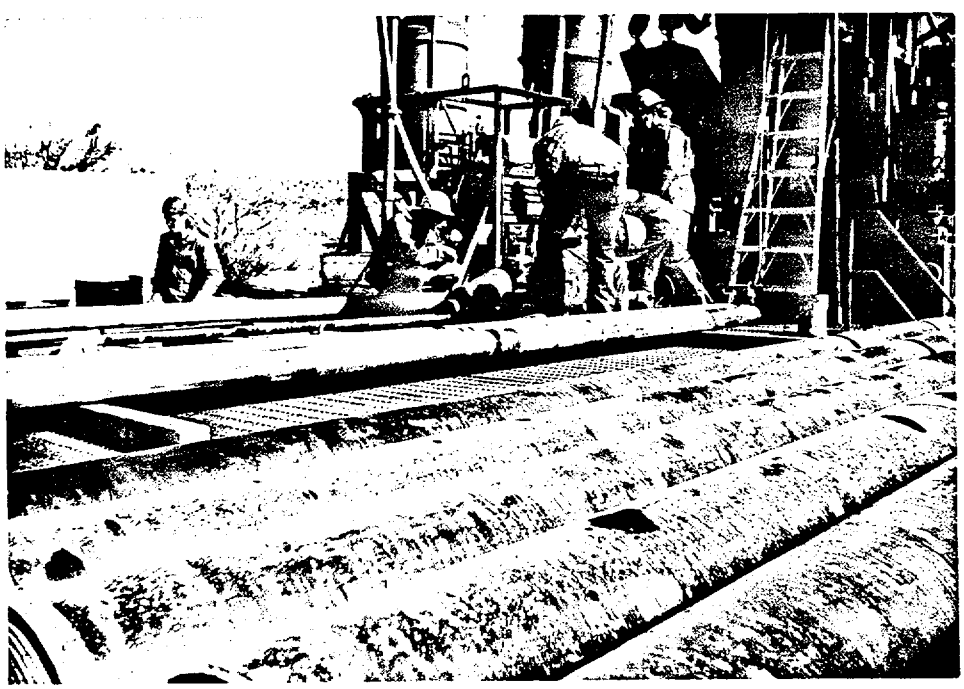
9 5/8" OD Dual Wall Drill Pipe



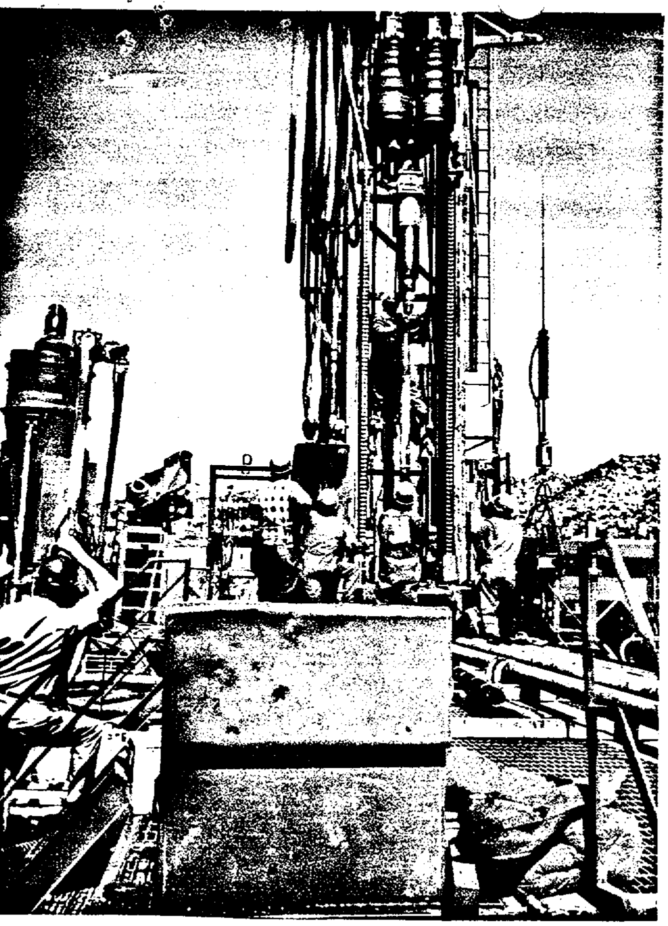
9 1/2 " X 4 1/2" Open-Centered Bit

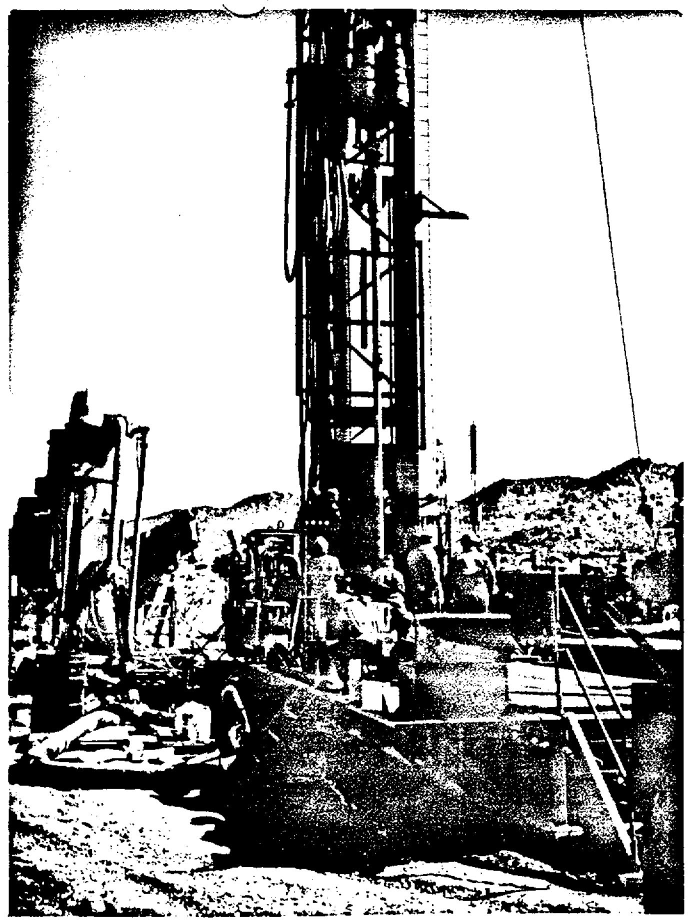


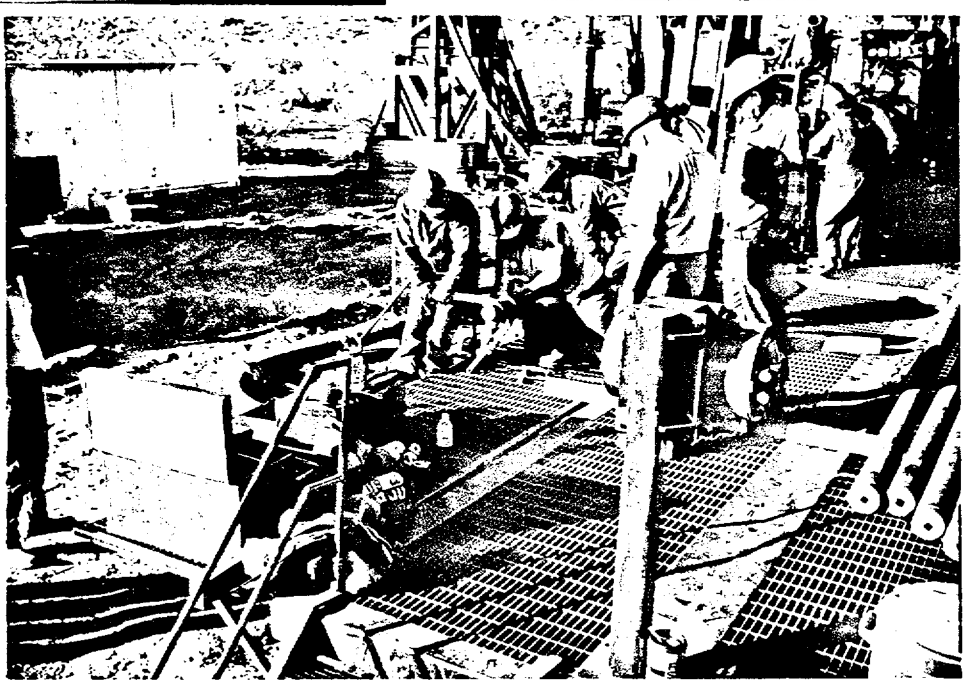




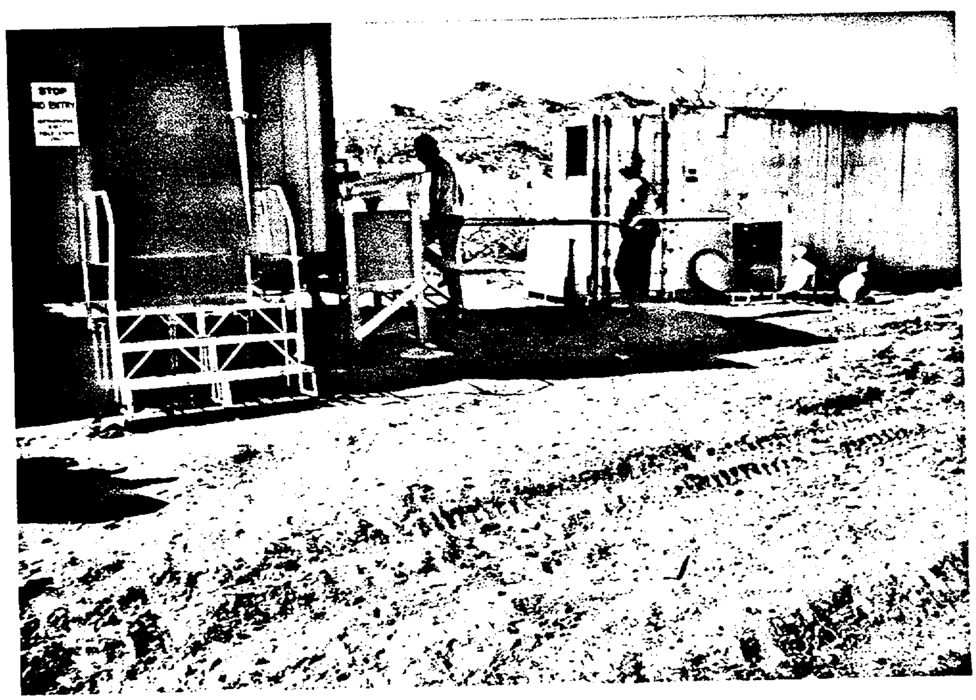
Preparation For Installation
Of Borehole And Coring Pipe



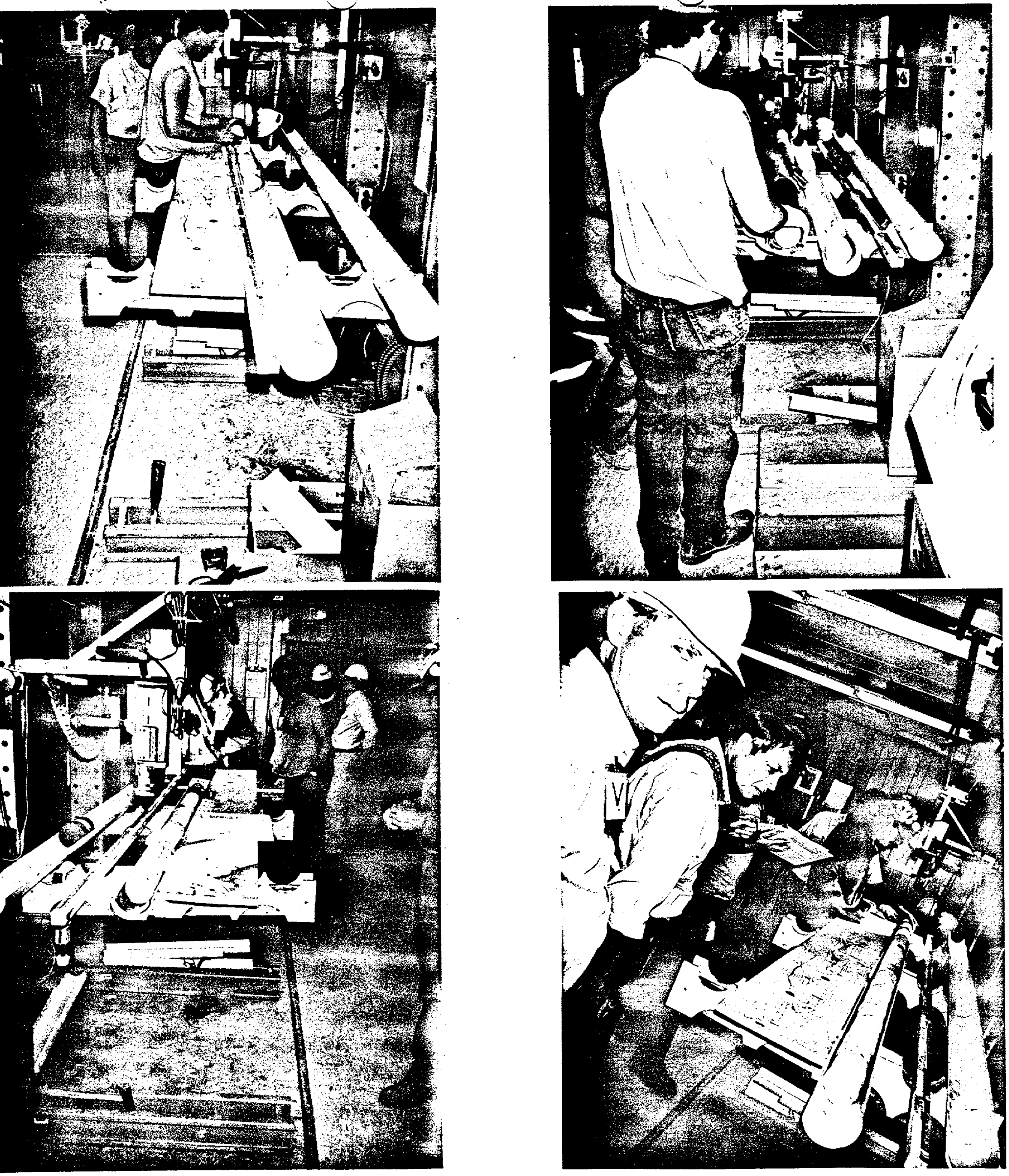




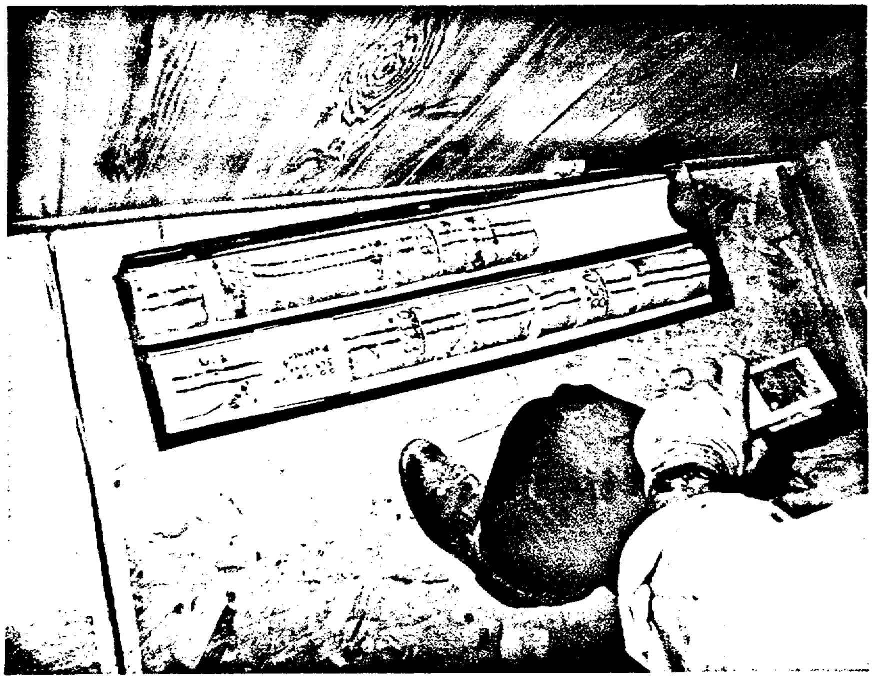
Drilling And Removal Of 10' Section Of
Core Sample From Split Core Tube Assembly



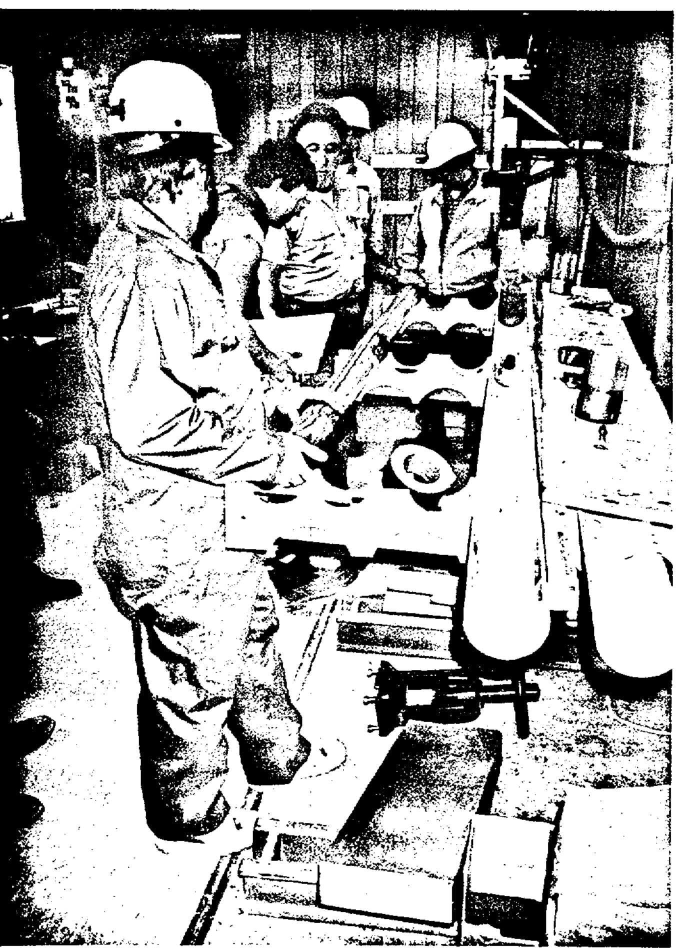
Transferring The Split Core Assembly To The Sample
Management Facility Trailer For Core Logging

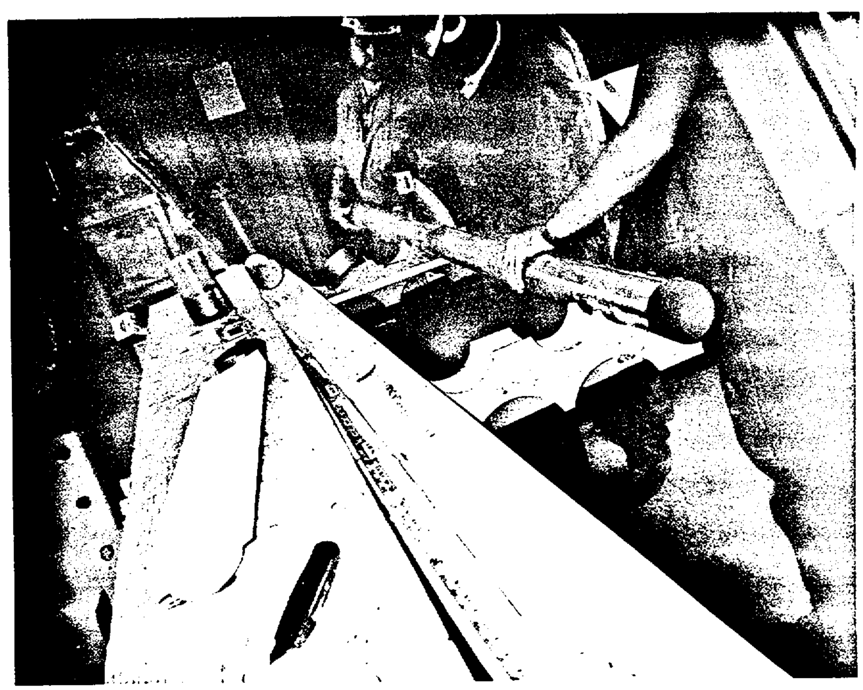


Logging, Identification, Photographing,
And Packaging Of Core Samples



Completed Length Of Core Samples Being Prepared For Shipment To Sample Management Facility





Packaging Core Samples Taken In Lexan Liner