BENDIX FIELD ENGINEERING CORPORATION

DATA COMPENDIUM FOR THE LOGGING TEST PITS AT THE ERDA GRAND JUNCTION COMPOUND

by

Mark Mathews

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TABLE OF CONTENTS

INTRODUCTION

The purpose of this report is to consolidate all the information available concerning the 21 test pits at the ERDA Grand Junction Office (GJO). Five test pits are used as standards of calibration for gross gamma logging equipment and three test pits are used as standards of calibration for gamma spectral logging equipment. The remainder of the test pits are either used for research purposes or not used.

Gamma logs are used in uranium exploration to estimate the grade (%eU_3O_8) and thickness of an uranium ore zone in an exploration drill hole. Test pits are needed to calibrate the gamma logging equipment in order to obtain accuracy, uniformity, standardization, and repeatibility in gamma logging. This is essential for accurate ore reserve calculations and ore potential estimates. The test pits at GJO have been and are available for use by private industry in calibrating their gamma logging equipment.

It is the author's opinion (since no other written guidelines are available) that test pits used as calibration standards should have the following:

A. The logging hole in the test pit should have a constant diameter with no casing and should be filled with air.

B. A barren zone should lie above and below the ore zone.

C. The ore zone should be homogeneous, in secular equilibrium, and contain a known grade (%eU_3O_8) of uranium.

D. The ore zone should approximate an infinite thickness in both the vertical and horizontal directions for gamma rays of interest.

E. The barren zones should approximate an infinite background in both the vertical and horizontal directions.

F. The bulk densities of the barren and ore zones should be constant and the same. These densities should simulate natural rock densities.

G. The loss of radon gas from the ore zone should be prevented.

H. The following physical parameters of both the ore and barren zones should be known for corrections of the gamma logging tool response, for future development of gamma logging tools, and for estimates of μ (gamma attenuation factor):

   a). Dimensions

   b). Concentrations of all radioactive materials.

   c). Porosity.

d). Water content.

e). Electrical resistivity.

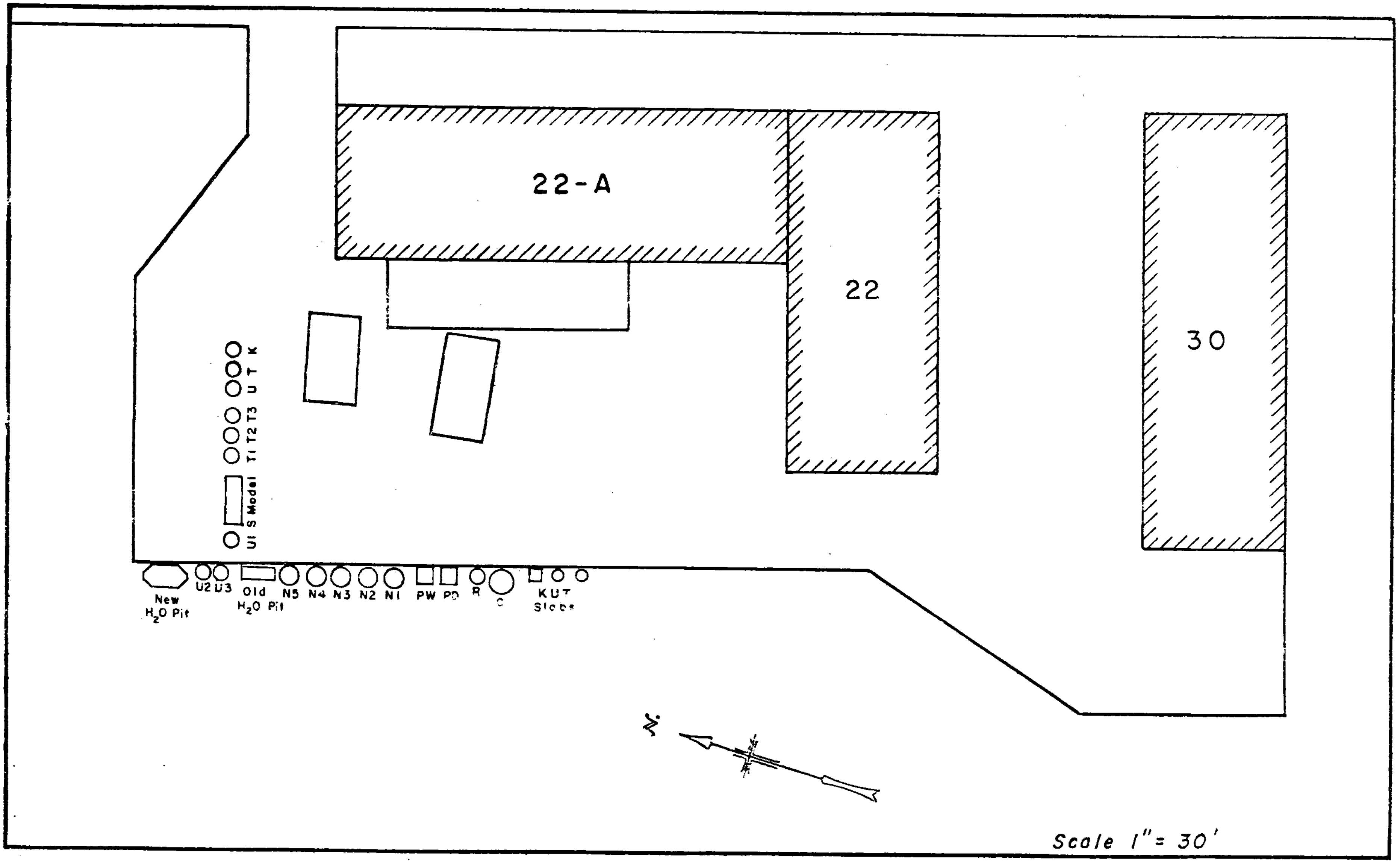
f). Mineral composition.

This definition for a calibration standard test pit will be the format used for summarizing the available information concerning the 21 test pits at the ERDA Grand Junction compound. A plan view of each test pit with its purpose, history, specifications, and known physical parameters is presented in this report. The unknown physical parameters of each test pit are also pointed out because they may be important to the new logging tools under development.

A television camera was lowered into the bottom of several test pits (K, U, T, T-1, T-2, T-3, U-1, U-2, U-3, "new" H_2O) on August 9, 1975 and a video tape was recorded on the condition of the logging holes. The contacts or interfaces between each ore zone and barren zone was readily observed but no measurements of the thickness of the various zones were made. Some of the test pits could not be viewed with the television camera because the entry pipes at the top of the logging holes were too small in diameter. On August 12, 1975 a mirror with a light attached to it along with a calibrated rod were lowered into the logging holes. The interfaces between the ore zones and barren zones were located and their separation from the top of each test pit was measured. The accuracy of these measurements was $\pm$ 0.05 ft. where the interface between the ore and barren zones was distinct and thin.

Figure 1 shows the location of the test pits at the ERDA Grand Junction compound in reference to buildings 22, 22-A, 30 and the blacktop paving near or around these test pits. Figure 2 is an enlargement of the location of the test pits in Figure 1.

The test pits recommended for calibration of gross gamma logging equipment are U, U-1, U-2, U-3, and "new" H_2O. The test pits recommended for calibration of spectral logging equipment are K, U, and T. The remainder of the test pits do not have the proper characteristics that are needed to be classified as standards of calibration for the uranium logging industry.

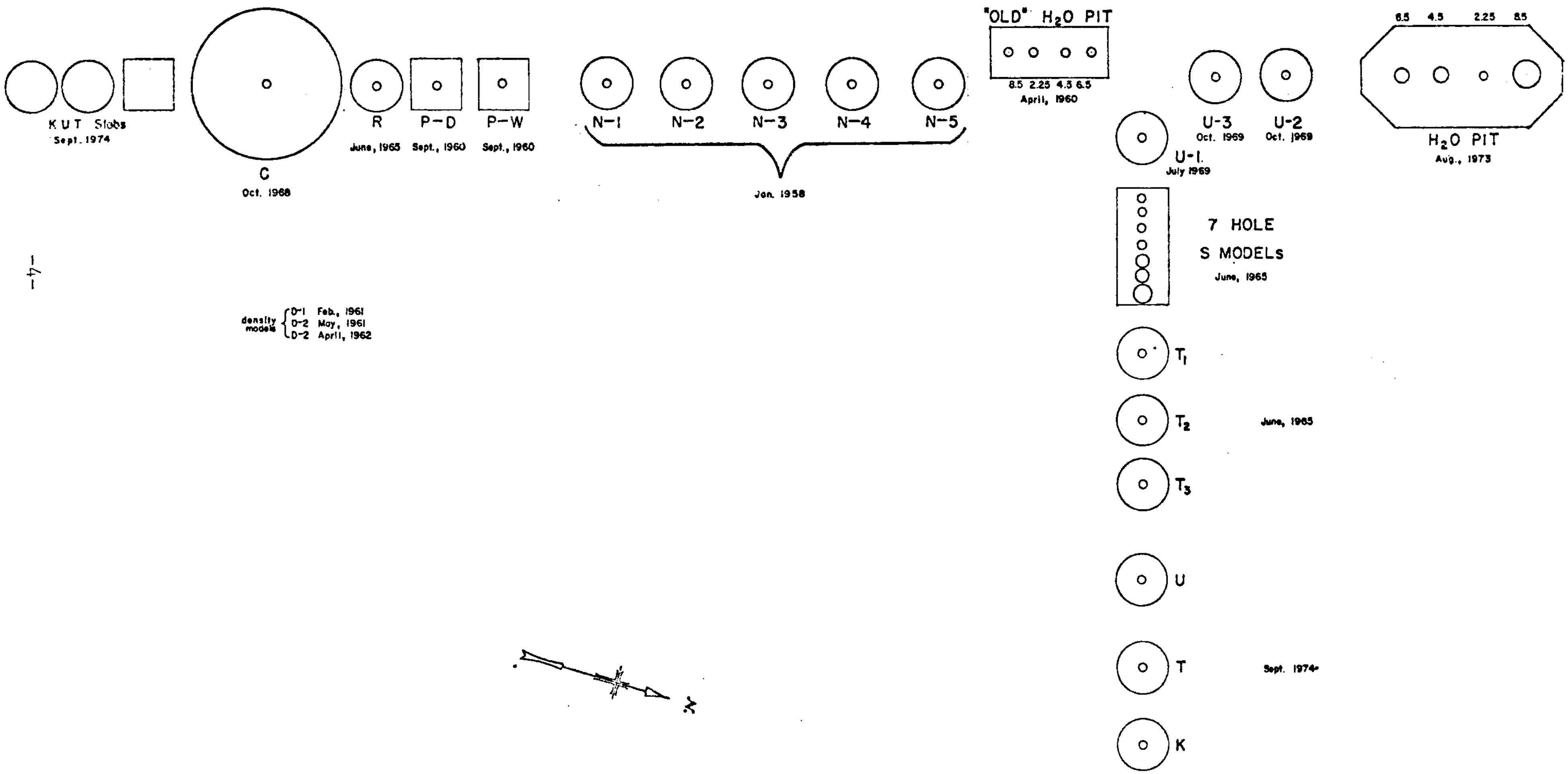


Test Pit Location

Figure 1

TEST PIT LOCATION

Figure 2



C TEST PIT

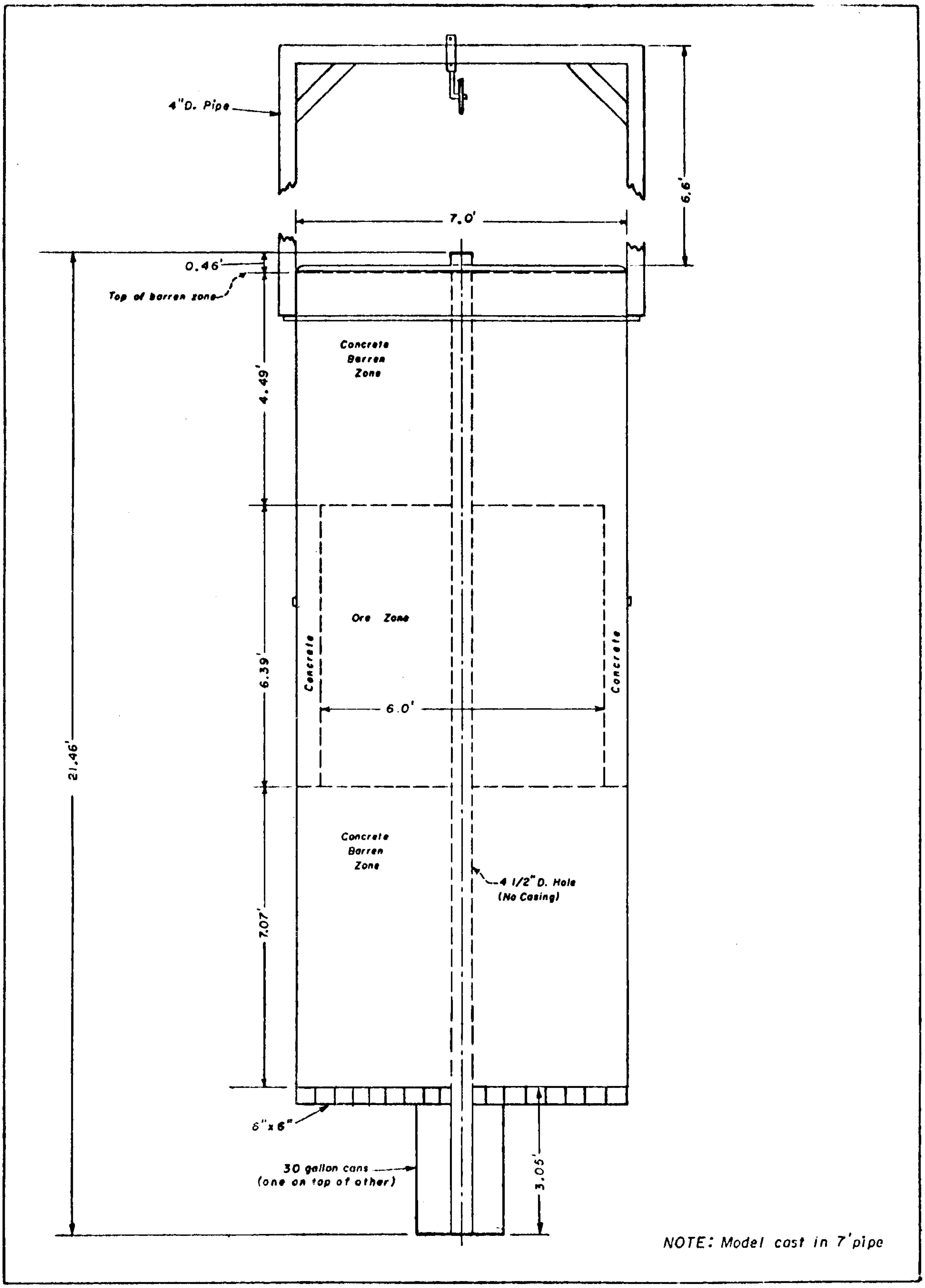
The C test pit, built in October 1968, was designed as a calibration test pit with a relatively thick (6.39 ft.) low-grade zone so that gross gamma logging equipment could be calibrated. The schematic diagram shows the thickness of the barren and ore zones and the dimensions of the pit. Table 1 lists the factors regarding this pit.

The construction of this pit is unique because the ore zone was constructed in a separate form, and after this concrete ore zone cured it was placed into the C pit on top of the lower barren zone. Then the C pit tank was filled with concrete, creating the upper barren zone. A problem exists in the upper 1/2 ft. of the ore zone because of improper handling of the wet concrete. This zone is very rough with cracks and has an inhomogeneous texture as viewed from the logging hole, and as a result a gamma ray log of this zone has a "chattering" character.

In reviewing the assay analysis of the 16 samples taken of the ore zone, one finds the results vary widely from sample to sample. The chemical analysis has a high of 0.414% U_3O_8 and a low of 0.203% U_3O_8 for the grade of the ore zone. The radiometric analysis has a high of 0.425% eU_3O_8 and a low of 0.206% eU_3O_8 for the grade of the ore zone. There are nine samples that have a chemical grade (%U_3O_8) greater than the radiometric grade (%eU_3O_8) and there are seven samples that have a radiometric grade (%eU_3O_8) greater than the chemical grade. Some of the large differences between the chemical grade and the radiometric grade are:

Sample	Chemical %U_3O_8	Radiometric %eU_3O_8	% Difference $\frac{\%U_3O_8 - \%eU_3O_8}{\%U_3O_8} \times 100$
LPI 449	0.414	0.371	10.3%
LPI 454	0.300	0.264	12.0%
LPI 455	0.326	0.425	-30.4%

The assay values for the 16 samples of the ore zone for the C test pit vary too much for the C test pit to be used as a calibration test pit. The reasons for these large differences are: lack of uniform mixing of crushed ore during construction, or inappropriate assays of the samples taken from the ore zones, or ore greatly out of secular equilibrium, or a combination of all of these items. The samples from the ore zone and the barren zones of this test pit need to be reanalyzed in order to check the results of the original assay. If the new assay results are similar to the original assay results, this test pit cannot be used as a calibration test pit for gross gamma ray logging equipment because of lack of uniform grade that can be assigned to the ore zone.



C TEST PIT

Figure 3

Table 1

C TEST PIT

ore zones	ore type & amount	17000 lbs.	0.287% eU_3O_8	Schwartzwalder	
		240 lbs.	4.64% eU_3O_8	Monument Valley	
	cement amount	5690 lbs.			
	water amount	unknown			
	sand type & amount	none			
barren zone	sand type & amount	unknown			
	cement amount	unknown			
	water amount	unknown			
assay analysis ore zone	chemical	0.282 $\%U_3O_8$			
	gamma only	0.280 $\%eU_3O_8$			
	gamma spec	unknown			
	gamma logging	unknown			
assay analysis barren zones	chemical	unknown			
	gamma only	unknown			
	gamma spec	unknown			
	gamma logging	unknown			
density	chemical analysis	upper barren 1.940 g/cc	ore zone 1.876 g/cc	lower barren 1.956 g/cc	
	in situ	unknown			
water or H^+	chemical analysis	average loss on drying at 110°C	upper bar. 5.06%	ore zone 6.58%	lower barren 3.59¢
	in situ	unknown			
Zeq (petrographic analysis)		unknown			
porosity		unknown			
cracks or fractures		unknown			
magnetic susceptibility		unknown			

Western Uranium Project
LUCIUS PITKIN, INC.
Contractor For United States Atomic Energy Commission
Contract No. AT(05-1)-912

CERTIFICATE OF ASSAY

Requested By LPI   September 23 (Date) 19 68

Sample No.	Calibration Pit, Grand Jct.	%U_3O_8	eU_3O_8	%LOD*	#/ft^3 Bulk Density
LPI-439	Lower Barren Zone 1			3.38	122
" 440	Lower Barren Zone 2			3.55	122
" 441	Lower Barren Zone 3			3.75	121
" 442	Lower Barren Zone 4			3.69	122
	Average			3.59	122 -- 1.956 g/cc
LPI-443	Ore Zone # 1	.245	.266	6.28	
" 444	# 2	.205	.206	6.52	
" 445	# 3	.203	.237	6.27	
" 446	# 4	.294	.283	6.64	118
" 447	# 5	.298	.280	6.65	
" 448	# 6	.329	.304	6.18	
" 449	# 7	.414	.371	6.44	
" 450	# 8	.263	.246	6.74	117
" 451	# 9	.260	.264	6.22	
" 452	#10	.318	.294	6.45	
" 453	#11	.246	.254	6.41	
" 454	#12	.300	.264	6.94	118
" 455	#13	.326	.425	6.71	
" 456	#14	.295	.280	6.36	
" 457	#15	.264	.276	7.34	114
" 458	#16	.248	.237	7.25	
	Average	.282	.280	6.58(7)	117 -- 1.876 g/cc
" 472	Upper Barren Zone 3			4.98	123
" 473	Upper Barren Zone 4			5.30	120
" 474	Upper Barren Zone 5			4.98	121
" 475	Upper Barren Zone 6			5.00	120
	Average			5.06(5)	121 -- 1.940 g/cc

*Loss on drying.

April 26, 1968
WORK REQUEST NO. LP-C-68-2

TO: Mr. J. C. Westbrook
Contract Administrator
U. S. Atomic Energy Commission
Grand Junction Office
Grand Junction, Colorado

Dear Mr. Westbrook:

SUBJECT: CONSTRUCTION OF A LOGGING VEHICLE CALIBRATION TEST PIT AT GRAND JUNCTION

Description of Proposed Work

It is proposed to construct a test pit for calibrating logging vehicles in the area near the present test pits. The proposed calibration test pit would be constructed in accordance with the attached sketches, with dimensions and location as shown.

The barren zones and the ore zone (approximately 0.25% eU_3O_8) would be large enough to provide true probe calibration, rather than for reference purposes only as with the present test pits.

The top of the test pit would be surrounded by a guard rail and would be reached by metal steps with handrails.

Advantages to be Gained and Justification

At present no calibration pit for logging vehicles is available. The present N-3 pit is now used to simulate a calibration pit but the ore zone and barren zones are too small for a true calibration pit. A proper calibration pit will improve the accuracy of logging data obtained by LPI for the AEC, and will also be available for use by commercial and industry logging units.

Method of Accomplishment

Uranium ore would be obtained from the Swartzwalder mine through the Cotter Corporation, Canon City, Colorado. This is primary ore and is in close radioactive equilibrium. If Cotter Corporation cannot sample this ore it may be necessary to arrange for sampling by Climax Uranium Company in Grand Junction. About nine (9) tons of at least 0.35% U_3O_8 grade ore will be required.

Fabrication of the steel shells would be done by a local steel company, the concrete and ore zone mixing by a local ready-mix concrete firm, and most of the remaining work would be done by LPI personnel.

It is proposed to pour the ore zone separately in a 6' x 6' cylindrical steel shell as a form. After curing it would be lifted by crane, and the zone then lowered into the test pit shell. This will avoid any contamination between the ore zone and barren zones.

<u>Estimate of Cost</u>

1-16' x 7' steel shell (as per sketch) with loose top	$ 610.00	
1-6' x 6' steel shell	200.00	
Steel for overhead mast assembly with one pulley	90.00	
Steel for railing and steps	180.00	
Paint - epoxy and aluminum	45.00	
Ready-mix concrete - 17 yds @$30.00	510.00	
Dry cement - 59 sacks @$2.00	118.00	
Washed plaster sand - 3 yds. @$6.00	18.00	
Uranium ore - Swartzwelder Mine - 9 tons of 0.35% U_3O_8	373.00	
Lumber for platform under pit and bracing inside	60.00	
Steel reinforcing rod and "I" beam for lifting ore zone	40.00	
		$ 2,244.00

<u>Labor - LPI</u>

Heavy Duty Mechanic - 5 days @$36.00	$ 180.00	
Carpenter - 3 days @$35.00	105.00	
Plumber - 2 days @$40.00	80.00	
Painter - 2 days @$38.00	76.00	
Laborer - 4 days @$30.00	120.00	
Sampler - 5 days @$31.00	155.00	
Weighmaster - 1 day @$32.00	32.00	$ 748.00

Miscellaneous

Excavation - Backhoe with operator 1 day @$12.00 per hour	$ 96.00	
Crane with operator - 2 days @$25.00 per hour	400.00	
A-frame truck - LPI	50.00	
D-6 Dozer - LPI	50.00	
Freight on Ore from Canon City to Grand Junction	206.00	
Ore Sampling by Climax Uranium Company - Estimated	100.00	
20- 55-gallon open head drums	200.00	
15- 1/2-gallon sample containers	5.00	
Laboratory Assay Work	350.00	
Engineering and Drafting	150.00	
Supervision	400.00	
		$ 2,007.00
Total		$ 4,999.00
Contingencies		401.00
Total Cost		$ 5,400.00

Time Required to Complete the Work

It is estimated that the time required to complete this work will be 10 weeks after receipt of uranium ore from Cotter Corporation.

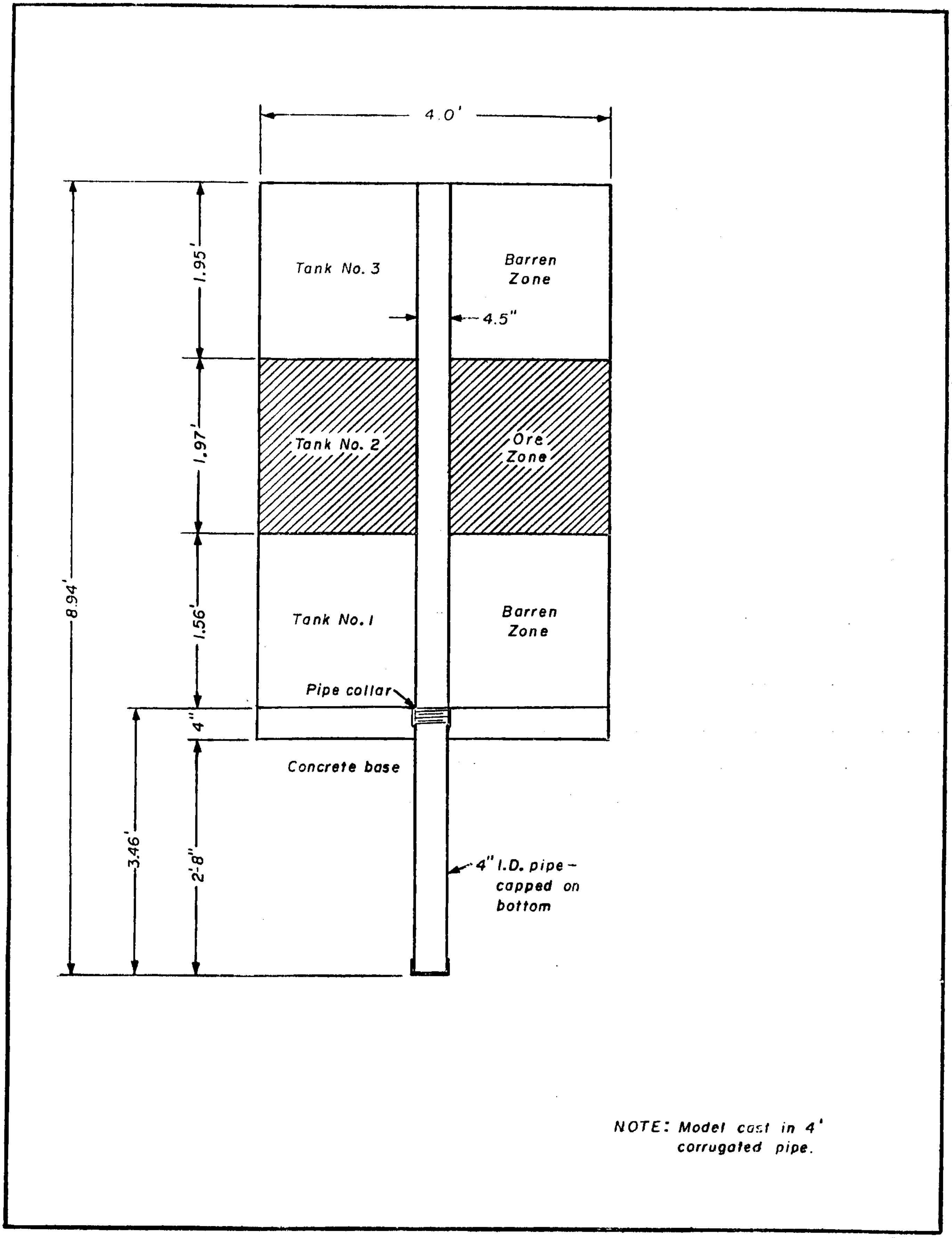
Source of Funds

General Plant Funds - FY 1968.

R TEST PIT

The R test pit, built in June, 1965 was designed as a research test pit so that the response from gross gamma logging equipment could be analyzed. The schematic diagram shows the thicknesses of the barren and ore zones and the dimensions of the pit. Table 2 lists the factors regarding this pit.

Records of the construction work order, the chemical, and radiometric analyses, and the sample numbers or samples of this pit could not be located. The difference between the chemical (6.546% U_3O_8) and radiometric (0.496% eU_3O_8) analyses, puts this pit ore zone at a large secular disequilibrium. The ore zone is only 1.97 ft. thick which is too thin to approximate an infinite thickness in the vertical direction for gamma rays of interest in calibrating gross gamma ray logging equipment. This test pit should not be used as a calibration test pit for gross gamma logging equipment.



"R" MODEL

Figure 4

Table 2

R TEST PIT

ore zones	ore type & amount	268 lbs. concentrate from Climax lot #111(84.03%U_3O_8
	cement amount	764 lbs.
	water amount	unknown
	sand type & amount	2038 lbs. (unknown)
barren zone	sand type & amount	3 parts sand (unknown)
	cement amount	1 part cement
	water amount	unknown
assay analysis ore zone	chemical	6.536 %U_3O_8
	gamma only	0.496 %eU_3O_8
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	1.673 g/cc
	in situ	unknown
water or H^+	chemical analysis	unknown
	in situ	unknown

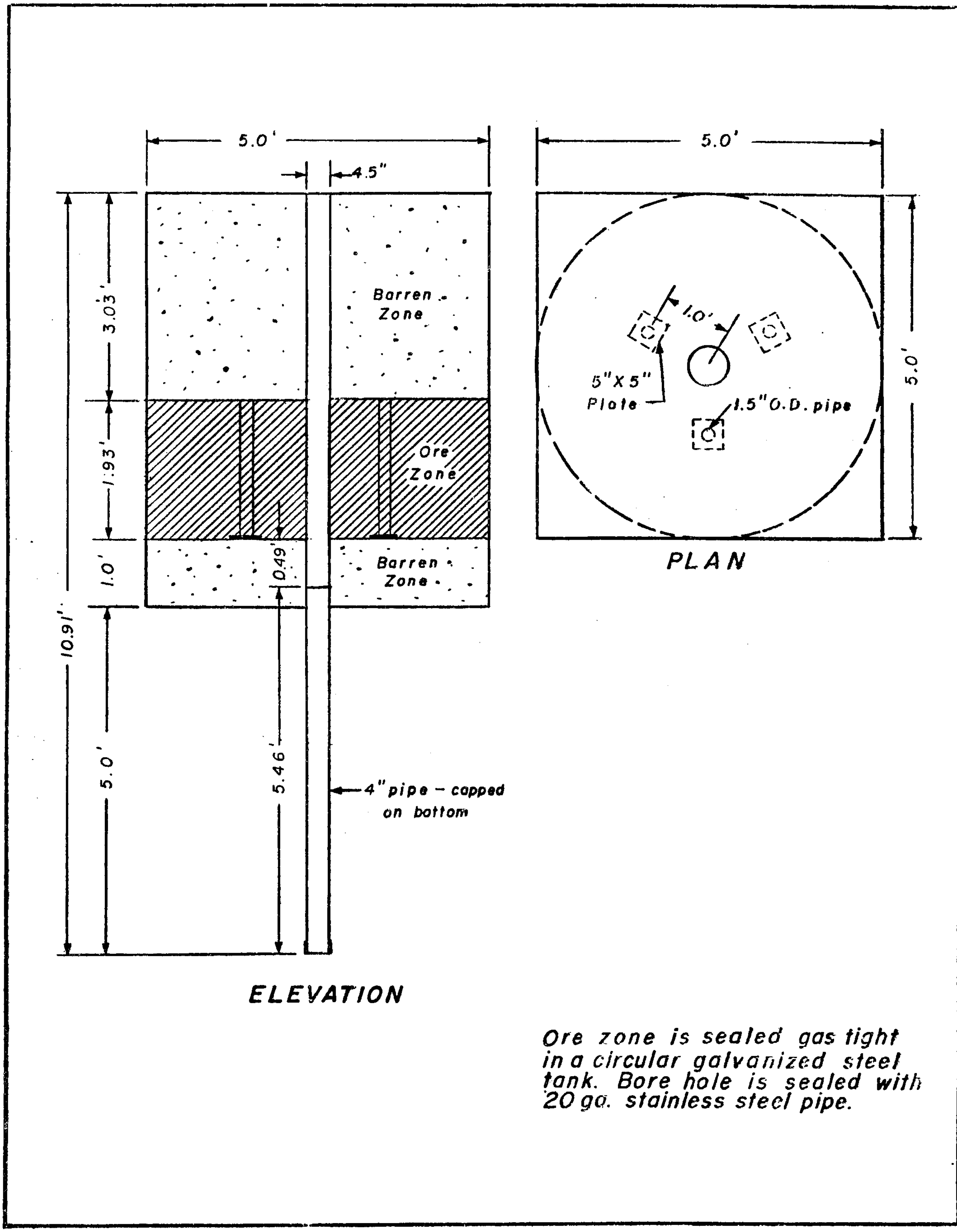
Zeq (petrographic analysis)	unknown
porosity	unknown
cracks or fractures	unknown
magnetic susceptibility	unknown

P-D & P-W TEST PITS

The P-D test pit was designed along with the P-W test pit in order to show the effect that free water in an ore zone has on the gamma logging response. Water which fills the void or pore spaces in a formation or ore zone increases the bulk density of the sample and moderates, scatters, or absorbs gamma rays and neutrons. Table 3 lists the factors regarding the P-D pit and Table 4 lists the factors regarding the P-W pit.

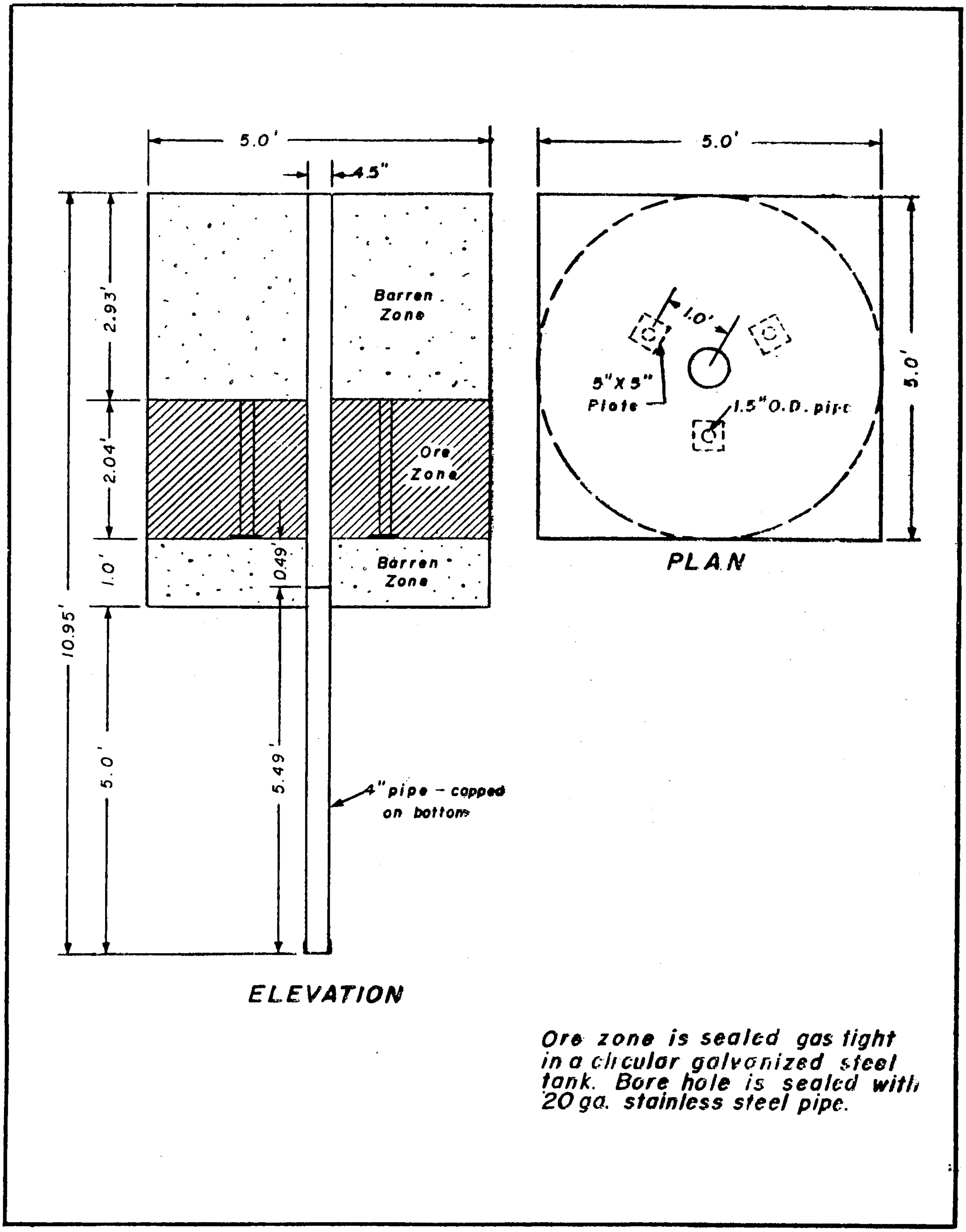
These two pits are research pits that have a large secular disequilibrium in their ore zones (see Table 3 and 4). The ore zones are sealed gas tight in circular galvanized steel tanks with a 20 guage stainless steel pipe in the borehole along the ore zone. In a paper by Dodd and Droullard*, the effect of water in the ore zone reduces the amplitude for the gamma ray log response and a correction factor is derived to account for this reduction.

*Dodd, P. H. and Droullard, R. F., May, 1964, "Some Current Concepts of Nuclear Borehole Logging for Uranium Exploration and Evaluation": 9th Annual Minerals Symposium by AIME, Moab, Utah.



P-D MODEL

Figure 5



P-W MODEL

Figure 6

Table 3

P-D TEST PIT

ore zones	ore type & amount	Climax maroon colored "slime" mill tailings (unknown weight)
	cement amount	none
	water amount	---
	sand type & amount	none
barren zone	sand type & amount	unknown
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.05% U_3O_8
	gamma only	0.50% eU_3O_8
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	1.310 g/cc
	in situ	unknown
water or H^+	chemical analysis	0.6860% L.O.D. at 110°C by weight
	in situ	unknown

Zeq (petrographic analysis)	unknown
porosity	unknown
cracks or fractures	unknown
magnetic susceptibility	unknown

Table 4

P-W TEST PIT

ore zones	ore type & amount	Climax maroon colored "slime" mill tailings unknown weight
	cement amount	none
	water amount	---
	sand type & amount	none
barren zone	sand type & amount	unknown
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	$0.044\% U_3O_8$
	gamma only	$0.362\% eU_3O_8$ w/H_2O--$0.489\% eU_3O_8$ dry
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	1.787 g/cc
	in situ	unknown
water or H^+	chemical analysis	26.19% L.O.D. at 110°C by weight
	in situ	unknown

Zeq (petrographic analysis)	unknown
porosity	unknown
cracks or fractures	unknown
magnetic susceptibility	unknown

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Specifications

1. PIT DESIGN: Two models, hereafter referred to as the "P" pits, are required. Each will consist of three layers of material as shown in Figure 1. The pits will be located immediately south of the "N" pits in such a position that they will be easily accessible to logging vehicles.

   a. The bottom layer of both "P" pits will consist of a one foot thick slab, square shaped in plan view (5 ft. sides) composed of "barren" concrete (grout mix). A 5-1/2 ft. long section of 4 inch I.D. galvanized pipe (4-1/2 inch O.D.) with a capped bottom end will extend 5 ft. below the bottom of the slab, and will be embedded 1/2 ft. into the slab.

   b. The middle layer will consist of a two foot high cylindrical steel tank filled with dry radioactive material in one pit and water saturated radioactive material in the other. The tanks will be sealed gas tight to prevent radon escape. The tanks can be constructed from 5 ft. diameter x 2 ft. high stock-watering tanks, available locally (Ray Fiegle Co.) at a cost of about $33 each. A thin walled center pipe, 4-1/2 inches O.D., is required to form the simulated hole in each tank. This can be constructed from thin (20 gauge) stainless steel to deter corosion. After the pipe is installed the tanks should be tested for leaks by filling them with water. A few vertical braces (pipes) may be required to provide sufficient compressive strength for each of the tanks. However, these braces must be as far away from the center pipe as possible (<u>at least 6 inches</u>), and should be as few in number as possible. The tanks should be painted inside with acid resistant paint to deter corosion.

   Covers for the two tanks can be constructed here on the compound by LPI. As for the tank which will contain the dry "ore", the cover will consist of a disc with a hole in the center which will fit the center pipe. One additional small hole in the cover is required for testing the seal of the tank after the cover is welded in place. This can be accomplished by connecting a pressure hose from a portable air compressor to a collar welded into the hole. The collar will be plugged after the test.

   As for the other tank which will contain the wet "ore", several collars will be required around the top of the cover (one near the center and 3 or 4 around the edge). These collars are needed to allow the air to escape from the ore when water is added to the tank. Water will be loaded by the Geophysical Services Branch by feeding a measured volume of water into a piece of tubing which will be placed in one of the collars so that it extends nearly to the bottom of the tank. Thus water will be introduced at the bottom, and when saturation is achieved, the water level will reach the open collars on top.

After the cover is welded in place, but before the water is added, the seal of the wet "ore" tank will be checked by the same method previously described for the dry "ore" tank, except that all collars (except the one used to introduce air pressure) will be plugged.

c. The top layer of both "P" pits will consist of a three foot thick slab, square shaped in plan view (5 ft. sides) composed of "barren" concrete (grout mix), with a 4-1/2 inch diameter hole formed in it. The hole should line up with the hole in the middle and bottom layers. The upper surface of the top layer should be no more than two feet above the level of the ground. Two hoisting hooks should be embedded in the concrete so that top layer of the two pits can be moved easily if the need should arise.

Construction can proceed as follows:

(1) Dig the holes for the two "P" pits in a location designated by the C&S Division, in the vicinity of the south end of the present "N" pits.

(2) Auger the holes for the lower sections of run pipe, or dig by hand, whichever is most expedient, and set the run pipes in place.

(3) Build forms, fasten run pipes in place, and pour bottom "barren" zone.

(4) Place stock-watering tanks (with center pipe and necessary bracing already welded in place) on top of the bottom layer of concrete. Tanks should be tested for leakage previous to this by filling them with water.

(5) Under the supervision of the Geophysical Services Branch, pour equal amounts of weighed dry "ore" into each tank, tamp it down to compact it as much as possible. See the following section: "Ore" Procurement and Preparation.

(6) Weld the two steel covers in place and test for air-tight seal.

At this point we (Geophysical Services Branch) will want to log both pits with a gamma ray logger to detect any differences between the two.

(7) Seal the dry "ore" pit.

(8) Saturate the wet "ore" pit with water and seal it.

(9) Build forms and pour the top "barren" zones.

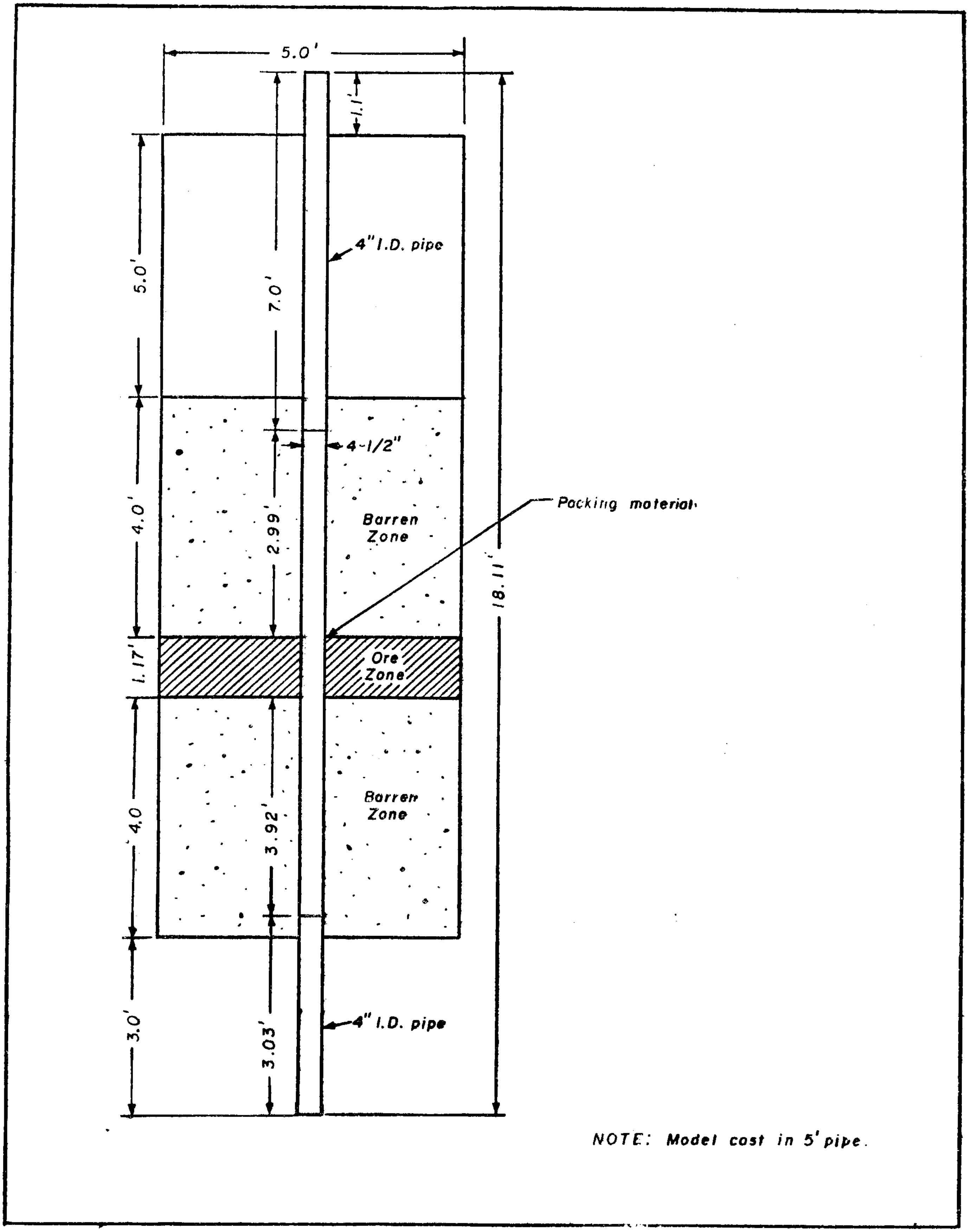
2. "ORE" PROCUREMENT AND PREPARATION

The material used as "ore" in the two pits can be obtained free of charge from the Climax mill in town. We want to use the maroon colored "slime", not the sand. LPI personnel should load 3-1/2 cubic yards of the "slime" material into a dump truck under the supervision of Geophysical [illegible] personnel (we want to select "ore" which is uniform in radioactivity). The truck should then be driven to the quonset-hut building at the old National Lead experimental mill on the compound. There the "slime" should be unloaded into previously cleaned (thoroughly washed out with a hose) drying pans where it can be stored temporarily. The "slime" should be dried thoroughly in the drying ovens in the quonset-hut, after which it should be loaded into drums and sealed to prevent it from absorbing water from the atmosphere. After all of the "ore" is dried and put into drums, the drums should be taken to the site of the "P" pits. It is important that we know the weight of the "ore" loaded into each tank. Therefore a portable scale should be brought to the "P" pit site so that the drums containing the "ore" can be weighed before and after the "ore" is transferred to the tanks. Samples of the "ore" will be taken by the Geophysical Services Branch when the tanks are loaded. These samples, will be analyzed for water content and gamma ray equivalent U_3O_8 content. After the "ore" is loaded "P" pit construction will proceed as outlined previously (starting with step (6) above).

N-1 TEST PIT

The N-1 test pit, constructed in January, 1958, according to the construction schematic, was the first test pit designed using a concrete mix for the ore and barren zones. The reason for using concrete was to obtain a density equivalent to naturally occurring ore bodies and barren rocks. Also the radius of this pit (2.5 ft.) is greater than the maximum distance gamma rays of interest will penetrate in rock formations. Previous test pits used for calibration purposes had been too small in radius to provide for an infinite thickness for the penetration of gamma rays of interest and had been filled with loose material of a density considerably lower than natural conditions. These conditions permitted greater penetration by gamma rays of interest in the test pits than would be achieved under natural conditions in a borehole. Other advantages gained by having concrete test pits are: The reduction of loss of radon gas from the ore zone and, the elimination of the need for a casing in the borehole of the test pits which would absorb some of the radiation. Table 5 lists the factors regarding this pit.

This test pit should be used only for research and not for calibration of gross gamma ray logging equipment because the ore zone is not in secular equilibrium and the ore zone is only 1.17 ft. thick which is too thin to approximate an infinite thickness in the vertical direction for gamma rays of interest.



N-1 MODEL

Figure 7

Table 5

N-1 TEST PIT

ore zones	ore type* & amount	unknown weight (3:1) ratio of aggregate to cement
	cement amount	unknown
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown (3:1) ratio of aggregate to cement
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.1936% U_3O_8
	gamma only	0.2480% eU_3O_8
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	unknown
	in situ	unknown
water or H^+	chemical analysis	unknown
	in situ	unknown
Zeq (petrographic analysis)		unknown
porosity		unknown
cracks or fractures		unknown
magnetic susceptibility		unknown

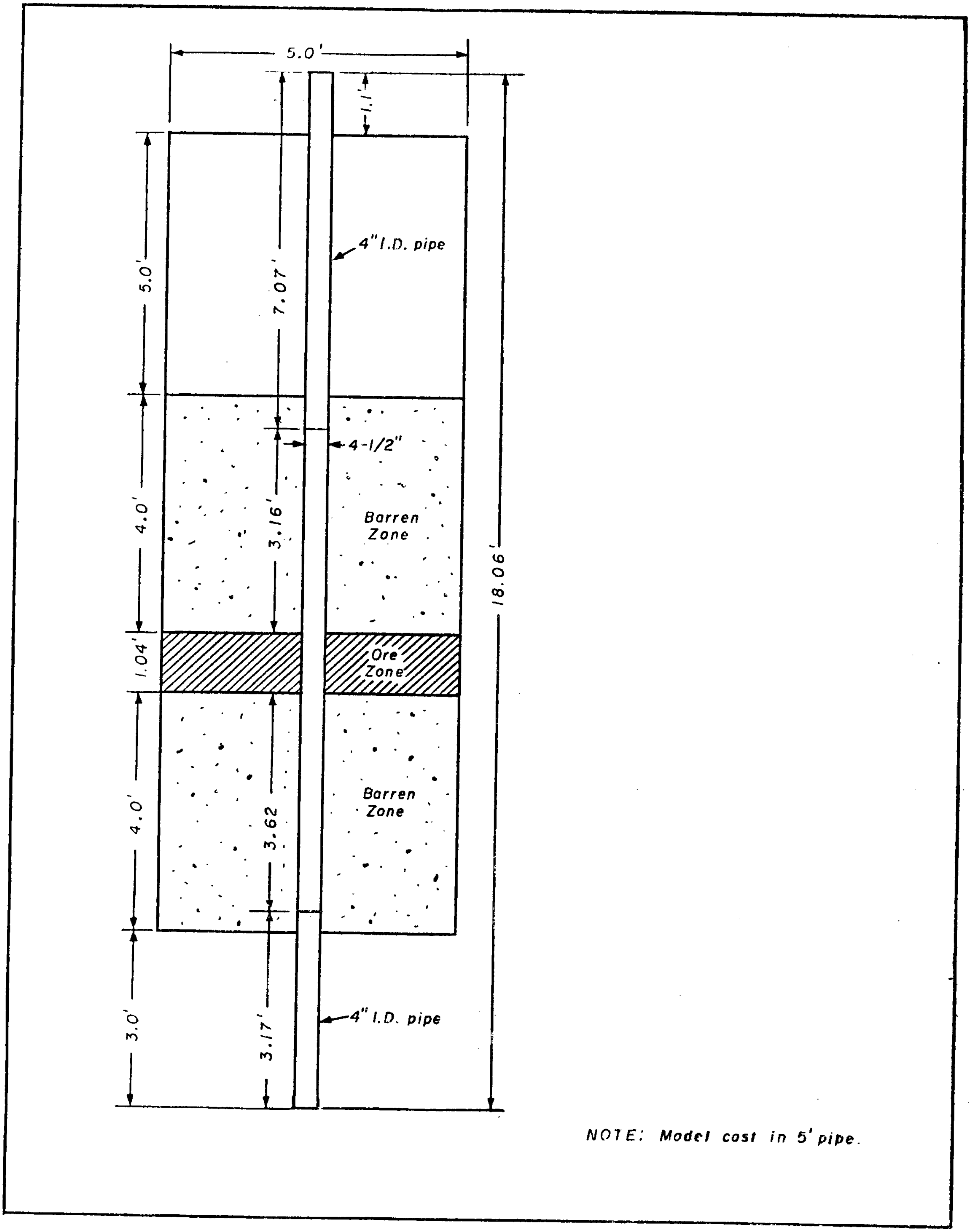
* ore came from Little Man Mine
SE ¼ S 14 T 27 N R 84 W
Carbon County, Wyoming

vein type ore (pitchblende)
in Precambrian rock

N-2 TEST PIT

The N-2 test pit, constructed in January, 1958 according to the construction schematic, was similar to the N-1 test pit. The only difference between the two test pits is that the N-2 test pit has a richer ore zone grade. Table 6 lists the factors regarding this pit.

The N-2 test pit should be used only for research and not for calibration of gross gamma ray logging equipment because the ore zone is not in secular equilibrium and the ore zone is only 1.04 ft. thick which is too thin to approximate an infinite thickness in the vertical direction for gamma rays of interest.



N-2 MODEL

Figure 8

Table 6

N-2 TEST PIT

ore zones	ore type* & amount	unknown (3:1) ratio aggregate to cement
	cement amount	unknown
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown (3:1) ratio aggregate to cement
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.3794% U_3O_8
	gamma only	0.4296% eU_3O_8
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	unknown
	in situ	unknown
water or H^+	chemical analysis	unknown
	in situ	unknown

Zeq (petrographic analysis)	unknown
porosity	unknown
cracks or fractures	unknown
magnetic susceptibility	unknown

*ore came from Little Man Mine
SE ¼ S 14 T 27 N R 84 W
Carbon County, Wyoming

vein type ore (pitchblende)
in Precambrian rock

N-3 TEST PIT

The N-3 test pit constructed in January, 1958 deviated from the construction schematic. Mr. R. F. Droullard was in charge of loading this test pit. The ore zone was increased in thickness from 1 ft. on the schematic to 4.15 ft. Otherwise it was built similar to the previous N test pits. Table 7 lists the factors regarding this pit.

In February, 1960 a 10 inch by 10 inch hole was cut into the outside shell of the N-3 test pit at the middle of the ore zone and a sample of this ore zone was collected. After this sample was collected, a plate was welded over this hole to re-seal the shell of this pit. An analysis of this sample for water was made with the results that there is 12.01% water by weight in the N-3 test pit ore zone.

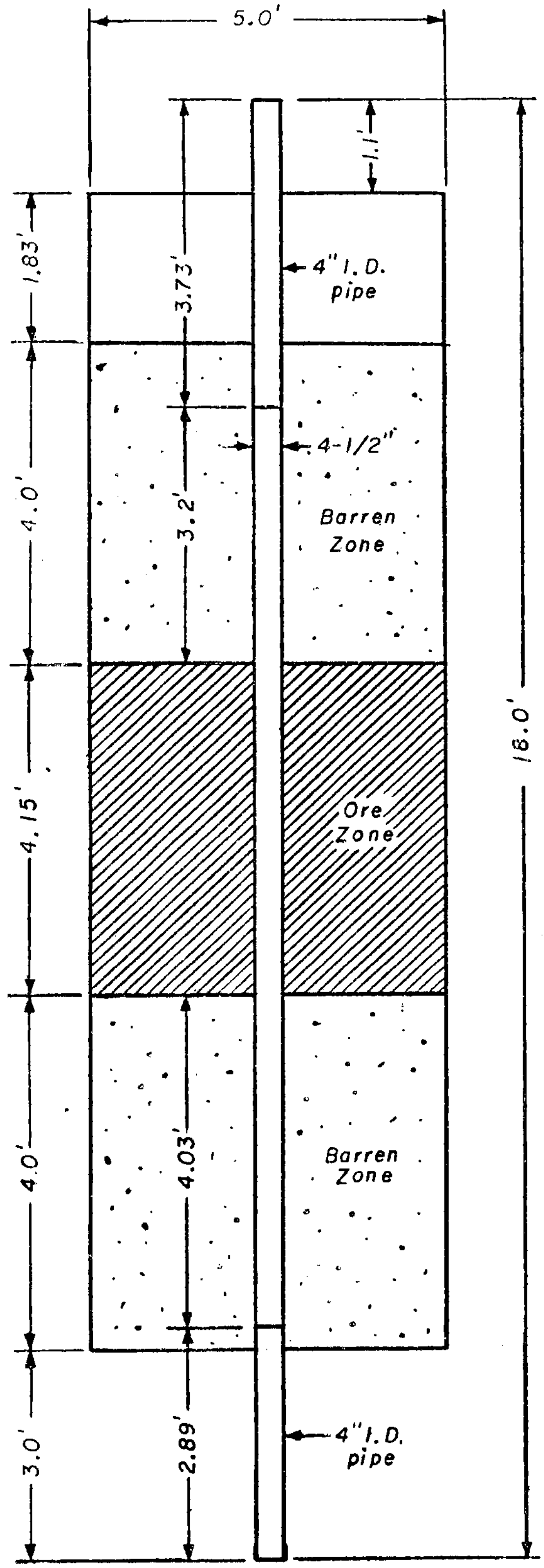
The N-3 test pit has been used as a calibration test pit for gross gamma ray logging equipment. This pit has the problems of secular disequilibrium and non-symmetric thickness of the ore zone. The disequilibrium problem is seen in the analysis of the ore zone. The chemical analysis of the samples from the ore zone shows there is a grade of 0.1855%U_3O_8 in this zone. The radiometric grade analyzed by the chemical laboratory shows there is a grade of 0.2381%eU_3O_8 in this zone. In a report by Eschliman and Key*, a grade of 0.241%eU_3O_8 was assigned to the N-3 test pit ore zone using gamma ray logging and a power curve calibration technique. At present a Ge(Li) radiometric analysis is being conducted on the samples from the ore zone of the N-3 test pit. The preliminary results so far show a grade of 0.130%eU_3O_8 for this ore zone.

The thickness problem was noticed while analyzing the difficulty of developing an accurate thickness of the ore zone from logs of the N-3 test pit. Recent measurements of this ore zone (Aug. 12, 1975) show the thickness to be 4.15 ft. which is very close to the assigned thickness of 4.19 ft. The N-3 test pit thickness problem stems from the asymmetry of this model which introduces inaccuracies when the count rate through the zone from background to background is integrated. The contact between the lower barren zone and the ore zone produces a plateau or tail area in what should be a smooth rise to the top of the ore zone when logging the N-3 test pit. A "tail factor" method has been devised to circumvent this problem; but this procedure is inadequate because different probe configurations have different spectral responses and different tail areas, and a different tail factor is needed for each digitizing increment used with a given probe. The method presently used to eliminate this plateau or tail area problem involves summing the upper side anomally counts and doubling that sum. Errors of as much as two percent are still considered possible with this method.

While measuring the thickness of the N-3 test pit ore zone (Aug. 12, 1975) a black substance was observed coating the borehole of this test pit. A sample of this substance was scraped off the borehole and is presently being analyzed by the Chemistry Department.

This test pit should be used only for research and not for calibration of gross gamma ray logging equipment because of the problems discussed above.

*Eschliman, D. H. and Key, B. N., October 24, 1972, "A Change of Assigned Radiometric Grade for the US AEC Gamma Ray Logging Calibration Models", Lucius Pitkin Geophysics/Electronics Report No. 5, Grand Junction, Colorado.



Borehole completely coated with black substance.

N-3 MODEL

Figure 9

Table 7

N-3 TEST PIT

ore zones	ore type* & amount	unknown weight (3:1) ratio of aggregate to cement
	cement amount	unknown
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown (3:1) ratio of aggregate to cement
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.1855% U_3O_8
	gamma only	0.240% eU_3O_8
	gamma spec	unknown
	gamma logging	0.241 $\pm$0.0008% eU_3O_8
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	1.83 g/cc (dry) 2.09 g/cc (wet)
	in situ	unknown
water or H^+	chemical analysis	12.01% L.O.D. at 110°C by weight
	in situ	12.32% by weight (neutron-neutron probe 601)

Zeq (petrographic analysis)	unknown
porosity	unknown
cracks or fractures	unknown
magnetic susceptibility	unknown

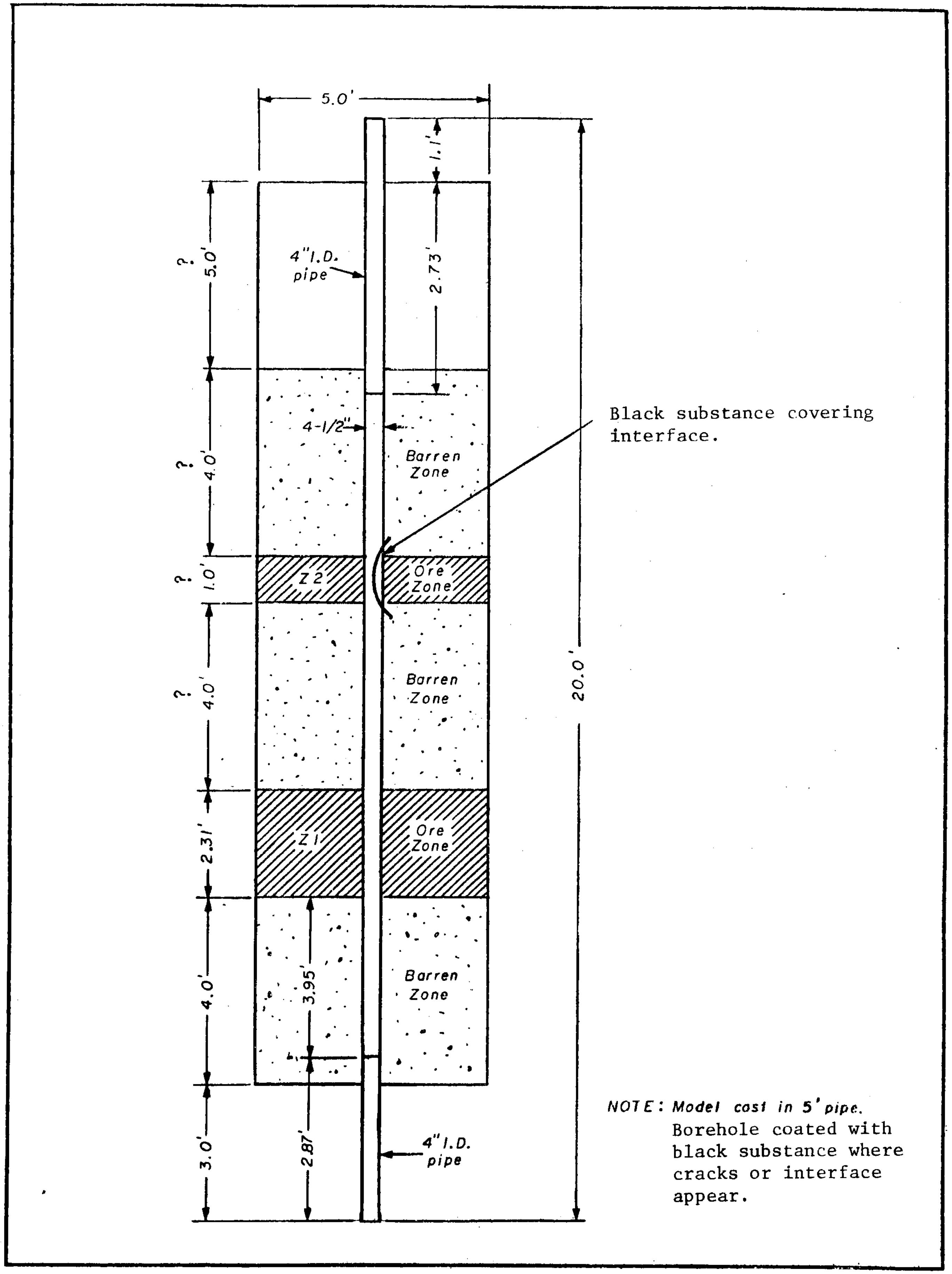
*ore came from Little Man Mine
SE ¼ S 14 T 27 N R 84 W
Carbon County, Wyoming

vein type ore (pitchblende)
in Precambrian rock

N-4 TEST PIT

The N-4 test pit constructed in January, 1958 deviated from the construction schematic. Mr. R. F. Droullard was in charge of loading this test pit. Instead of one ore zone, two were constructed for this pit with a barren zone inbetween them. The lower ore zone, Z_1, is 2.31 ft. thick and the upper ore zone, Z_2, is 1.0 ft. thick. The barren zone between these ore zones is 4 ft. thick. Table 8 lists the factors regarding this pit. A black substance similar to the substance in the N-3 test pit covered the upper ore zone, Z_2, so the measurements for thickness of the barren zone and Z_2 could not be made on August 12, 1975.

The N-4 test pit should be used only for research and not for calibration of gross gamma ray logging equipment because the ore zones are not in secular equilibrium and they are too thin to approximate an infinite thickness in the vertical direction for gamma rays of interest.



N-4 MODEL

Figure 10

Table 8

N-4 TEST PIT

ore zones	ore type* & amount	unknown weight (3:1) ratio of aggregate to cement	
	cement amount	unknown	
	water amount	unknown	
	sand type & amount	unknown	
barren zone	sand type & amount	unknown (3:1) ratio of aggregate to cement	
	cement amount	unknown	
	water amount	unknown	
assay analysis ore zone	chemical	lower zone Z_1 0.1920% U_3O_8	upper zone Z_2 0.8875% U_3O_8
	gamma only	0.2459% eU_3O_8	0.9183% eU_3O_8
	gamma spec	unknown	unknown
	gamma logging	unknown	unknown
assay analysis barren zones	chemical	unknown	
	gamma only	unknown	
	gamma spec	unknown	
	gamma logging	unknown	
density	chemical analysis	unknown	
	in situ	unknown	
water or H^+	chemical analysis	unknown	
	in situ	unknown	
Zeq (petrographic analysis)		unknown	
porosity		unknown	
cracks or fractures		unknown	
magnetic susceptibility		unknown	

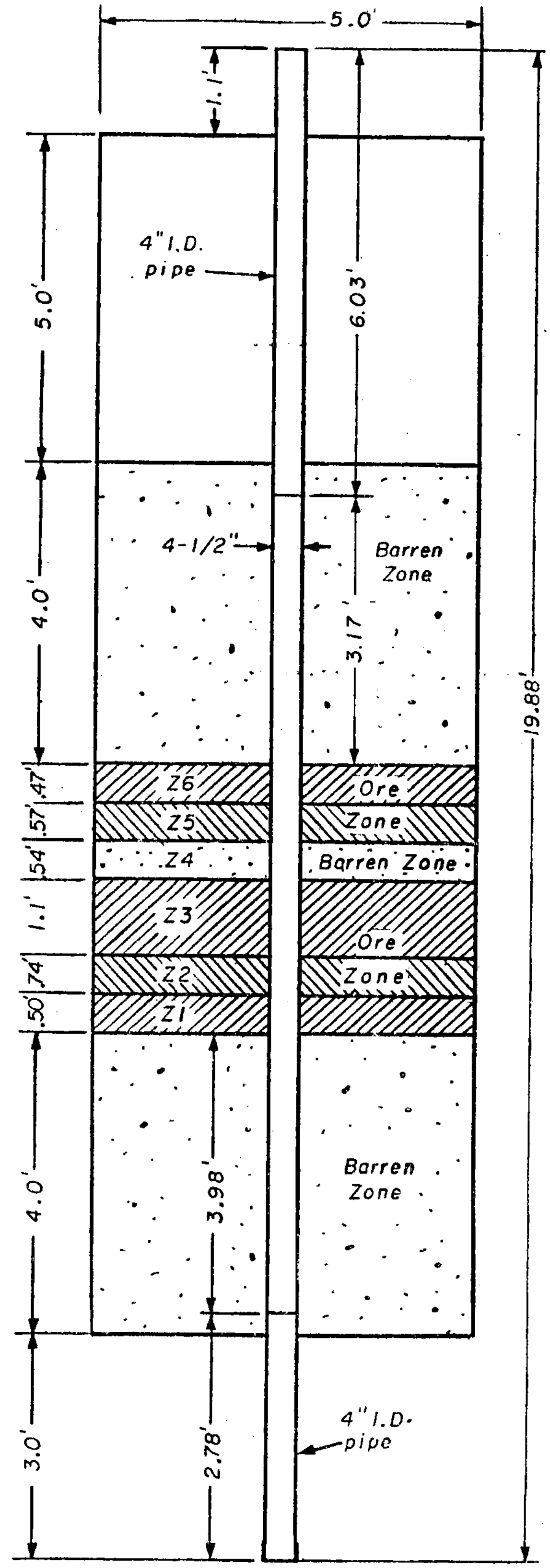
*ore came from Little Man Mine
SE ¼ S 14 T 27 N R 84 W
Carbon County, Wyoming

vein type ore (pitchblende)
in Precambrian rock

N-5 TEST PIT

The N-5 test pit constructed in January, 1958 deviated from the construction schematic. Mr. R. F. Droullard was in charge of loading the test pit. This pit has 5 thin ore zones with different grades and a thin barren zone sandwiched together as shown in the schematic. The factors for this pit are listed in Table 9.

The N-5 test pit is a research test pit and was constructed to evaluate or test the GAMLOG or MDDAT computer program. The MDDAT program analyzes gamma logs from exploration boreholes in a quantitative manner and determines the concentration of gamma ray emitting elements in the layered rocks penetrated by these boreholes.



NOTE: Model cast in 5' pipe.

Borehole covered with black substance where cracks or interface appear.

N-5 MODEL

Figure 11

Table 9

N-5 TEST PIT

ore zones	ore type* & amount	unknown weight (3:1) ratio of aggregate to cement					
	cement amount	unknown					
	water amount	unknown					
	sand type & amount	unknown					
barren zone	sand type & amount	unknown (3:1) ratio of aggregate to cement					
	cement amount	unknown					
	water amount	unknown					
assay analysis ore zone		Z_1	Z_2	Z_3	Z_4barren	Z_5	Z_6
	chemical $\%U_3O_8$	0.1960	0.0840	0.9096	unknown	0.1714	1.6308
	gamma only $\%eU_3O_8$	0.2500	0.1030	0.9464	unknown	0.2192	1.7145
	gamma spec	unknown	unknown	unknown	unknown	unknown	unknown
	gamma logging	unknown	unknown	unknown	unknown	unknown	unknown
assay analysis barren zones	chemical	unknown					
	gamma only	unknown					
	gamma spec	unknown					
	gamma logging	unknown					
density	chemical analysis	unknown					
	in situ	unknown					
water or H^+	chemical analysis	unknown					
	in situ	unknown					
Zeq (petrographic analysis)		unknown					
porosity		unknown					
cracks or fractures		unknown					
magnetic susceptibility		unknown					

*ore came from Little Man Mine
SE ¼ S 14 T 27 N R 84 W
Carbon County, Wyoming

vein type ore (pitchblende)
in Precambrian rock

USAEC TEST PIT DATA

Headings:
- L&P - Lucius Pitkin, Inc.
- Brown - Brown Laboratories, Grand Junction, Colorado
- USAEC - Geophysical Services Branch, PED
- Chem - Chemical assay - $\% U_3O_8$
- Rad-A - Radiometric Beta and Gamma Assay - $\% eU_3O_8$
- Rad-B - Radiometric Gamma Only Assay - $\% eU_3O_8$

Model N-1   T = 1.1 Feet

Sample No.	L&P Rad-A	L&P Chem	Brown Rad-A	Brown Chem	USAEC Rad-B
39729	0.22	0.19	0.22	0.19	0.226
39730	0.21	0.20	0.23	0.19	0.235
39731	0.21	0.19	0.22	0.18	0.223
39732	0.22	0.19	0.21	0.19	0.226
39733	0.24	0.22	0.26	0.22	0.255
	0.220	0.193	0.228	0.194	0.234

Model N-2   T = 0.98 Feet

Sample No.	L&P Rad-A	L&P Chem	Brown Rad-A	Brown Chem	USAEC Rad-B
39734	0.35	0.40	0.41	0.38	0.401
39735	0.33	0.38	0.45	0.40	0.433
39736	0.34	0.32	0.43	0.39	0.412
39737	0.36	0.40	0.39	0.37	0.376
39378	0.34	0.39	0.41	0.39	0.405
	0.344	0.378	0.418	0.386	0.406

Model N-3   T = 4.19 Feet

Sample No.	L&P Rad-A	L&P Chem	Brown Rad-A	Brown Chem	USAEC Rad-B
39756	0.20	0.18	0.25	0.19	0.228
39757	0.20	0.19	0.21	0.19	0.221
39758	0.19	0.19	0.21	0.18	0.218
39759	0.20	0.19	0.22	0.19	0.215
39760	0.19	0.19	0.21	0.18	0.230
39761	0.19	0.19	0.23	0.19	0.230
39762	0.21	0.19	0.23	0.19	0.227
39763	0.20	0.19	0.23	0.18	0.221
39764	0.15	0.19	0.23	0.18	0.226
	0.196	0.189	0.224	0.186	0.224

Model 1421 (Bottom Zone) T = 2.25 Feet

Sample No.	L P Rad-A	L P Chem	Brown Rad-A	Brown Chem	USAEC Rad-A
39741	0.19	0.20	0.22	0.20	0.234
39742	0.19	0.20	0.24	0.19	0.239
39743	0.19	0.20	0.22	0.20	0.236
39744	0.20	0.20	0.23	0.19	0.233
39745	[illegible]	0.19	0.23	0.20	0.231
39746	0.19	0.21	[illegible]	0.20	0.209
39747	0.19	0.20	0.25	[illegible]	0.241
39748	0.19	0.19	0.23	0.19	0.228
39749	0.18	0.19	0.23	0.19	0.233
39750	0.17	0.20	0.23	0.19	0.231
39751	0.18	0.20	0.23	0.18	0.232
39752	0.20	0.20	0.23	0.19	0.235
	0.189	0.198	0.230	0.193	0.231

Model 1422 T = 1.0 Feet

Sample No.	L P Rad-A	L P Chem	Brown Rad-A	Brown Chem	USAEC Rad-A
39765	0.87	0.93	0.88	0.87	0.872
39766	0.87	0.91	0.98	0.91	0.903
39767	0.83	0.92	0.75	0.79	0.829
39768	0.87	0.94	0.86	0.89	0.881
39769	0.80	0.87	0.94	0.89	0.917
39770	0.74	0.89	0.91	0.89	0.926
	0.847	0.910	0.891	0.873	0.888

Model M-5 Zone 1 T = 0.54 Feet

Sample No.	L P Rad-A	L P Chem	Brown Rad-A	Brown Chem	USAEC Rad-B
39739	0.19	0.20	0.23	0.19	0.229
39740	0.20	0.20	0.24	0.19	0.234
	0.195	0.20	0.235	0.19	0.232

Model M-5 Zone 2 T = 0.5 Feet

Sample No.	L P Rad-A	L P Chem	Brown Rad-A	Brown Chem	USAEC Rad-A
39753	0.09	0.09	0.10	0.09	0.103
39754	0.09	0.10	0.10	0.09	0.102
39755	0.09	0.09	0.11	0.09	0.106
	0.09	0.093	0.103	0.09	0.103

Model N-5 Zone 3 T = 1.08 Feet

Sample No.	L&P Rad-A	L&P Chem	Brown Rad-A	Brown Chem	USAEC Rad-B
39771	0.90	0.94	0.93	0.94	0.915
39772	0.78	0.83	0.94	0.92	0.941
39773	0.83	0.92	0.95	0.91	0.936
39774	0.88	0.92	0.87	0.83	0.898
39775	0.92	0.94	0.91	0.89	0.873
39776	0.92	0.96	0.93	0.89	0.909
39777	0.92	0.95	0.83	0.83	0.840
	0.878	0.922	0.909	0.887	0.902

Model N-5 Zone 4 T = 0.5 Feet

BARREN

Model N-5 Zone 5 T = 0.5 Feet

Sample No.	L&P Rad-A	L&P Chem	Brown Rad-A	Brown Chem	USAEC Rad-B
39778	0.20	0.20	0.22	0.20	0.224
39779	0.16	0.16	0.19	0.14	0.171
39780	0.20	0.18	0.19	0.17	0.204
39781	0.19	0.13	0.21	0.17	0.215
39783	0.18	0.17	0.20	0.17	0.206
	0.186	0.178	0.202	0.162	0.204

Model N-5 Zone 6 T = 0.5 Feet

Sample No.	L&P Rad-A	L&P Chem	Brown Rad-A	Brown Chem	USAEC Rad-B
39783	1.49	1.64	1.65	1.60	1.653
39784	1.49	1.67	1.64	1.62	1.665
39785	1.52	1.60	1.57	1.56	1.525
39786	1.56	1.71	1.60	1.61	1.641
	1.52	1.66	1.615	1.60	1.621

N TEST PITS

N-1 Test Pit 10-16-59

sample	chemical $\%U_3O_8$	radiometric $\%eU_3O_8$	8-19-60
X3420	0.19	0.22	0.24
X3421	0.19	0.24	0.24
X3422	0.19	0.23	0.23
X3423	0.19	0.23	0.23
X3424	0.22	0.24	0.25
AVERAGE	0.19(6)	0.23(2)	0.23(8)

N-2 Test Pit 10-16-59

X3425	0.38	0.40	0.45
X3426	0.39	0.42	0.44
X3427	0.38	0.41	0.41
X3428	0.37	0.38	0.37
X3429	0.38	0.40	0.41
AVERAGE	0.38(0)	0.40(2)	0.41(6)

N-3 Test Pit 10-16-59

X3430	0.19	0.26	0.24
X3431	0.19	0.23	0.23
X3432	0.18	0.22	0.24
X3433	0.18	0.22	0.21
X3434	0.18	0.23	0.23
X3435	0.18	0.22	0.24
X3436	0.19	0.23	0.23
X3437	0.18	0.23	0.23
X3438	0.18	0.23	0.24
X3439	0.19	0.24	0.25
AVERAGE	0.18(4)	0.23(1)	0.23(4)

N-5 Test Pit Zone 1 10-16-59

sample	chemical $\%U_3O_8$	radiometric $\%eU_3O_8$	
			8-19-60
X3457	0.21	0.24	0.26
X3458	0.19	0.24	0.25
AVERAGE	0.20(0)	0.24(0)	0.25(5)
	Zone 2		
X3459	0.08	0.10	0.11
X3460	0.08	0.10	0.10
X3461	0.08	0.10	0.11
AVERAGE	0.08(0)	0.10(0)	0.10(7)
	Zone 3		
X3462	0.94	0.90	0.95
X3463	0.94	0.99	0.97
X3464	0.92	0.97	0.93
X3465	0.88	0.96	0.92
X3466	0.89	0.88	0.97
X3467	0.91	0.89	0.94
X3468	0.85	0.87	0.87
AVERAGE	0.90(4)	0.92(3)	0.93(6)

Zone 4

barren; no chemical or radiometric analysis

	Zone 5		
X3469	0.19	0.23	0.24
X3470	0.15	0.18	0.19
X3471	0.17	0.22	0.21
X3472	0.17	0.23	0.22
X3473	0.17	0.21	0.22
AVERAGE	0.17(0)	0.21(4)	0.21(6)
	Zone 6		
X3474	1.62	1.59	1.67
X3475	1.65	1.66	1.70
X3476	1.57	1.56	1.71
X3477	1.56	1.60	1.67
AVERAGE	1.60(0)	1.60(3)	1.68(8)

N-4 Test Pit   Zone 1   10-16-59

sample	chemical $\%U_3O_8$	radiometric $\%eU_3O_8$	8-19-60
X3440	0.19	0.24	0.24
X3441	0.19	0.23	0.24
X3442	0.19	0.22	0.25
X3443	0.19	0.23	0.23
X3444	0.19	0.24	0.24
X3445	0.20	0.25	0.23
X3446	0.19	0.23	0.23
X3447	0.19	0.25	0.25
X3448	0.20	0.22	0.23
X3449	0.19	0.24	0.24
X3450	0.20	0.23	0.24
AVERAGE	0.19(3)	0.23(5)	0.23(8)

Zone 2

X3451	0.88	0.89	0.91
X3452	0.92	0.94	0.96
X3453	0.81	0.83	0.85
X3454	0.89	0.86	0.93
X3455	0.89	0.84	0.93
X3456	0.91	0.81	0.88
AVERAGE	0.88(3)	0.86(2)	0.91(0)

N TEST PITS

N-1 Test Pit 3-3-66

sample	chemical $\%U_3O_8$	radiometric $\%eU_3O_8$
A228	0.190	0.238
A229	0.193	0.239
A230	0.186	0.251
A231	0.184	0.240
A232	0.215	0.272
AVERAGE	0.193(6)	0.248(0)

N-2 Test Pit 3-3-66

A233	0.380	0.420
A234	0.382	0.442
A235	0.385	0.430
A236	0.367	0.410
A237	0.383	0.446
AVERAGE	0.379(4)	0.429(6)

N-3 Test Pit 2-25-66

A112	0.184	0.229
A113	0.192	0.250
A114	0.186	0.241
A115	0.185	0.232
A116	0.182	0.224
A117	0.185	0.237
A118	0.185	0.254
A119	0.186	0.237
A120	0.184	0.236
A121	0.186	0.241
AVERAGE	0.185(5)	0.238(1)

N-4 Test Pit   Zone 1   3-3-66

sample	chemical $\%U_3O_8$	radiometric $\%eU_3O_8$
A126	0.193	0.242
A127	0.196	0.250
A128	0.189	0.256
A129	0.192	0.240
A130	0.190	0.248
A131	0.191	0.243
A132	0.193	0.242
AVERAGE	0.192(0)	0.245(9)
	Zone 1?	
A238	0.191	0.251
A239	0.190	0.251
A240	0.191	0.240
A241	0.190	0.252
A242	0.190	0.241
AVERAGE	0.190(4)	0.247(0)
	Zone 2	
A133	0.878	0.922
A134	0.932	0.957
A135	0.813	0.850
A136	0.896	0.927
A137	0.894	0.924
A138	0.912	0.930
AVERAGE	0.887(5)	0.918(3)

N-5 Test Pit   Zone 1   3-3-66

sample	chemical $\%U_3O_8$	radiometric $\%eU_3O_8$
A139	0.198	0.244
A140	0.194	0.256
AVERAGE	0.196(0)	0.250(0)

Zone 2

A141	0.084	0.090
A142	0.082	0.110
A143	0.086	0.109
AVERAGE	0.084(0)	0.103(0)

Zone 3

A144	0.946	0.968
A145	0.944	0.959
A146	0.924	0.937
A147	0.891	0.957
A148	0.897	0.931
A149	0.913	0.982
A150	0.852	0.891
AVERAGE	0.909(6)	0.946(4)

Zone 4

barren; no chemical or radiometric analysis

Zone 5

A151	0.193	0.237
A152	0.153	0.182
A153	0.174	0.221
A154	0.171	0.230
A155	0.166	0.226
AVERAGE	0.171(4)	0.219(2)

Zone 6

A156	1.636	1.769
A157	1.660	1.781
A158	1.582	1.592
A159	1.645	1.716
AVERAGE	1.630(8)	1.714(5)

Form No. 1 Rev.
4/2/70 - 1 00

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.
CONTRACTOR FOR UNITED STATES ATOMIC ENERGY COMMISSION

CERTIFICATE OF ASSAY

REQUESTED BY LPI REQUISITION NO. N-3 Pit RERUN DATE July 27, 1971

The following results were obtained for the N-3 pit samples of which six of the original ten were available. These were the sealed cans obtained from the Commission.

Each assay was the result of a 100,000 counts with an updated electronic system built and calibrated by the LPI electronics laboratory having a dead time correction of 3.4 u sec calculated for the system. Attached is the data obtained from the present analysis.

SAMPLE #	A-112	A-113	A-114	A-115	A-116	A-117	A-118	A-119	A-120	A-121
AVG F run	0.2286	0.2509	0.2379	*	0.2295	0.2441	.2456	*	*	*
Precision @95% Confidence Level	0.0011	0.0014	0.0021		0.0016	0.0036	.0050			
Original	.229	.250	.241	.232	.224	.237	.254	.237	.236	.241

	AVG	Precision @ 95% Confidence Level
Six sample reruns	0.239%	0.009%
Six original runs	0.239	0.012
Total original run	0.238	0.009

*Sample not available for analysis

Richard S. Shay
Sr. Chemist

-47-

N-3 PIT

Sample # Weight	A-112 21.566	A-113 16.204	A-114 14.604	A-115	A-116 18.692	A-117 13.524	A-118 14.362
6/26/71	0.2295	0.2513	0.2411		0.2294	0.2499	0.2490
6/28/71	0.2284	0.2495	0.2351		0.2271	0.2365	0.2404
6/30/71	0.2288	0.2508	0.2365		0.2317	0.2435	0.2443
6/29/71	0.2307	0.2525	0.2417		0.2291	0.2460	0.2443
6/29/71	0.2293	0.2484	0.2387		0.2281	0.2452	0.2412
7/2/71	0.2269	0.2505	0.2386		0.2293	0.2449	0.2449
7/8/71	0.2269	0.2502	0.2353		0.2289	0.2404	0.2419
7/15/71	0.2287	0.2519	0.2373		0.2307	0.2455	0.2456
7/20/71	0.2284	0.2510	0.2378		0.2283	0.2427	0.2578
7/19/71	0.2284	0.2533	0.2375		0.2325	0.2464	0.2472

U. S. ATOMIC ENERGY COMMISSION

WORK REQUEST PROPOSAL
Grand Junction Operations Office
Grand Junction, Colorado

Date: November 29, 1957
Work Request Proposal No. ED-1
Total Estimated Project Cost: $7,500.00
Requested by this Proposal: $7,500.00

TITLE: VERTICAL TEST PITS

Prepared by: M. E. Crew

Approval Recommended by:

Ernest R. Gordon, Director, ED

Approval Recommended by:

C. Peters, Director, C&S Division

Approval Recommended by:

Elton A. Youngberg, AMO

Approved by:

Manager, Grand Junction Operations Office

PROBLEM:

To provide facilities for calibration of gamma ray logging equipment. Previous test pits used for calibration purposes have been too small in diameter to provide infinite thickness for penetration by gamma rays and have been filled with loose material of a density considerably lower than in-hole conditions, thereby permitting greater penetration by gamma rays than would be achieved in a drill hole. It is therefore considered necessary to provide test pits with a radius equal or greater than the maximum distance gamma rays will penetrate in rock formations and of a density equivalent to that of a naturally occurring ore body in place. Several grade-thickness combinations must be available to adequately control the calibration curve. The zones both above and below the ore zone must be approximately the same density as the ore zones. Without test pits for calibration, the interpretation of our gamma ray logs would be at best, a guess and subject to errors of interpretation in the order of ± 100% in both grade and thickness.

PROPOSED WORK:

Five vertical test pits with welded sheet steel outer shell filled with various thicknesses and grades of both ore material and barren material mixed in concrete to equal the density of ore deposits in place are proposed. Pits must have a four inch hole in the center of each to accommodate the logging probe, have covers to keep out excess moisture, and as a safety feature, should have a permanent ladder and a walkway on the top to facilitate placing and removing the probes. The attached sketches present a cross section of the proposed test pits.

ADVANTAGES TO BE GAINED:

With the proposed installation it will be possible to determine the accuracy of gamma ray logging techniques and equipment used in estimating grade and thickness of ore in a drill hole. This is essential for accurate ore reserve compilation and is very important in connection with ore potential estimates. With the new pits we hope to perfect techniques of logging that will exceed in accuracy any presently used either by government or private industry. It is proposed to continue experimental work indefinitely, using the pits as a standard.

The test pits will be made available for use by private industry in calibrating their logging equipment, thus indirectly benefitting the Commission by increased reliability of ore reserve data submitted by companies who use the test pits for calibration.

By using concrete the density of the pit fillings has been increased from a range of 19-22 cubic feet per ton (the greatest obtainable using packed sand) to 15 cubic feet per ton, which approximates an average for Plateau type uranium ore bodies and host rocks in place. Since absorption of gamma rays is a function of the density of the material penetrated, it is important that the approximate density of ore bodies be attained in test pits to be used for calibration purposes. This fact was confirmed by measurements in the pit loaded under requisition number 18700 before it was decided to proceed with concrete loadings for the remaining pits. Other advantages of concrete over sand packed pits are: (1) prevention of loss of radon from the ore zone, (2) elimination of the need for a casing in the center which would absorb some of the radiation, and (3) will permit electric logging and alpha and beta radiation measurements should they be desired in future experimental work.

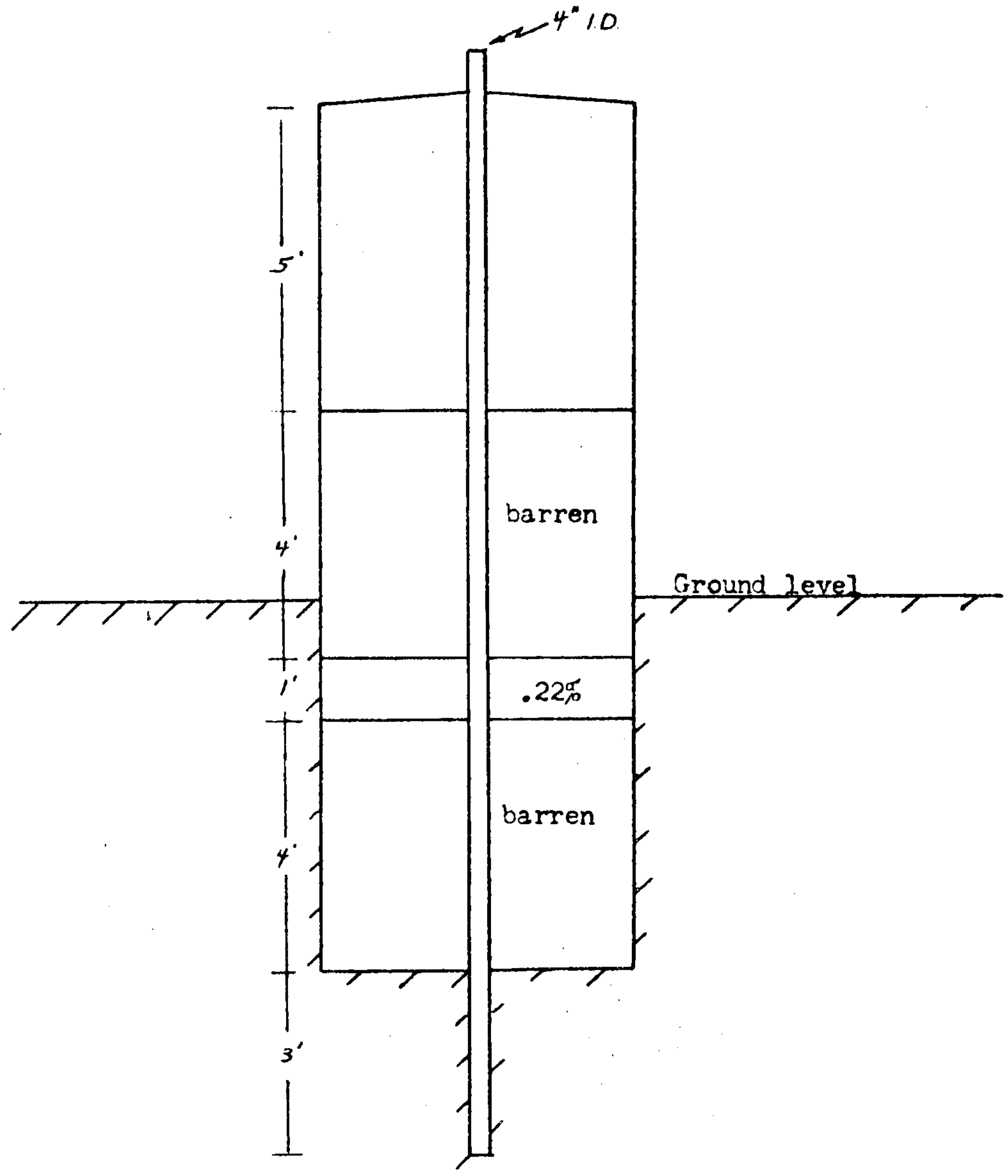
<u>SCHEDULE AND METHOD OF PERFORMING THE WORK:</u>

The following requisitions have been submitted for work on the project:

19149 - 5/16/57 Request S & W construct 5 test pits for calibration of gamma ray logging equipment.
18660 - 6/20/57 Modification of 19149 to use 10 gauge iron walls and 12 gauge iron dividers.
18700 - 9/18/57 Request S & W load one test pit as per instructions from R. F. Droullard.
20276 - 10/18/57 Request S & W load four test pits as per instructions from R. F. Droullard.
20291 - 11/12/57 Request S & W construct metal stairs and walkway with safety rails on test pits.
19921 - 11/7/57 Request S & W haul 2 tons ore from Grants to Compound.

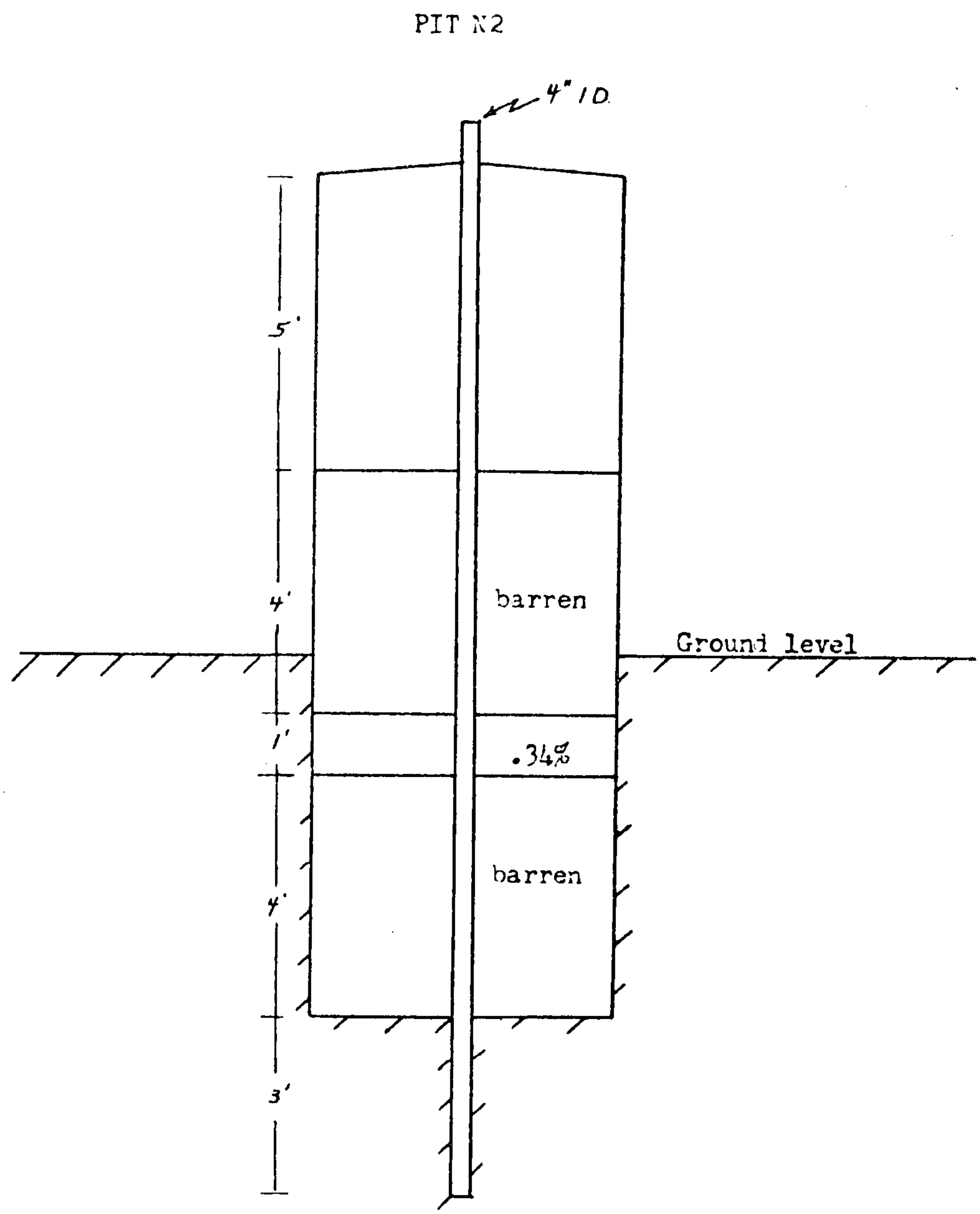
At present all 5 shells are complete and in place, 3 pits have been completely loaded and 2 pits partially loaded. Remaining to be done is the loading of ore and upper barren zones in two pits, covers for all five and the walkway and stairs as a safety measure.

PIT N1



Pits N1, N2, & N3 to be used to establish points on calibration curve.

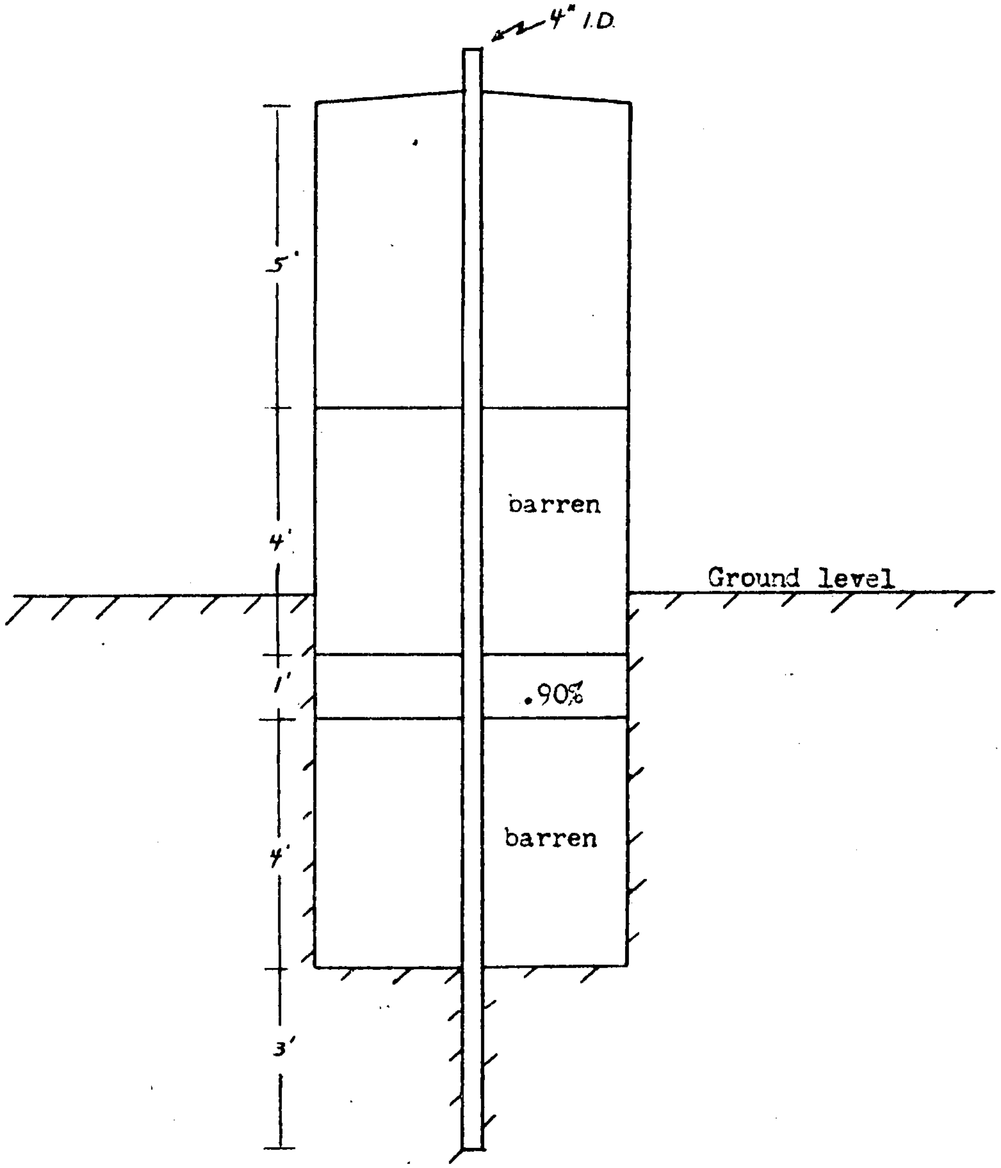
Figure 12



Pits N1, N2, & N3 to be used to establish points on calibration curve.

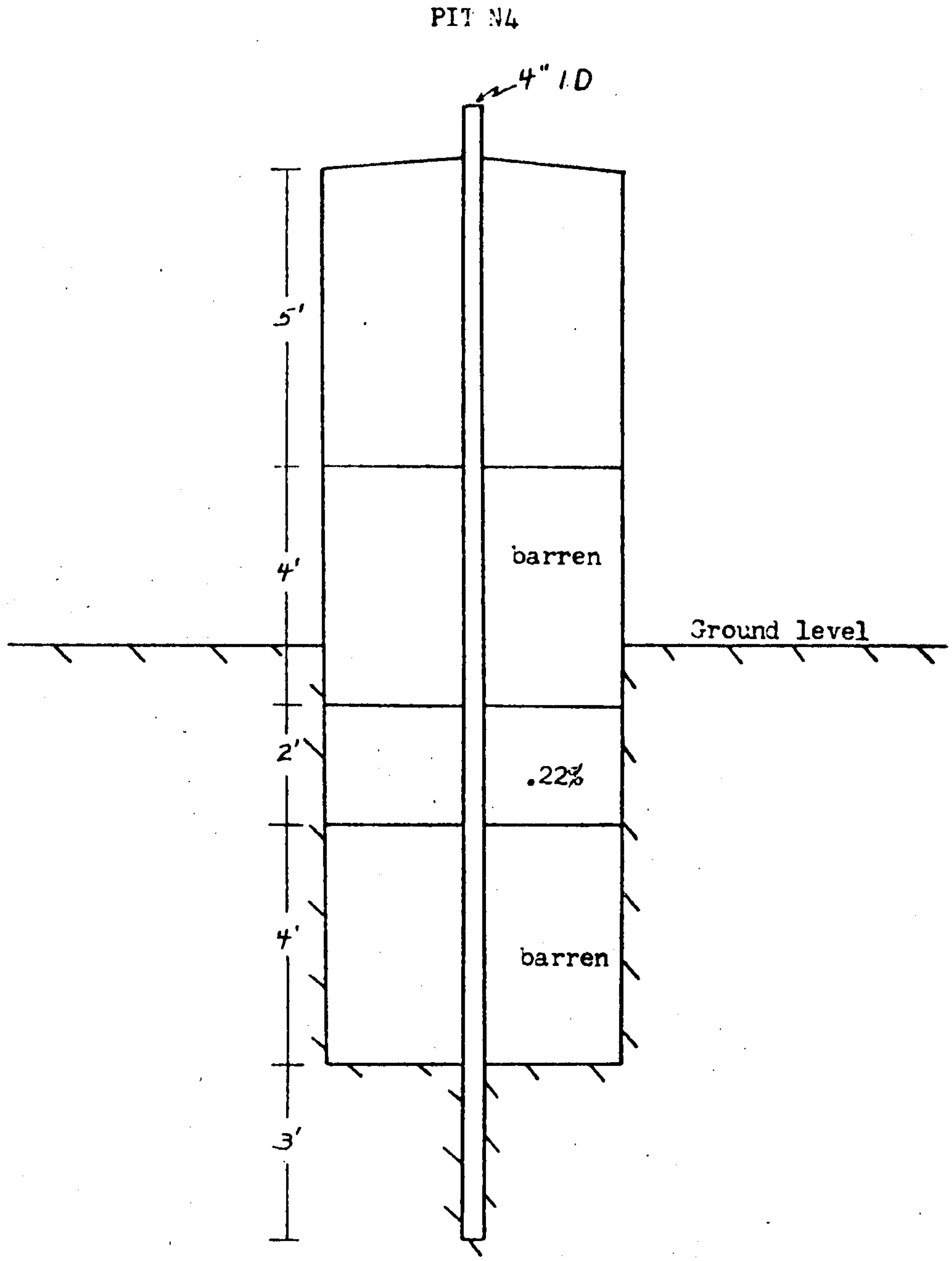
Figure 13

PIT N3



Pits N1, N2, & N3 to be used to establish points on calibration curve.

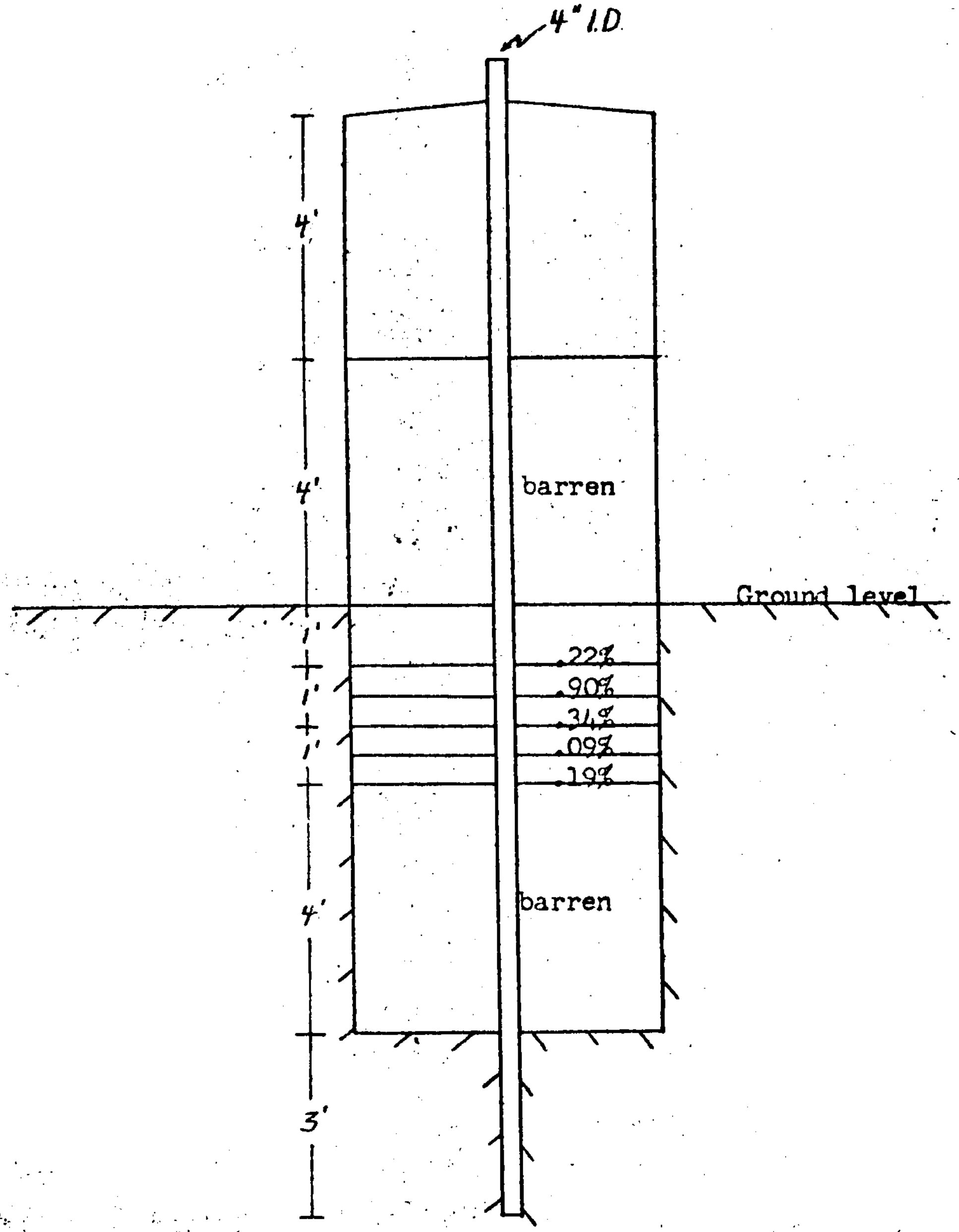
Figure 14



This pit to be used in combination with pit N1 to determine dead time losses in equipment.

Figure 15

PIT N5

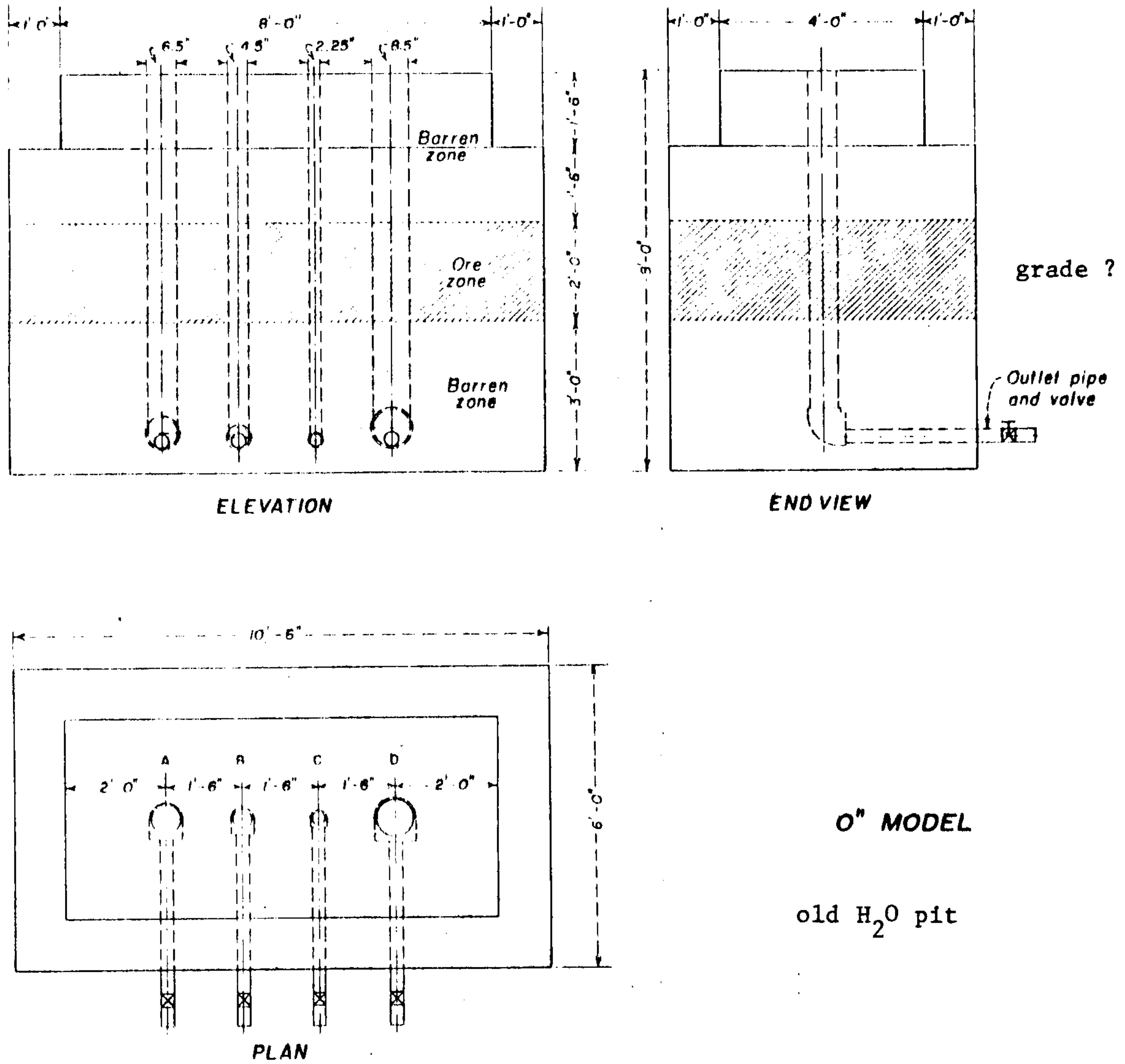


This pit to be used to show response from a complex ore zone.

Figure 16

OLD H_2O TEST PIT ("O" Model)

The old H_2O test pit was built in April, 1960 and modified in June, 1961. This pit was designed to calculate the water factor in a borehole for gamma ray logging equipment. In June, 1960 a mixing barrel and slurry pump were installed so that mud slurry could be pumped into the pit. In this manner a correction factor for gamma ray logging equipment due to simulated drilling fluid could be obtained. Casing and borehole size corrections were also calculated using this pit. The data on this test pit is sketchy and the construction plans could not be located. Since a new H_2O test pit has been constructed, the old H_2O test pit should be removed because it has settled and cracked. Table 10 lists the factors for this pit.



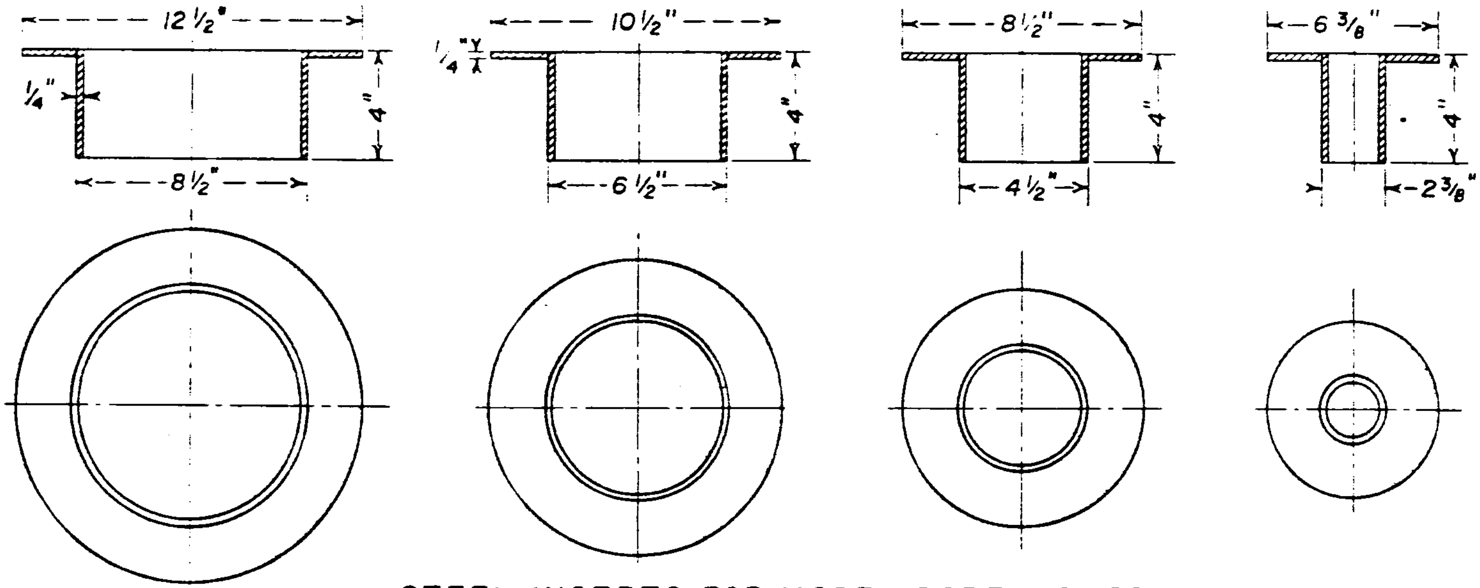
grade ?

O" MODEL

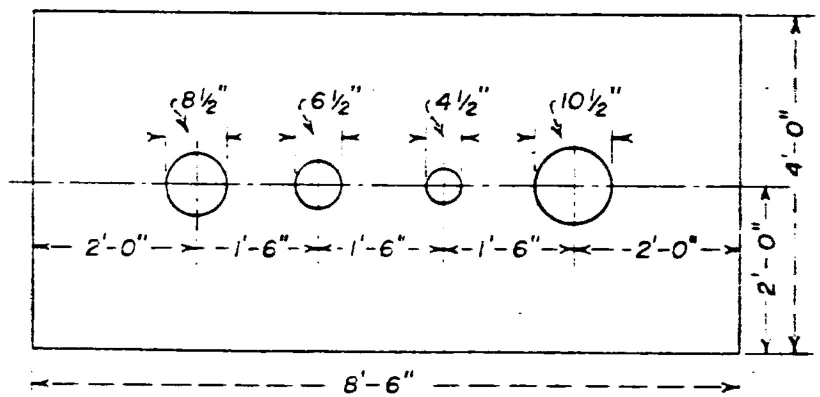
old H_2O pit

Figure 17

no date



STEEL INSERTS FOR MODEL BORE HOLES



COVER PLATE

1/4" STEEL

"O" MODEL DETAILS

Figure 18

Table 10

OLD H_2O TEST PIT ("O" model)

ore zones	ore type & amount	see below 5000 lbs.
	cement amount	1700 lbs. type 1
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	unknown
	in situ	unknown
water or H^+	chemical analysis	unknown
	in situ	unknown
Zeq (petrographic analysis)	unknown	
porosity	unknown	
cracks or fractures	unknown	
magnetic susceptibility	unknown	

5000 lbs. of ore
all of Salt Lake ore &
all of "A" grade ore &
"B" grade ore necessary
to make a total of 5000 lbs.

approx. 2900 lbs Salt Lake City ore (0.62%eU_3O_8)
approx. 1700 lbs "A" ore from old "W" pit (0.50%eU_3O_8)
approx. 1700 lbs "B" ore from old "W" pit (0.25%eU_3O_8)

STAND. FORM NO. 64

WR-61

Office Memorandum • UNITED STATES GOVERNMENT

TO : Walter B. Carlson, Assistant Manager for Administration, GJ

DATE: November 17, 1959

FROM : David D. Baker, Director Production Evaluation Division, GJ

SUBJECT: JUSTIFICATION FOR A GAMMA RAY LOGGING TEST PIT

SYMBOL: PGS:RFD

The requisition and specifications attached to this memorandum calls for the construction of a gamma ray logging test pit to be located adjacent to existing pits in the compound. Construction and Supply Division personnel have made a cost estimate of $900.

We need this facility for the following reasons:

1. Determination of the effects of bore hole size.
2. Determination of the effects of solids in suspension in the bore hole medium upon gamma ray intensity.
3. Calibration of small diameter gamma ray detecting devices.
4. Determination of the effects of casing upon gamma ray intensity.
5. Calibration of differential face scanners.

All of the above items, except number 5, have a direct bearing upon the validity of gamma ray logging performed by the Commission and private industry. It is planned to have private logging companies such as Century Geophysical Corporation use this pit to furnish the Commission with information necessary in interpreting their gamma ray logs for ore reserves.

Attachment:
1. Requisition w/specifications

CC: LPI Purchasing
R. F. Droullard

To Sidney
This is OK.
11-17-59

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.
USAEC Contract No. AT(05-1)-776
Grand Junction, Colorado

AMENDMENT NO. ______________

WORK ORDER No. LPI 60-1 DATE November 27, 1959

AUTHORIZED BY R. J. Gidney DATE November 17, 1959 FUNDS AUTHORIZED $ 900.00

DATE TO BEGIN November 23, 1959 DATE TO BE COMPLETED December 20,1959

SCOPE OF WORK

Construct test pit according to the attached specification. Pit to be located adjacent to existing test facilities near Building 22.

Facility should be constructed without unnecessary delay to avoid freezing problems.

ACCOUNTING DISPOSITION ______________

APPROVED BY [signature]

CHARGE TO Financial Plan 111-601

ISSUED BY R. W. Garlitz

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.
USAEC Contract No. AT(05-1)-776
Grand Junction, Colorado

BUDGET CONTROL REPORT

TO:

JOB NO. LPI 60-1

JOB NAME Construction of test pits

ATTENTION:

Gentlemen:

Based upon our latest budget estimate, by AEC Form 90 1252 dated November 17, 1959, and changes in the work since that date, our current budget figures as of November 27, 1959, are as follows:

Budget at	$900.00
Change Orders Received.	
Changes requested, in process	
Financial Plan 111-601	
Revised total Budget as of November 27, 1959	$900.00
Previous Estimated Date of Completion	
Revised Estimated Date of Completion	

Yours very truly,

LUCIUS PITKIN, INC.
USAEC Contract No. AT(05-1)-776

By Original Signed by J. L. NAYLOR

APPROVED:

For ____________________

By ____________________

Date ____________________

Form No. A-12

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.
USAEC Contract No. AT(05-1)-776
Grand Junction, Colorado

Change No. 2
June 13, 1961

CONSTRUCTION WORK ORDER ADVICE

WORK ORDER NO. LP 61-2 DATE December 6, 1960

AUTHORIZED BY Req. 5006 DATE June 7, 1961 FUNDS AUTHORIZED Est. $3[illegible].00

DATE TO BEGIN June 14, 1961 DATE TO BE COMPLETED June 26, 1961

SCOPE OF WORK:
Additional work on original work order LP 61-2. Modifications on the "O" pits in accordance with the attached instructions.

old H_2O

ACCOUNTING DISPOSITION 31-100 APPROVED BY Original Signed By Harold Canning Harold Canning

CHARGE TO (PLANT PROJECT NO.) 111-613 ISSUED BY Original Signed By R. W. Carlitz R. W. Carlitz

DISTRIBUTION

1 - Operations
2 - Cost Accounting
3 - Fiscal Accounting
4 - Procurement File
5 - Construction & Supply Division
6 - LPI Payroll

Form No. A-13

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.
USAEC Contract No. AT(05-1)-776
Grand Junction, Colorado

Change No. 2
June 13, 1961

BUDGET CONTROL REPORT

JOB DESCRIPTION **Construct base, gallows and pulley assembly for density calibration.** JOB NO. **LP 61-2**

Based upon our latest budget estimate, by **AEC Form 90, 5006**

dated **June 7**, 19 **61**, and changes in the work since that date, our current budget figures as of **June 13**, 19 **61**, are as follows:

Budget at .... $ **Est. 250.00**

Change orders received .... **#1 March 28, 1961** .... $ **Est. 116.00**

Changes requested, ~~in process~~ .. **#2 June 11, 1961** .... $ **Est. 382.00**

Received total Budget as of **June 13, 1961** $ **748.00**

Previous Estimated Date of Completion **April 3, 1961**

Revised Estimated Date of Completion **June 26, 1961**

By Original Signed By Harold Canning **Harold Canning**

Title **Office Manager**

DISTRIBUTION
1 - Operations
2 - Cost Accounting
3 - Fiscal Accounting
4 - Procurement File
5 - Construction & Supply Division ✓
6 - LPI Payroll

U. S. ATOMIC ENERGY COMMISSION
REQUISITION

[illegible] COPY

TO: SEND ALL BUT LAST COPY TO [illegible] OFFICE. NO LETTER OF TRANSMITTAL NECESSARY

FROM (NAME AND ADDRESS OF REQUISITIONING OFFICE)
ROSS L. KINNAMAN, CHIEF
GEOPHYSICAL SERVICES BRANCH

SHIP TO (EXACT ADDRESS AND SPECIAL MARKINGS)
R. F. DROUILLARD
BUILDING 22

PLACE ALL RELATED INFORMATION AND INSTRUCTIONS ON THIS REQUISITION

ITEM NO.	QUANTITY	UNIT	DETAILED DESCRIPTION OF ARTICLES OR SERVICES	ACTION TAKEN (For Supplying Office Use)
1	1	Job	Have LPI make modifications on the "O" pits according to the attached instructions.	
			Modifications are necessary to make the pits useable for determining needed parameters for bore hole variations.	
			Est. labor cost: $242.00 Est. cost of materials: $140.00	
			Note Date Needed.	
			OK [signature] 6-12-61	

REQUISITION NO. No. 5006

SUBMITTED BY (NAME AND TITLE)
[signature] for
JOHN S. BARRY, DEPUTY DIRECTOR, PRODUCTION EVALUATION DIV.

APPROVED BY (NAME AND TITLE)
[signature]
R. J. GILBEY, DIRECTOR, CONSTRUCTION AND SUPPLY DIVISION

FOR SUPPLYING OFFICE USE

31-100
LPI #61-21

Check [illegible] if this form is used as a continuation sheet or extract. [illegible] the requisition number typed above.
☐ CONTINUATION SHEET ☐ EXTRACT

DATE OF REQUISITION
6/7/61

DATE NEEDED (LATEST POSSIBLE DATE)
6/26/61

COST SYMBOL (MUST BE [illegible]) [illegible] 6/8/61
61-J General Plant Projects

INSTRUCTIONS FOR MODIFICATION OF "O" PITS

1. Extend the four lower drains on the west side of the pits 6 inches by welding in an additional length of pipe of the proper diameter.

2. Move the water service pipe, located on the north side of the pits, out at least 13 inches to permit clearence for additional material.

3. Increase the horizontal dimensions of the lower barren zone by one foot of grout material. Final dimension will be 10 feet long, 6 feet wide, and approximately 2-1/2 feet high. The top must be flush with the top of the existing lower barren zone. The approximate amount of grout material will be 2.6 cubic yards.

4. After the lower barren zone has hardened, the ore zone will be increased in the horizontal dimensions by one foot. Final dimension will then be 10 feet long, 6 feet wide and 2 feet high. The ore zone will be made of the following amounts of materials:

   A. 1700 pounds of cement, type 1.

   B. 5000 pounds of ore (to be supplied by Geophysical Services Branch and available on Compound).

   The ore for the ore zone will be made up from approximately 2900 pounds of Salt Lake City ore (0.62% eU_3O_8) plus whatever is necessary of the "A" ore from the old "W" pit (~ 0.50% eU_3O_8 - 1700 lbs.) and the "B" ore from the old "W" pit (~ 0.25% eU_3O_8 - 1700 lbs). The sequence, then, is as follows:

   a. All of the Salt Lake ore

   b. All of the "A" grade ore

   c. What amount of "B" grade that is necessary to make a total of 5000 lbs.

   It will be necessary to blend these ores in the Readymix truck with the cement for at least 1/2 hour before adding any water. The fine particle size of the Salt Lake ore will result in a large amount of water consumption to reach proper pouring consistancy.

5. No upper barren zone will be poured.

6. Re-attach water service pipe to the upper rail at north end.

Form M-2

Date November 23, 1959
Issued by Lindsay

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.

Maintenance Work Order

Requestor Kirreman   Verbal [ ]   Phone [ ]   Form 90 [x]   Form 50 [ ]

Building or Area Location Test Pits.

SCOPE OF WORK

Construct a test pit according to the attached specifications. Pit to be located adjacent to existing test facilities near Bldg. 22.

XXXXXXXX

Starting Date ____________   Completion Date ____________

Total Hours ____________   Employee ____________ (Signature)

Cost Code ~~R 130-1752~~ LPI 60-1

Form M-2

Date June 9, 1960
Issued by Lindsay

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.

Maintenance Work Order

Requestor Kinnaman Verbal [ ] Phone [ ] Form 90 [x] Form 50 [ ]

Building or Area Location

SCOPE OF WORK

1-- Install the existing mixing barrel and stirring motor on the west side of the "N" series pits and near the outlets of the "O" series. Install on concrete base.

2-- Install slurry pump near base of mixer and make necessary plumbing assemblies to allow pumping mud slurry to each of the four holes in the "O" pit group. Provision must be made, through plumbing, to return mud flow to mixer.

3-- Make necessary adapters for collars of each hole (4) to accept pump output through a 2 inch or larger rubber hose.

4-- Install a water tap on the west side of the pits, near mixer and provide hose to reach all pits.

Starting Date ______ Completion Date ______

Total Hours ______ Employee ______ (Signature)

Cost Code R 371-2465

Form M-2

Date ~~December 14, 1960~~

Issued by ~~Lindsay~~

WESTERN URANIUM PROJECT

LUCIUS PITKIN, INC.

Maintenance Work Order

Requestor Kinnaman Verbal [ ] Phone [ ] Form 90 [x] Form 50 [ ]

Building or Area Location ______

SCOPE OF WORK

Construct temporary tarpaulin windbreak around the railings of the 0 Pits. Also around the mixing barrel and manifold pipes on west side of 0 pits.

Arrange and operate Salamander in area covered around the barrel and pipes Until notified by Kinnaman or Scott.

Starting Date ______ Completion Date ______

Total Hours ______ Employee ______ (Signature)

Cost Code ~~R 553-3799~~

NEW H_2O TEST PIT

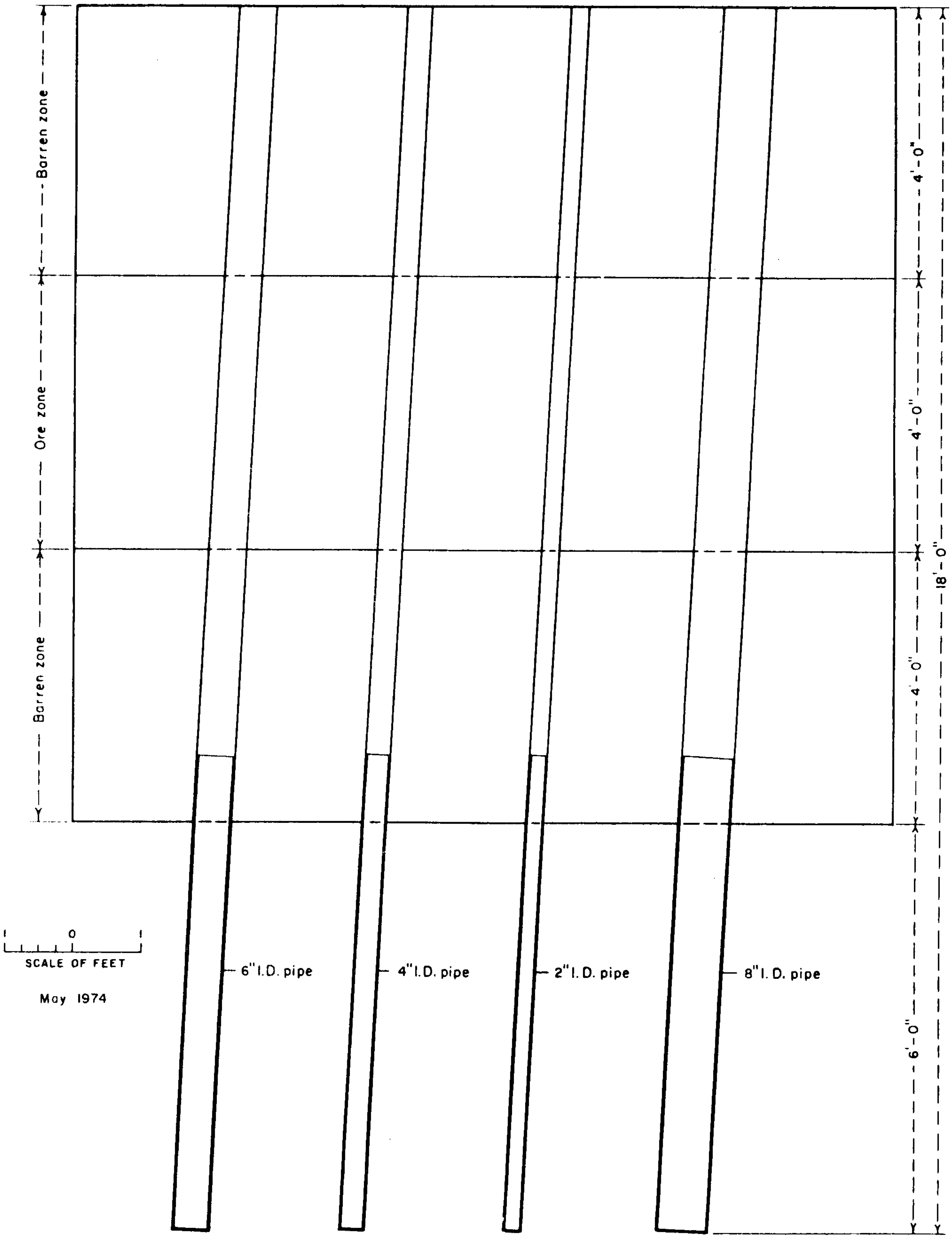
The new H_2O test pit was build in September, 1973 to replace the old H_2O test pit ("O" model) because the old H_2O test pit had cracked and leaked water. This pit is designed to calibrate the effects of borehole size, water, and casing on gross gamma logging equipment. Table 11 lists the factors for this pit and a report "The Construction of the New Water Factor Model" by Knapp and Bush*, explains the details of the construction. This pit has served its purpose and should continue as a calibration test pit.

*Knapp, K. E. and Bush, W. E., May, 1975, "The Construction of the New Water Factor Model", Lucius Pitkin Report, Grand Junction, Colorado, copy of this paper included in this report on pages 75-98.

WATER FACTOR MODEL

US AEC COMPOUND — GRAND JUNCTION, COLO.

(ELEVATION - EAST FACE)



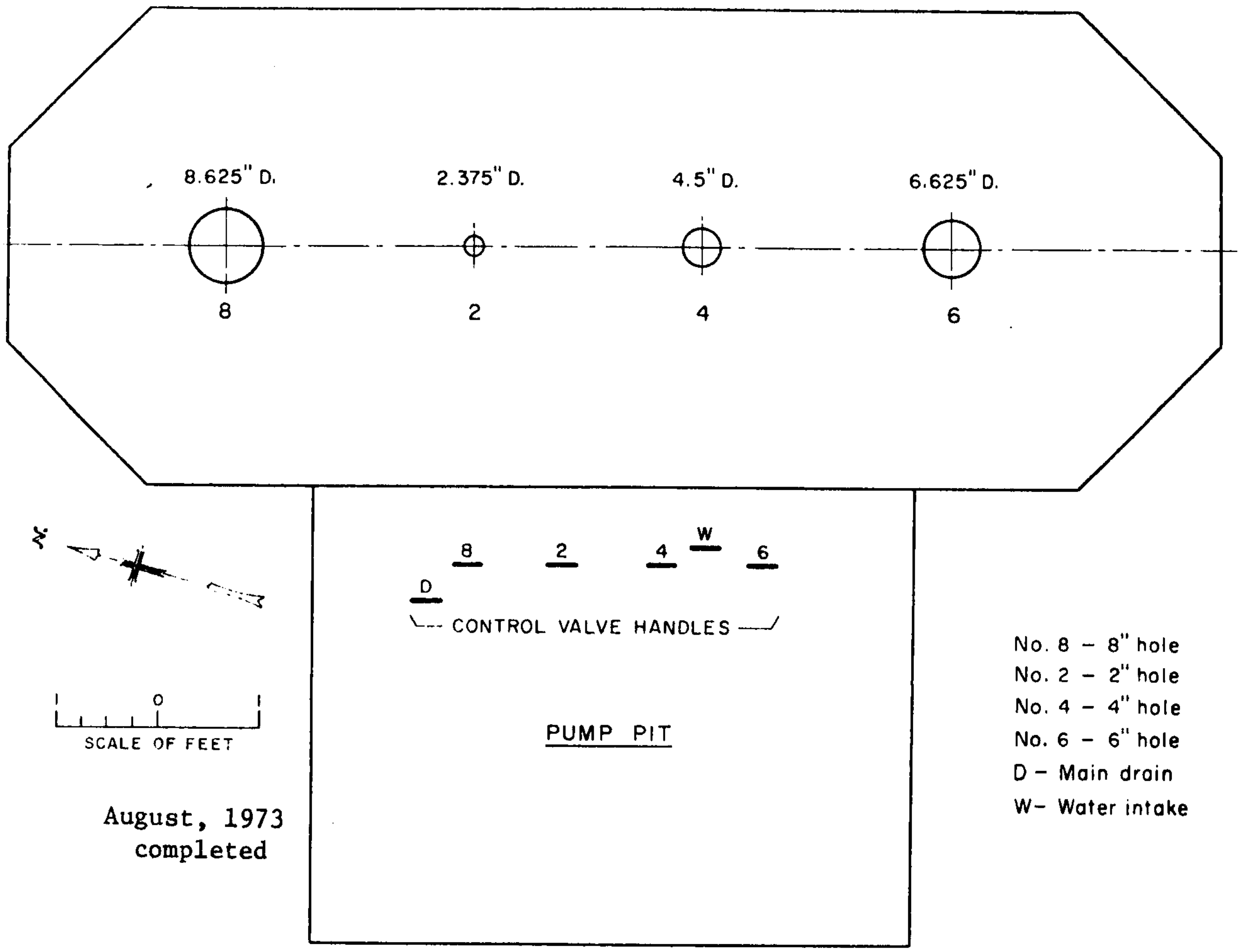
WATER FACTOR MODEL

US AEC COMPOUND

GRAND JUNCTION, COLO.

New H_2O Test Pit

(PLAN)



August, 1973
completed

Note: Indicated hole size is standard pipe O.D.

Operation: A. To fill any of the four holes with water:–
- a. Close main drain valve D
- b. Open appropriate control valve (s) - 2, 4, 6, or 8
- c. Open water valve W

B. To drain, open valve D and control valve for hole

MODEL PARAMETERS

	% eU_3O_8	% U_3O_8	Bulk Density	Bulk Density	%LOD
Ore Zone	.320	.321	20.90 ft^3/ton	1.534 g/cc	6.77

	eTh	eU	eK	Bulk Density	Bulk Density	%LOD
Upper Barren Zone	8.5 ppm	3.1 ppm	1.79%	14.95 ft^3/ton	2.145 g/cc	4.12
Lower Barren Zone	6.8 ppm	2.8 ppm	1.73%	15.06 ft^3/ton	2.129 g/cc	0.96

Table 11

new H_2O TEST PIT

ore zones	ore type & amount	See below		
	cement amount	6876 lbs.		
	water amount	unknown		
	sand type & amount	unknown 10503 lbs.		
barren zone	sand type & amount	unknown		
	cement amount	unknown		
	water amount	unknown		
assay analysis ore zone	chemical	0.321 $\%U_3O_8$		
	gamma only	0.320 $\%eU_3O_8$		
	gamma spec	unknown		
	gamma logging	unknown		
assay analysis barren zones		upper barren		lower barren
	chemical	unknown		unknown
	gamma only	unknown		unknown
	gamma spec	eTh 8.5 ppm eU 3.1ppm eK 1.79%		eTh 6.8ppm eU 2.8ppm eK 1.73%
	gamma logging	unknown		unknown
density		upper barren	ore zone	lower barren
	chemical analysis	2.145 g/cc	1.534 g/cc	2.129 g/cc
	in situ	unknown		
water or H^+		upper barren	ore zone	lower barren
	chemical analysis	1.12% LOD	6.77% LOD	0.96% LOD
	in situ	unknown		

Zeq (petrographic analysis)	unknown
porosity	unknown
cracks or fractures	unknown
magnetic susceptibility	unknown

Ore Used	Weight (lbs.)	$\% U_3O_8$	$\% eU_3O_8$
Climax Ore	4,632	0.134	0.301
Residue Test Pit U-2	1,885	1.172	1.107
Residue Test Pit U-3	2,260	0.426	0.418
Schwartzwalder Ore	1,553	2.924	3.008

LPI-75-7

THE CONSTRUCTION OF THE NEW WATER FACTOR MODEL

K. E. Knapp and W. E. Bush

May 1975

THE CONSTRUCTION OF THE NEW WATER FACTOR MODEL AT THE USERDA FACILITY GRAND JUNCTION, COLORADO

The new water factor model has been constructed for the purpose of determining water and hole diameter factors for industry gamma-ray logging probes. It consists of a 4-foot thick ore zone (uranium ore mixed in concrete), with 4-foot thick zones of barren concrete immediately below and above. Four holes of varying sizes extend through the three zones at approximately 3 degrees off vertical. A run pipe extends below each hole for a total hole depth of approximately 18 feet. See Appendix A.

Lucius Pitkin, Inc. supplied all labor and materials, with the exception of the delivery of concrete by an outside firm and the use of their concrete mixer, and of the use of equipment and operator in excavating for the model.

Preparatory work started in August, 1973 with site work consisting of the removal of three small density models and one large lignite coal model (Figure 1).

Excavation for the model, which is three-quarters below the earth surface, was accomplished with a backhoe. The 15-foot deep excavation may be seen in the accompanying Figures 3, 4, and 5. A 4-foot high retaining form was used at the bottom of the pit, because of an excessive amount of seepage water, which caused some caving in the gravel bed (water being encountered at approximately 12 feet below the surface).

The four run-pipes (diameters of 2 inches, 4 inches, 6 inches, and 8 inches) were welded into a single unit, using 2-inch pipe for spacers to maintain proper alignment (Figure 2). The unit was lowered into the retaining form (Figure 3), and after the pipes were properly oriented (Figures 4 and 5) the form was filled with concrete (Figure 6). Later, a 6-inch (approx.) thick slab of concrete extending over the entire floor of the excavation was poured to a height within 12 inches of the top of the 7-foot high run pipes. After a form was built for pouring the lower barren zone, drain pipes were welded into the sides of each of the run pipes and extended to a point where they would protrude slightly beyond the side of the lower barren zone (Figure 7).

Reinforcing mesh and rod were placed in the form, as were the lathe-turned form pipes (Figure 8). Alignment of the latter with the run pipes below was assured by guides welded to the inner surfaces of the lower ends of the form pipes. Then the junctions of the form pipes and the run pipes were sealed with caulking compound and a thin layer of grease was applied to the surface of the form pipes. The form was then filled with redi-mix concrete, as normally produced by the mixing plant (Figure 9), two quart-sized samples being taken. The form pipes were turned a few degrees when the concrete started to "set-up." The following morning the form pipes were pulled with the aid of winch truck from the concrete and wiped clean to ready them for the next pour. The form was extended upward 4 feet for pouring the ore zone. Reinforcing mesh and the form pipes were placed, as before. The surface of the barren zone was painted with a concrete bonding material for a sealant, and caulking compound was used at the junction of the form pipes and the concrete barren zone. After greasing the form pipes the form was ready for pouring (Figure 10).

The ore zone (Appendix B) is composed of finely-ground (minus 10 mesh) ore, well blended with sand to a predetermined concentration of uranium. The sand-ore mixture was blended and charged into the mixer on a concrete-mixing truck (Figure 11), which was returned to the bulk plant for cement and water. After thorough mixing (20-30 minutes), the batch was poured (Figures 12 and 13). During the pour 10 quart-sized samples were taken (Figure 13). Form pipes were pulled as described above.

The upper barren zone was poured, following the building of the form, the extension of the reinforcing mesh and the placing of the form pipes as previously described (Figures 15 and 16). Two quart-sized samples were taken during the pour. The form pipes were pulled the following morning (Figure 17).

A pump pit with a sump and sump pump were constructed along side of the model. Water and electrical lines were run into the pit. The pipes to be used for draining water from each of the four probe holes were extended upward to bring them above the floor of the pump pit (Figures 18 and 19). A 1-1/2-inch plastic line was laid at a depth of 2-1/2 to 3 feet for a distance of about 140 feet from the pump pit to discharge into a 12-inch surface water drain line (Figure 21). A form for the pump pit walls was built and concrete poured (Figures 20 and 22). A steel cover was fabricated for the pump pit and valves and connections were installed on the drain lines and incoming water line (Figure 23). A sump pump was placed in the sump and connected to the 1-1/2-inch discharge line.

To complete the construction an overhead pipe for the support of pulleys was installed, as was a stairway, and a hand railing around the upper perimeter of the model (Figures 24 and 25).

This project was completed in December, 1973.

The chemical and radiometric analyses are shown in Appendix C.

Figure 1.

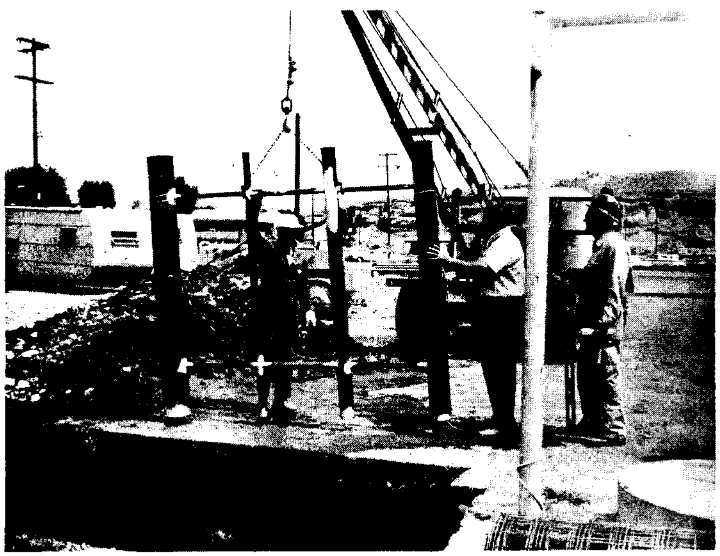


Figure 2.

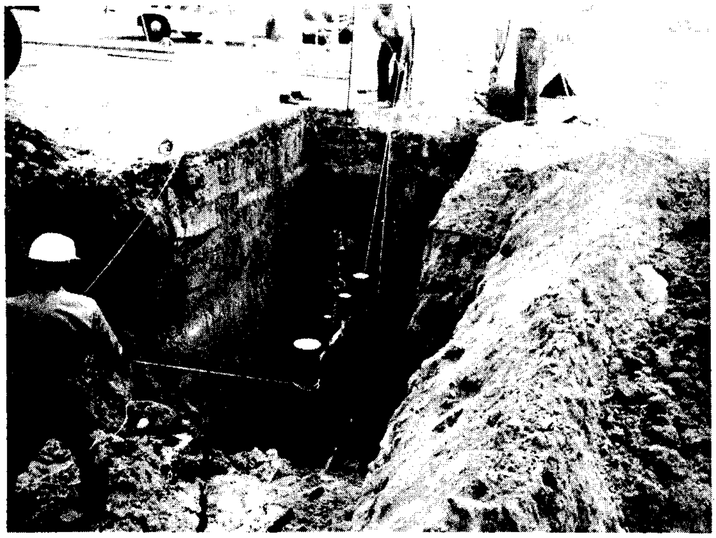


Figure 3.

Figure 4.

Figure 5.

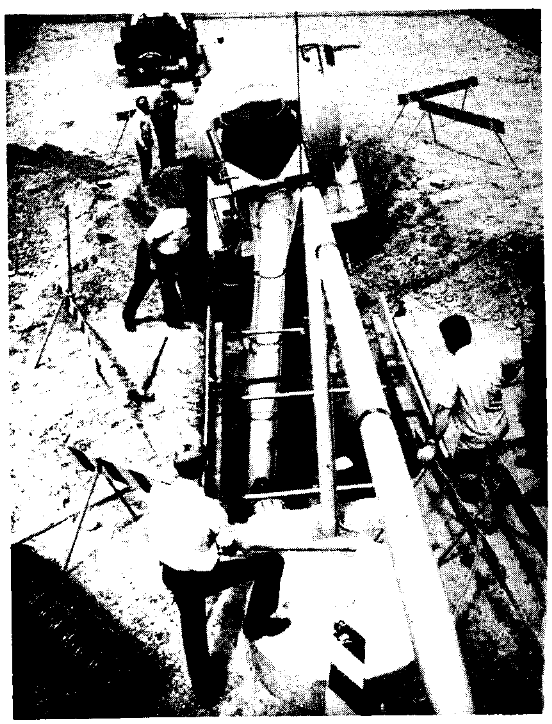


Figure 6.

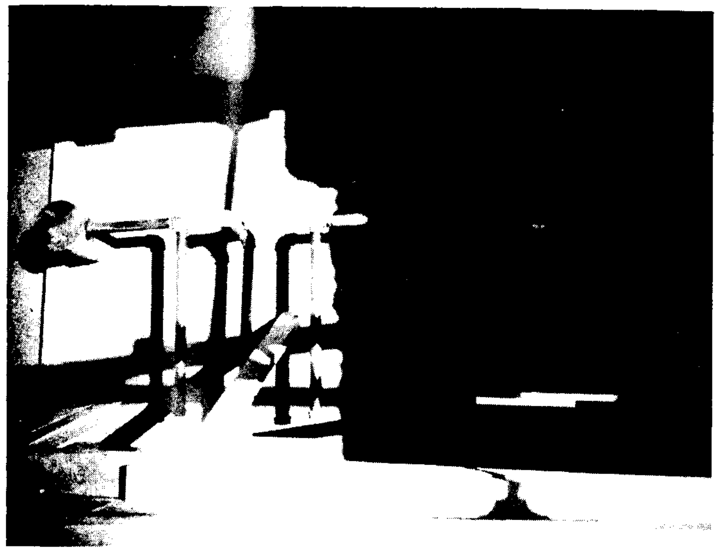


Figure 7.

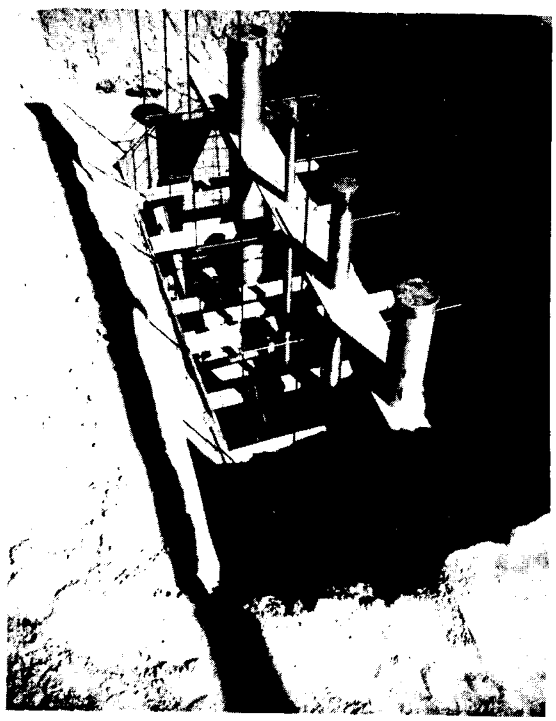


Figure 8.

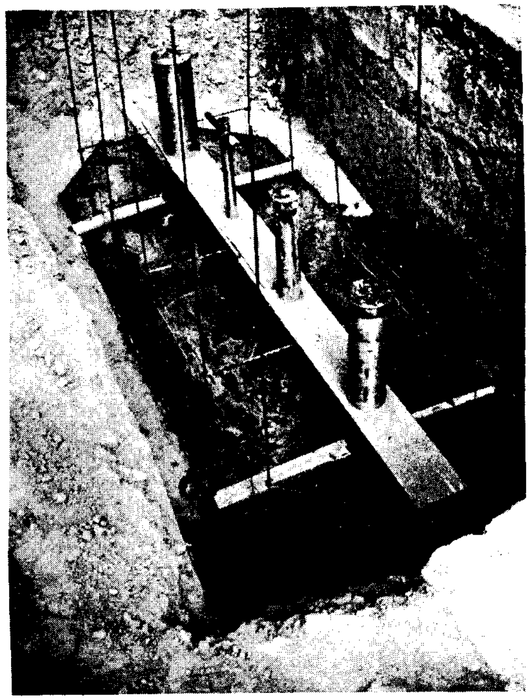


Figure 9.

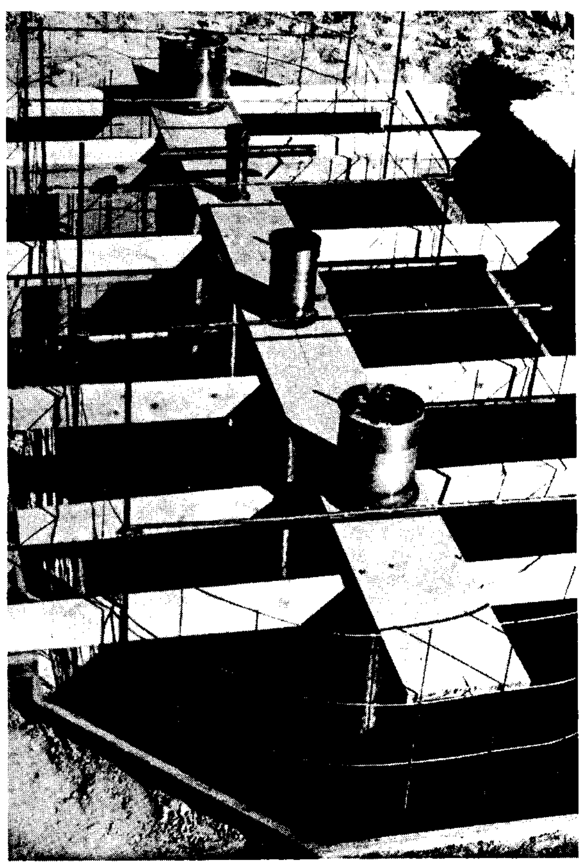


Figure 10.

Figure 11.

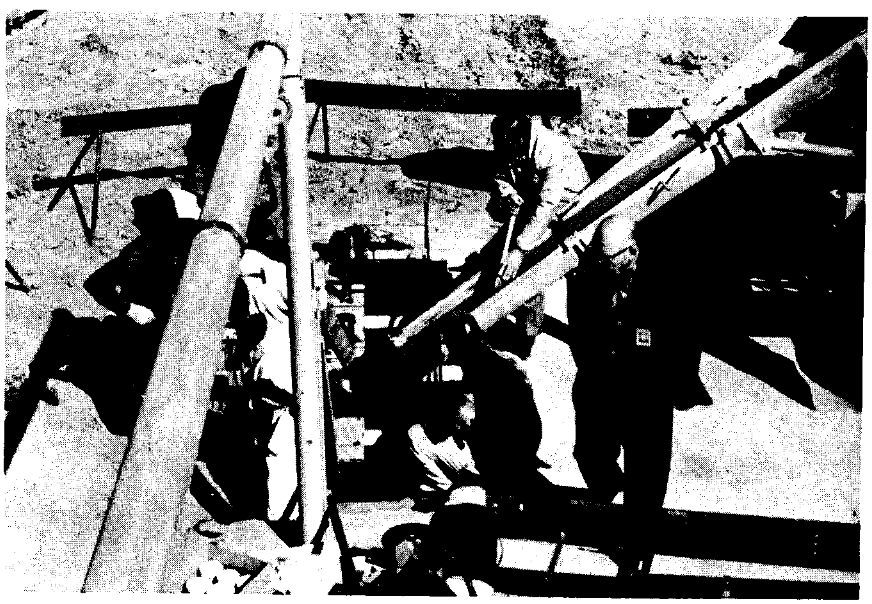


Figure 12.

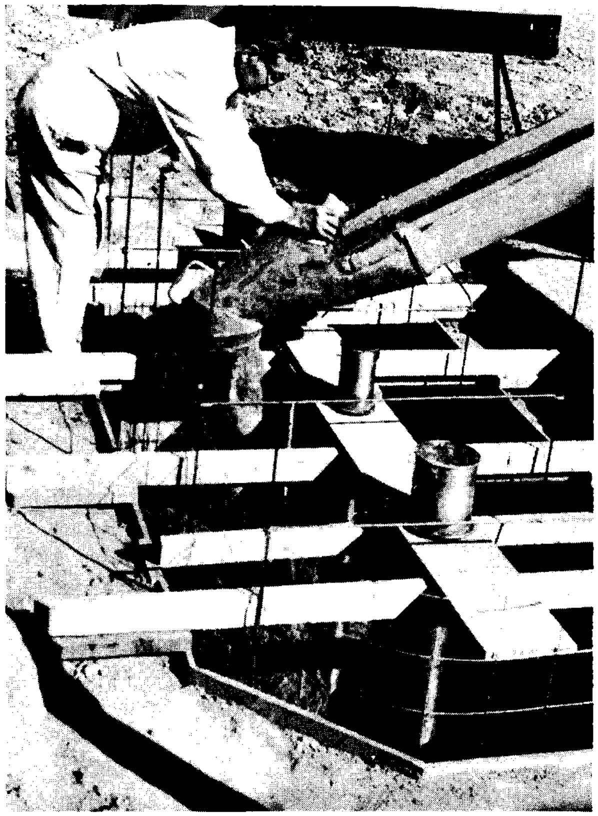


Figure 13.

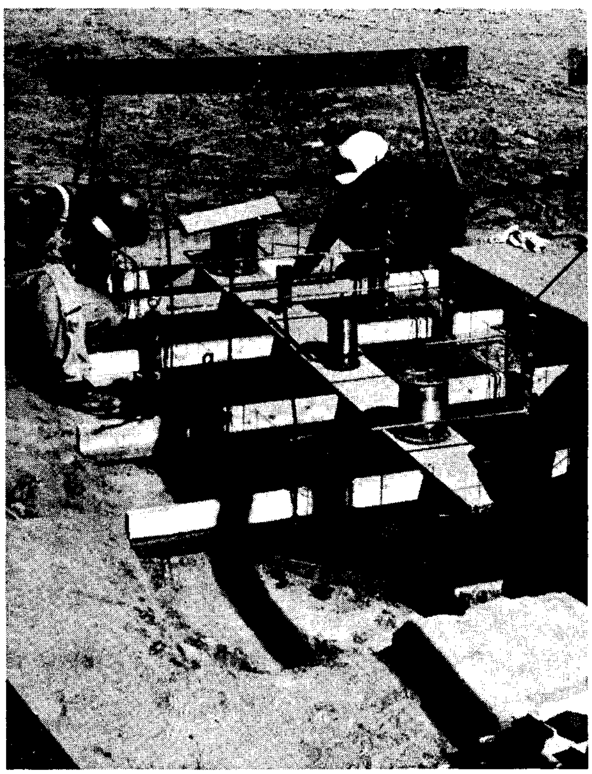


Figure 14.

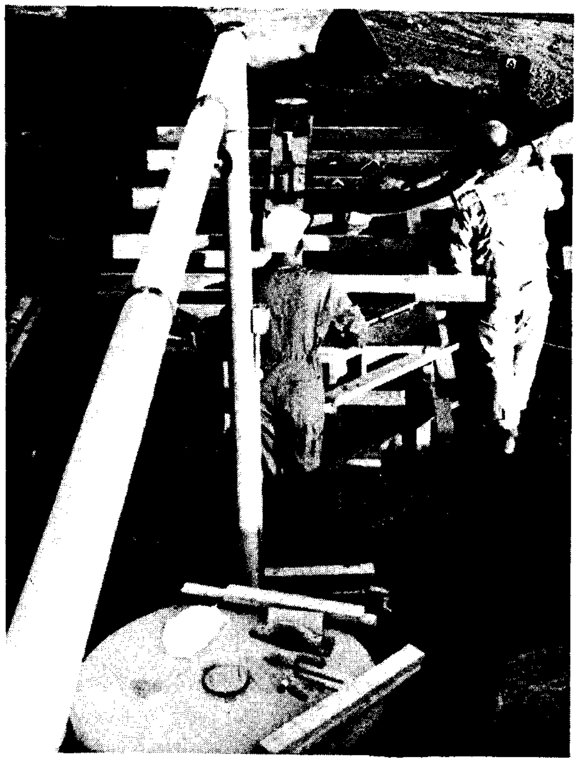
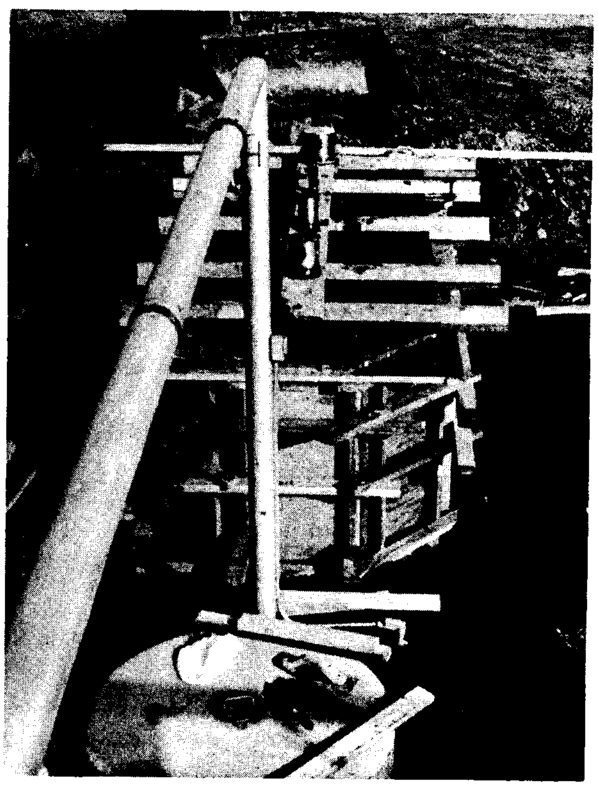


Figure 15.



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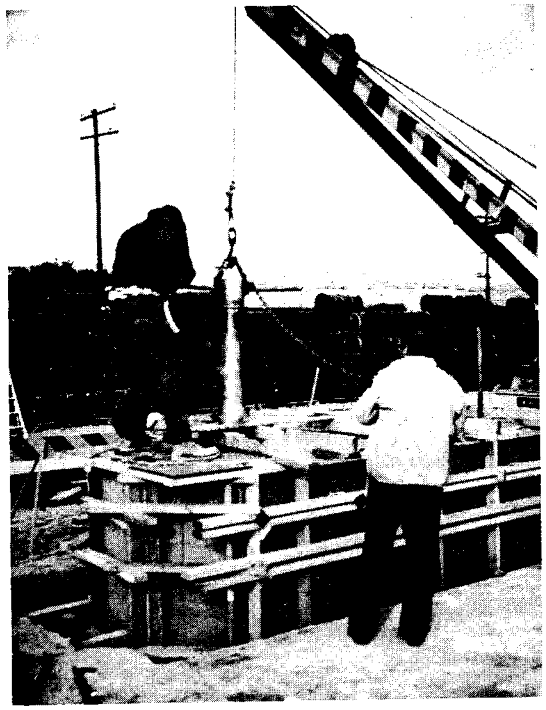


Figure 17.

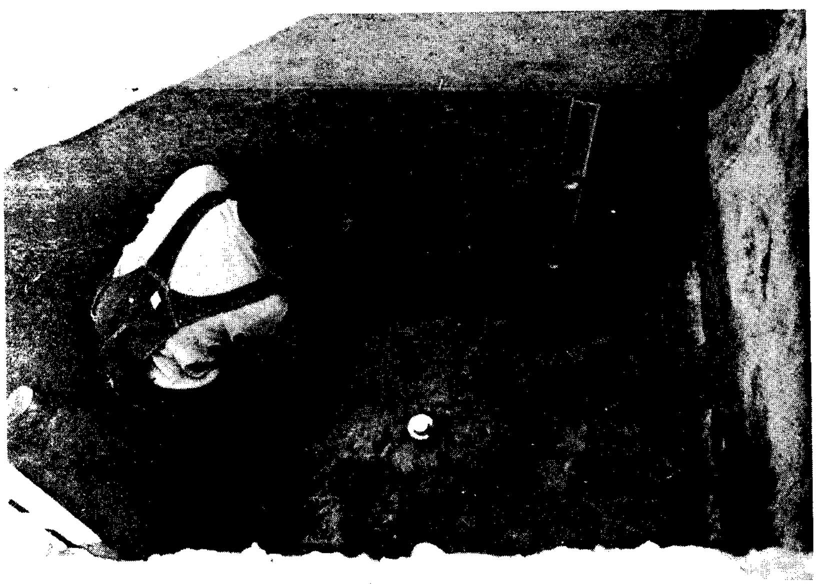


Figure 18.

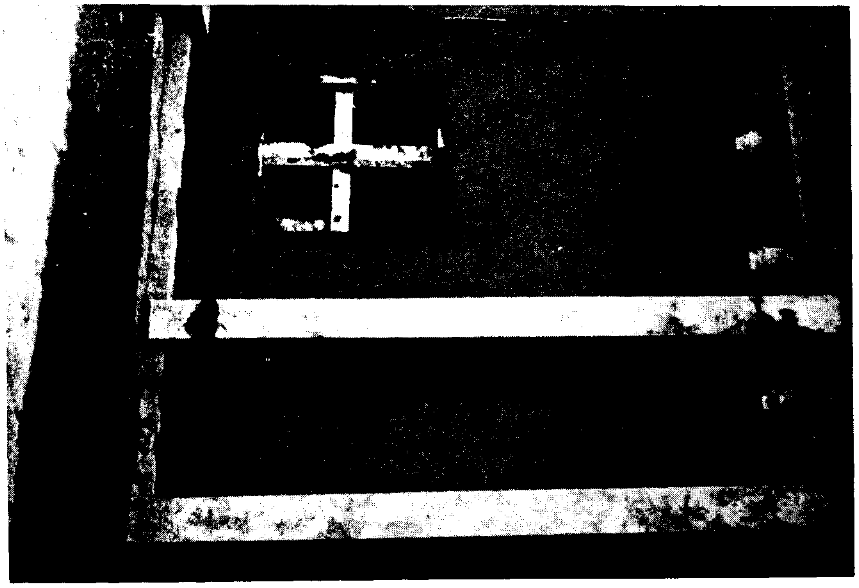


Figure 19.

Figure 20.

Figure 21.

Figure 22.

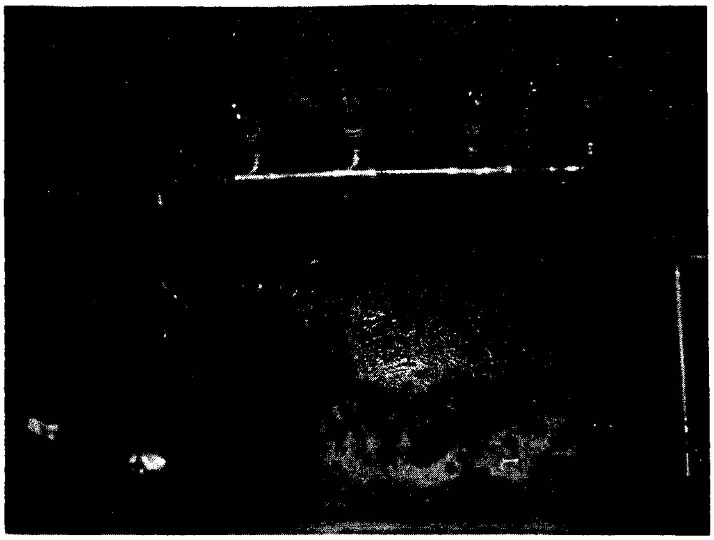


Figure 23.

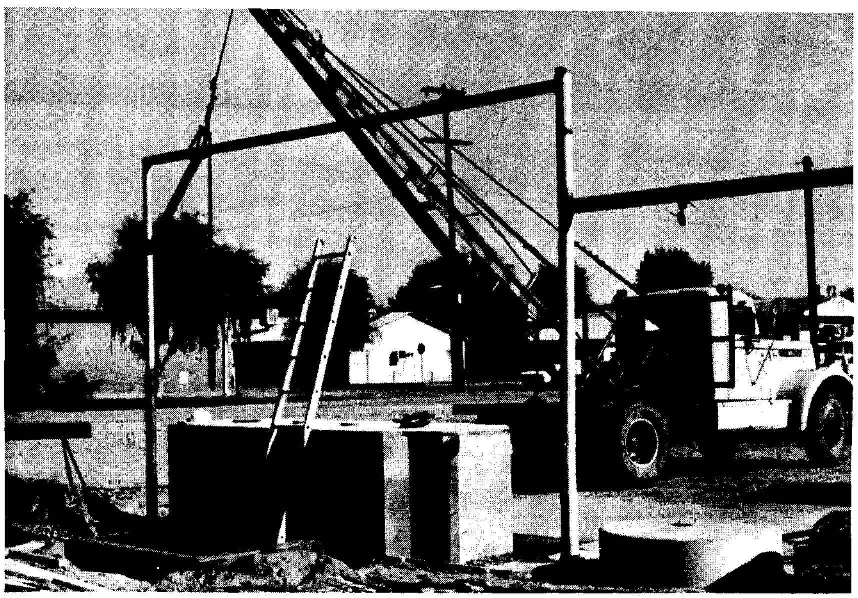


Figure 24.

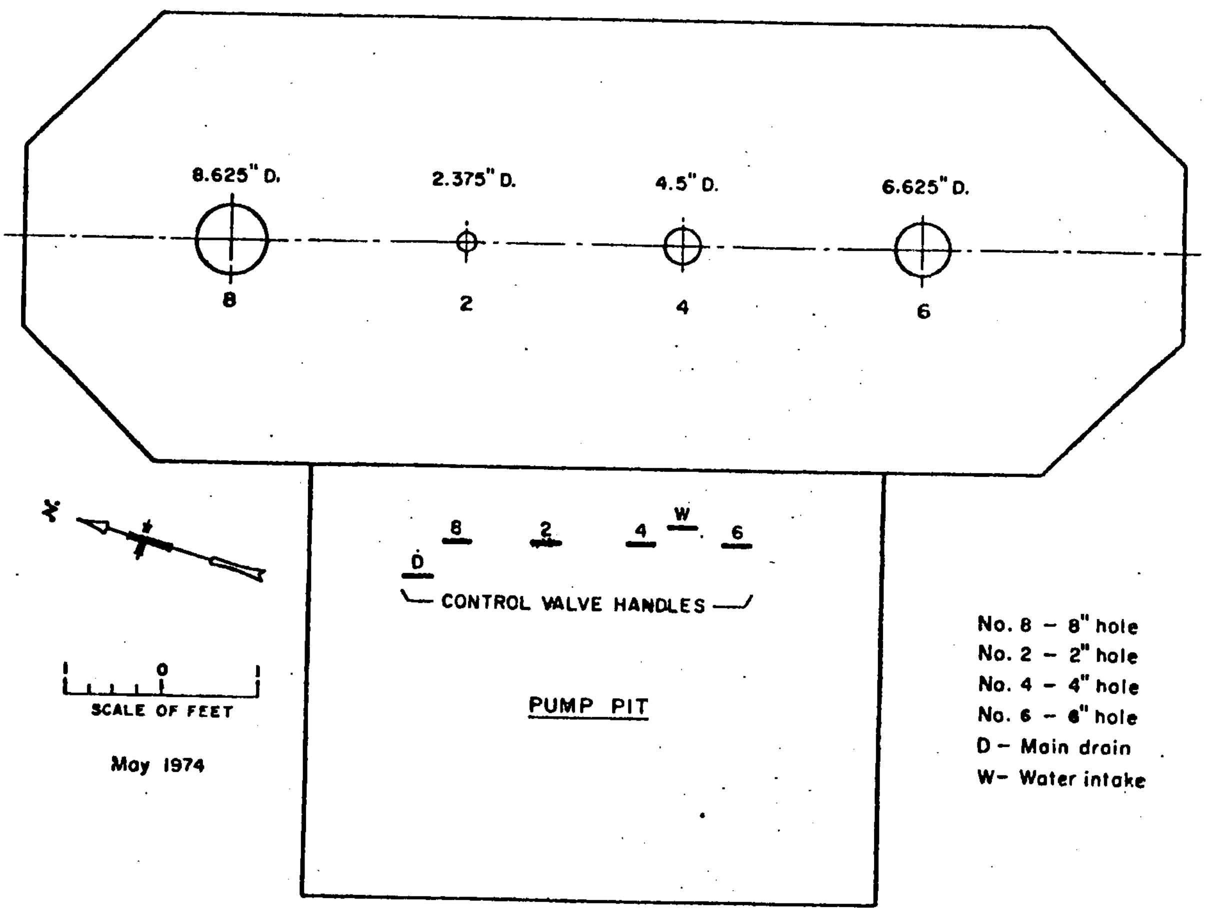
Figure 25.

APPENDIX A

WATER FACTOR MODEL

USERDA FACILITY | GRAND JUNCTION, COLO.

(PLAN)



Note: Indicated hole size is standard pipe O.D.

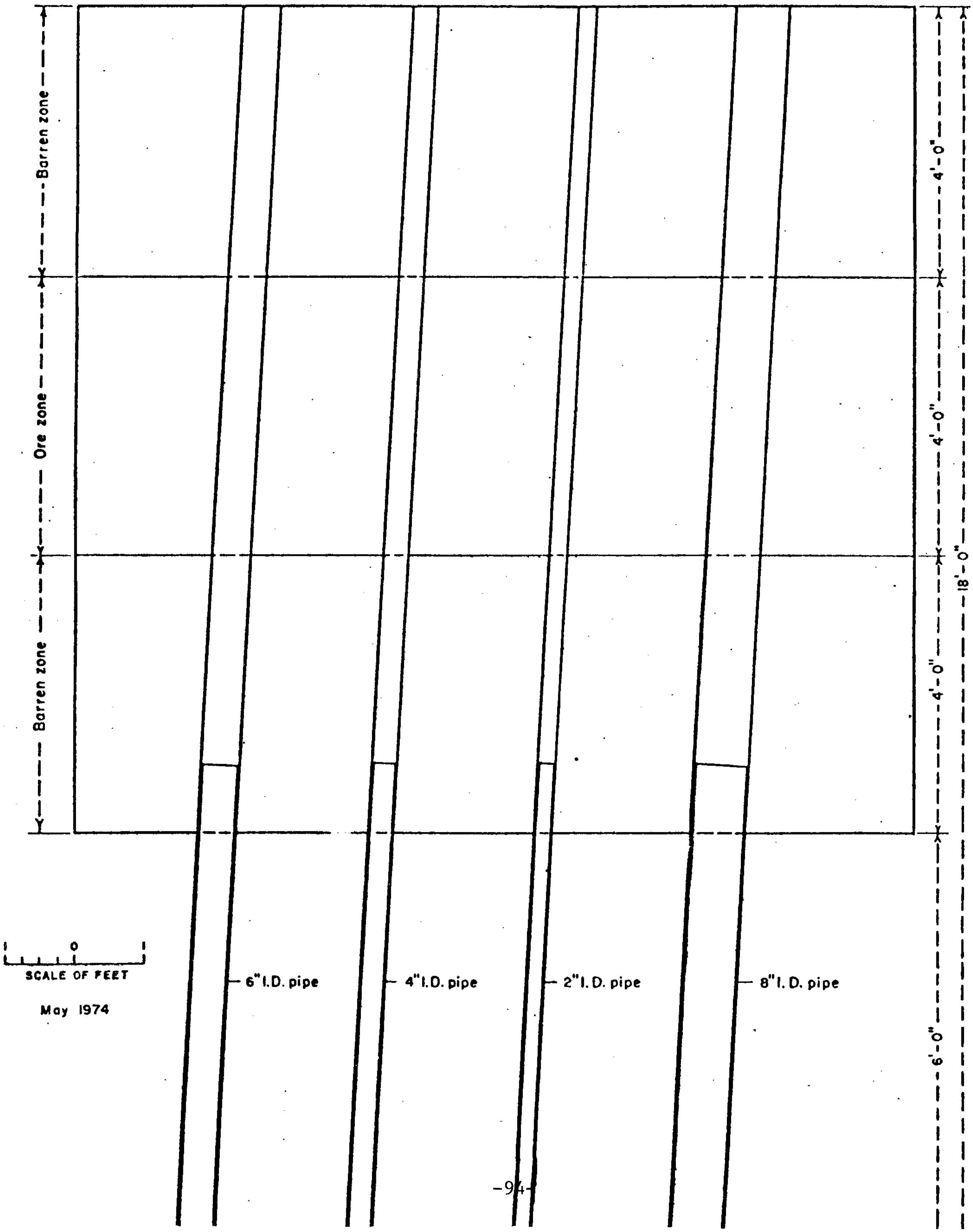
Operation: A. To fill any of the four holes with water:–
- a. Close main drain valve D
- b. Open appropriate control valve(s) – 2, 4, 6, or 8
- c. Open water valve W

B. To drain, open valve D and control valve for hole

WATER FACTOR MODEL

USERDA FACILITY | GRAND JUNCTION, COLO.

(ELEVATION - EAST FACE)



APPENDIX B

Water Factor Model
Grand Junction, Colorado

Ore Zone Poured 9/27/73

	Wet Pounds	$\%H_2O$	Dry Pounds	$\%U_3O_8$	$\%eU_3O_8$
Climax Ore	4,712	1.70	4,632	0.134	0.301
Residue Test Pit U-2	2,118	11.02	1,885	1.172	1.107
Residue Test Pit U-3	2,594	12.86	2,260	0.426	0.418
Schwartzwalder Ore	1,562	0.53	1,533	2.924	3.008
Sand	10,503	1.98	10,297		
Cement	6,876				

APPENDIX C

Water Factor Model Data
Ore Zone

Sample No.	Sample No.	% U_3O_8	%eU_3O_8	% LOD
0007314-1	1	0.324	0.317	7.20
-2		0.323	0.317	
7315-1	3	0.335	0.333	6.43
-2		0.331	0.321	
7316-1	4	0.311	0.314	6.58
-2		0.312	0.310	
7317-1	5	0.318	0.333	7.50
-2		0.322	0.330	
7318-1	7	0.303	0.302	6.94
-2		0.300	0.301	
7319-1	8	0.317	0.315	6.33
-2		0.312	0.310	
7320-1	10	0.343	0.336	6.40
-2		0.345	0.346	
	Average	0.321	0.320	6.77

WATER FACTOR MODEL DATA
Ore Zone-Dry Samples

Sample No.	Sample No.	% LOD	Bulk Density g/cc
0007403	2	3.36	1.46
0007404	6	3.63	1.50
0007405	9	3.54	1.65

Barren Zone-Dry Samples

Sample No.	Sample No.	% LOD	Bulk Density g/cc	Gamma Spec		
				ppm Th	ppm U	% K
0007406	Lower-1	1.01	2.10	6.8	2.8	1.73
0007407	Lower-2	0.91	2.16			
0007408	Upper-1	1.15	2.13			
0007409	Upper-2	1.09	2.15	8.5	3.1	1.79

O.C.

REQUISITION NUMBER 300502
DATE 11/08/73

SEMIQUANTITATIVE EMISSION SPECTROGRAPHIC ANALYSIS
ELEMENT COMPARISON IN PERCENT

APPENDIX C

WATER FACTOR MODEL

BARREN ZONES

LPI NO:	LOWER 7406	BARREN 7407	UPPER 7408	BARREN 7409
AL	7.0000	8.0000	8.0000	8.0000
B	.0050	.0030	.0030	.0030
BA	.0600	.0700	.0700	.0600
BE	.0003	.0003	.0004	.0003
CA	9.0000	8.0000	8.0000	8.0000
CR	.0040	.0020	.0030	.0020
CU	.0060	.0070	.0060	.0050
FE	2.5000	2.5000	2.5000	1.5000
GA	.0001	.0001	.0001	.0001
K	2.5000	2.0000	2.0000	2.0000
LI	.0010	.0010	.0010	.0010
MG	.8000	.7000	.8000	.8000
MN	.1500	.1500	.1500	.1500
NA	1.5000	1.5000	1.5000	1.5000
NI	.0010	.0010	.0010	.0010
P	.0500	.0500	.0500	.0500
PB	.0030	.0020	.0030	.0030
SI	10.9999	10.9999	10.9999	10.9999
SR	.0800	.0700	.0800	.0800
TI	.3000	.3000	.3000	.2500
V	.0080	.0070	.0080	.0080
Y	.0030	.0030	.0030	.0030
YB	.0001	.0001	.0001	.0001
ZN	.0300	.0200	.0300	.0300
ZR	.0100	.0200	.0200	.0200

ELEMENTS NOT FOUND:
AG AS AU BI CD CE CO CS DY ER EU GD GE HF HG HO IN IR LA LU MO NB ND OS PD PR PT RB RE RH RU SB SC SE SM
SN TA TB TE TH TL TM U W

X.9999 DESIGNATES A CONCENTRATION GREATER THAN X PERCENT.

U-1 TEST PIT

The U-1 test pit, built in July, 1969, was designed as a high grade calibration test pit so that gross gamma ray logging equipment could be calibrated. The schematic diagram shows the thickness of the zones and Table 12 lists the factors regarding this pit.

In a report by Eschliman and Key*, a grade of 2.48% eU_3O_8 was assigned to the U-1 test pit ore zone. The chemical grade (2.415% U_3O_8) and the radiometric grade analyzed by the Chemistry Laboratory (2.442% eU_3O_8) are all in close agreement. All the grades assigned to this pit are in close agreement which means this test pit is near secular equilibrium. This pit has served its purpose and should continue as a calibration test pit.

*Eschliman, D. H. and Key, B. N., October 24, 1972, "A Change of Assigned Radiometric Grades for the US AEC Gamma Ray Logging Calibration Models", Lucius Pitkin Geophysics/Electronics Report No. 5, Grand Junction, Colorado.

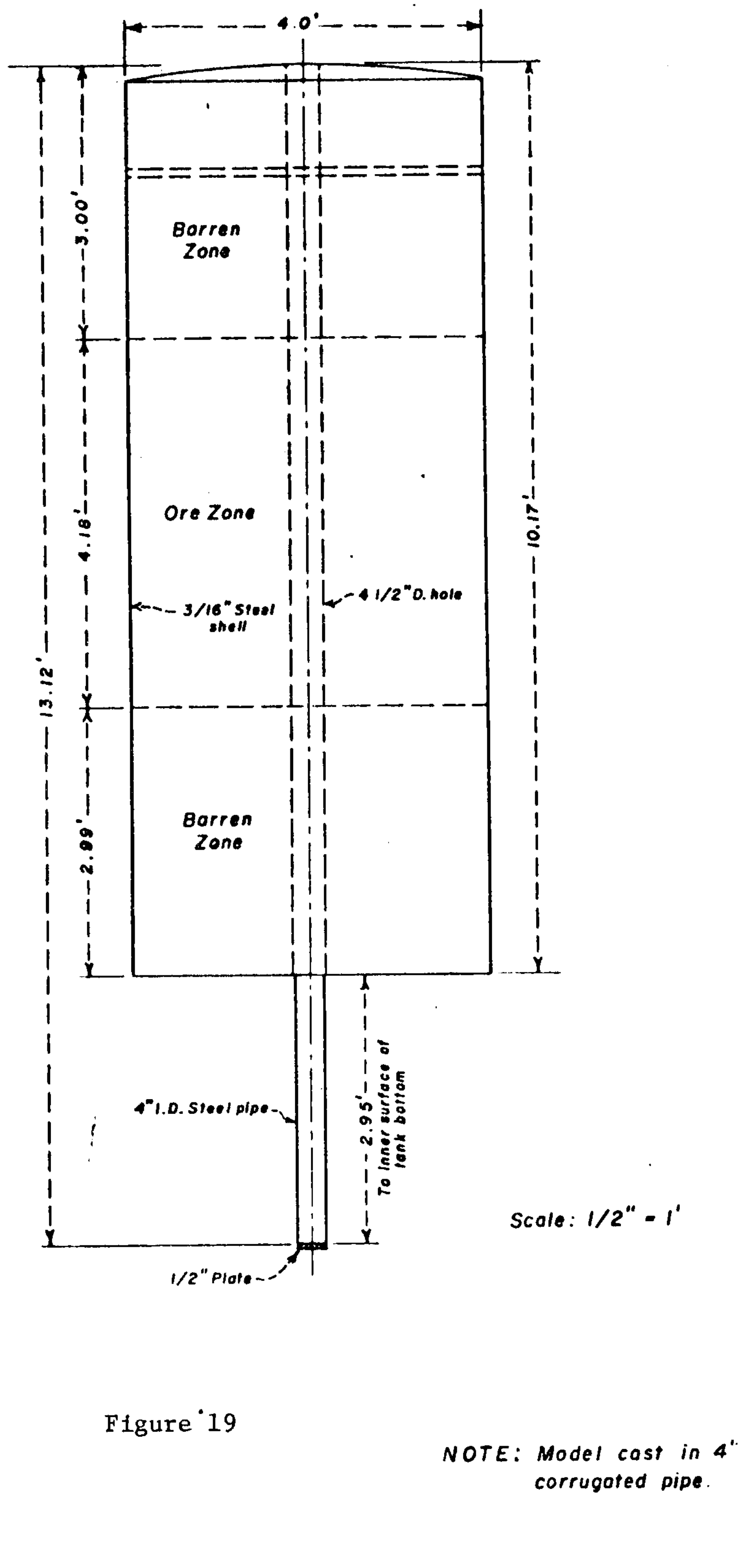


Figure 19

U-I TEST PIT

Table 12

U-1 TEST PIT

ore zones	ore type & amount	430.8 lbs. of 11.19% eU_3O_8 Schwartzwalder Ore 4861.7 lbs. of 2.62% eU_3O_8 Schwartzwalder Ore
	cement amount	1755 lbs.
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	2.415 % U_3O_8
	gamma only	2.422 % eU_3O_8
	gamma spec	unknown
	gamma logging	2.482 $\pm$0.0071% eU_3O_8
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	2.074 g/cc
	in situ	unknown
water or H^+	chemical analysis	4.45% L.O.D. at 110°C
	in situ	10.13% (neutron-neutron probe)
Zeq (petrographic analysis)	unknown	
porosity	unknown	
cracks or fractures	unknown	
magnetic susceptibility	unknown	

U-1 TEST PIT

Sample	chemical % U_3O_8	radiometric % eU_3O_8	% LOD	dry bulk density g/cc
LPI 507	2.462	2.442		
LPI 508	2.401	2.427	4.45	2.084
LPI 509	2.420	2.507		
LPI 510	2.451	2.428		
LPI 511	2.381	2.364		
LPI 512	2.428	2.407	4.27	2.084
LPI 513	2.438	2.406		
LPI 514	2.424	2.415		
LPI 515	2.404	2.457	4.48	2.052
LPI 516	2.441	2.478		
LPI 517	2.416	2.456		
LPI 518	2.414	2.501		
LPI 519	2.445	2.521	4.62	2.068
LPI 520	2.404	2.497		
LPI 521	2.430	2.501		
LPI 522	2.360	2.354		
LPI 523	2.384	2.369	4.44	2.084
LPI 524	2.364	2.422		
average	2.415	2.442	4.45	2.074

6-4-69 date of analysis

True typed copy

May 16, 1968
Work Request RID 68-1

Addressee: James C. Westbrook, Assistant Manager for Administration

Project Title: Construction of One "High-Grade" Calibration Test Pit

Description of Proposed Facility: The "high-grade" test pit will be patterned after the "N" series test pits except for the top being near ground level and the installation of an overhead pulley frame. The ore zone will have a three foot barren zone above and below. A steel tank that is watertight on all sides except the top will be used to contain the material.

A specific breakdown of the work to be done is as follows:

1. Fabricate a steel tank having an inside diameter of four feet and a length of ten feet. The top of the tank will be open. The bottom end of the tank will have a three-foot long by four inch I.D. run pipe installed and sealed at the bottom. All joints will be watertight. The tank walls and the bottom end plate should be 3/16-inch steel. All sides of the steel should be coated with an appropriate primer followed by a protective paint finish. The finished tank must be round. (See attached drawing.)

2. The tank contents will consist of: (1) A bottom barren zone 3 feet thick consisting of a mortar sand grout mix. (2) An ore zone 4 feet thick with an ore grade near 3% eU_3O_8 consisting of finely crushed ore, sand and cement mixed according to directions to be supplied by the Geophysical Branch. Approximately 4,800 pounds of uranium ore averaging 4% equivalent U_3O_8 will be required. The crushed ore must have a maximum particle size such that it will all pass through a 10 mesh sieve. (3) A top barren zone 3 feet thick consisting of a mortar sand grout mix.

3. The access hole in the test pit will be 4.5 inches and made with a form pipe having this diameter. Great care must be taken when pouring the ore zone to prevent ore seepage into the lower barren zone. If necessary the top of the lower barren zone will have to be sealed at the edges.

4. A 1/16 inch thick square aluminum plate having a side dimension of 36 inches and a hole in the center of 4.5 inches will be installed at the ore/barren interface at the top and the bottom. (Trim corners to fit.) A No. 12 aluminum wire with a plastic cover will be connected to each aluminum plate and the two wires brought to the top of the tank on the inside.

5. An overhead mast with a pulley assembly patterned after the "R" test pits is to be installed. All exposed metal is to be painted.

6. The test pit is to be located between the "O" pits and the "S" pits. The top of the pit should be no higher than one foot above the blacktop.

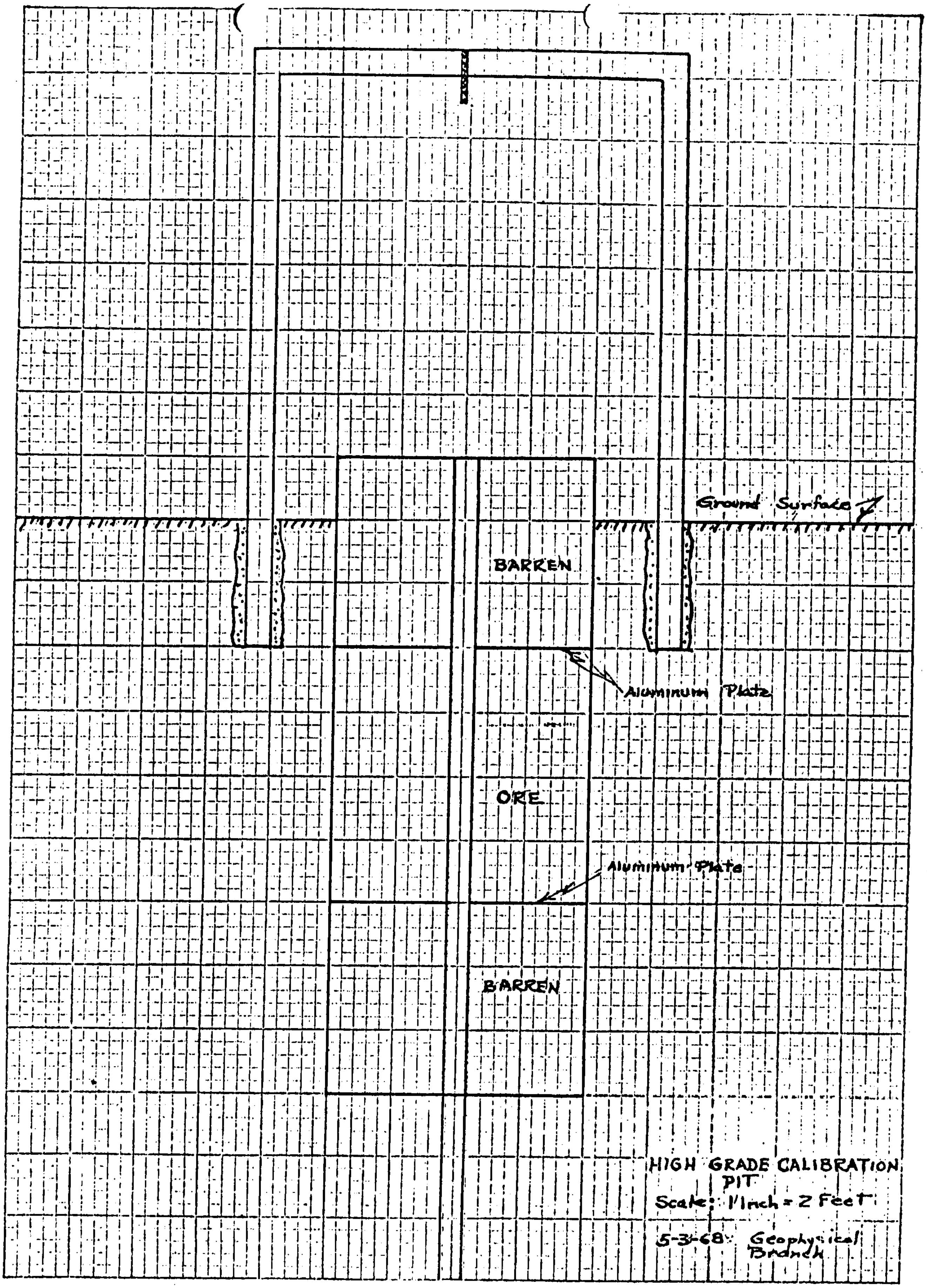
Justification: During the past year experience has shown that many gamma-ray logging units are unable to measure ore grades in the neighborhood of 2% or greater. Yet such grades or even higher grades are commonly found in the major uranium deposits. Inability to measure grades in this range can be due to several known causes and possibly some that are unknown at the present. It is the purpose of this test pit to subject gamma-ray logging equipment to the intense gamma-ray flux which will indicate the presence or absence of certain malfunctions under controlled conditions. This is a significant part of the Commission's program of monitoring industry gamma-ray logging.

Method of Project Accomplishment: This project is to be completed through the contractor. The steel tank fabrication will have to be done at a steel tank fabricating shop. Commission personnel will sample the material loaded into the tank.

Estimate of Cost: The total estimated cost for the test pit is $2,900.00. The general category breakdown of this cost is estimated as follows:

			Actual
1.	Steel tank fabrication	$ 300.00	288.
2.	Cost of ore and crushing	1,300.00	±1,958.
3.	Cost of barren zones	100.00	289. (materials & cement)
4.	Cost of aluminum plate assembly	50.00	
5.	Cost of overhead mast	100.00	
6.	Cost of labor for installation	700.00	962. + additional
7.	Miscellaneous material	50.00	
8.	Contingency	300.00	85. (crane rental)

Scheduled Starting and Completion Dates: Work can start on this project as soon as it is received by the contractor. There may be some delay in getting the ore material. We would expect to complete the project by about August 1, 1968.



Ground Surface
BARREN
Aluminum Plate
ORE
Aluminum Plate
BARREN
HIGH GRADE CALIBRATION PIT
Scale: 1 inch = 2 Feet
5-3-68 Geophysical Branch

SIDE VIEW

U-2 TEST PIT

The U-2 test pit, built in October, 1969 was designed as an intermediate grade calibration test pit so that gross gamma ray logging equipment could be calibrated. The schematic diagram shows the thickness of the zones and Table 13 lists the factors for this pit.

In a report by Eschliman and Key*, a grade of 1.201% eU_3O_8 was assigned to the U-2 test pit ore zone. The chemical grade (1.233% U_3O_8) and the radiometric grade analyzed by the Chemistry Laboratory (1.253% eU_3O_8) are in close agreement. All the grades assigned to this test pit are in close agreement, which means this test pit is near secular equilibrium. This pit has served its purpose and should continue as a calibration test pit.

*Eschliman, D. H. and Key, B. N., October 24, 1972, "A Change of Assigned Radiometric Grades for the US AEC Gamma Ray Logging Calibration Models", Lucius Pitkin Geophysics/Electronics Report No. 5, Grand Junction, Colorado.

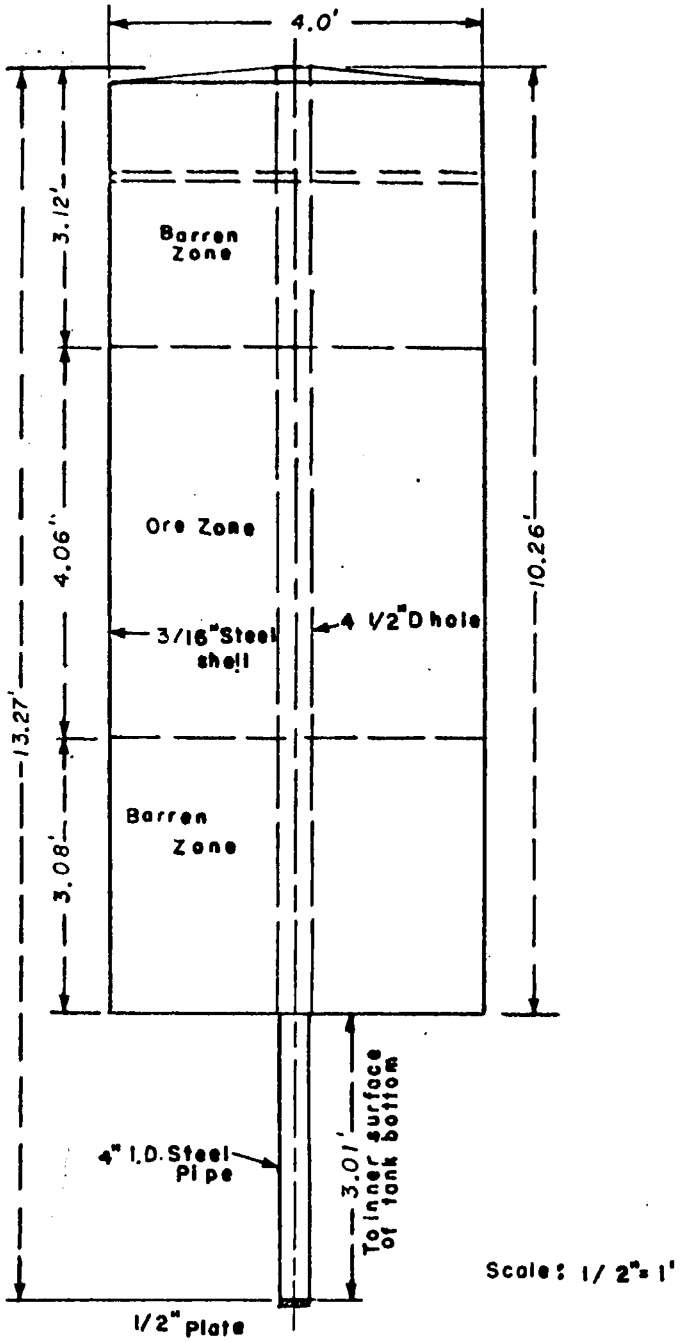


Figure 20

NOTE: Model cast in 4' corrugated pipe

U-2 TEST PIT

Table 13
U-2 TEST PIT

ore zones	ore type & amount	See below
	cement amount	1755 lbs.
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	1.233 %U_3O_8
	gamma only	1.229 %eU_3O_8
	gamma spec	unknown
	gamma logging	1.201 $\pm$0.0038%eU_3O_8
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	1.699 g/cc
	in situ	unknown
water or H^+	chemical analysis	9.21% L.O.D. at 110°C
	in situ	14.34% (neutron-neutron probe)
Zeq (petrographic analysis)		unknown
porosity		unknown
cracks or fractures		unknown
magnetic susceptibility		unknown

716 lbs. of ground ore zone from U-1 test pit
1980 lbs. of 2.62% eU_3O_8 Schwartzwalder Ore
1413 lbs. of ground ore zone from high grade Texas pit
1480 lbs. of ground ore zone from C test pit

U-2 TEST PIT

Sample	chemical % U_3O_8	radiometric % eU_3O_8	% L.O.D.	dry bulk density g/cc
A-4835	1.227	1.232	8.20	
A-4836	1.291	1.319	10.13	1.699
A-4837	1.243	1.240	7.82	
A-4838	1.221	1.254	10.51	1.699
A-4839	1.248	1.254	8.69	
A-4840	1.198	1.244	10.71	1.699
A-4841	1.210	1.232	8.55	
A-4842	1.197	1.246	10.16	
A-4843	1.263	1.258	8.15	
average	1.233	1.253	9.21	1.699

7-7-69 date of analysis

U-3 TEST PIT

The U-3 test pit, built in October, 1969 was designed as an intermediate grade calibration test pit so that gross gamma ray logging equipment could be calibrated. The schematic diagram shows the thickness of the zones, and Table 14 lists the factors for this pit.

In a report by Eschliman and Key*, a grade of 0.459% eU_3O_8 was assigned to the U-3 test pit ore zone. The chemical grade (0.481% U_3O_8) and the radiometric grade analyzed by the Chemistry Laboratory (0.470% eU_3O_8) are in close agreement. All the grades assigned to this test pit are in close agreement which means this test pit is near secular equilibrium. This pit has served its purpose and should continue as a calibration test pit.

*Eschliman, D. H. and Key, B. N., October 24, 1972, "A Change of Assigned Radiometric Grades for the US AEC Gamma Ray Logging Calibration Models", Lucius Pitkin Geophysics/Electronics Report No. 5, Grand Junction, Colorado.

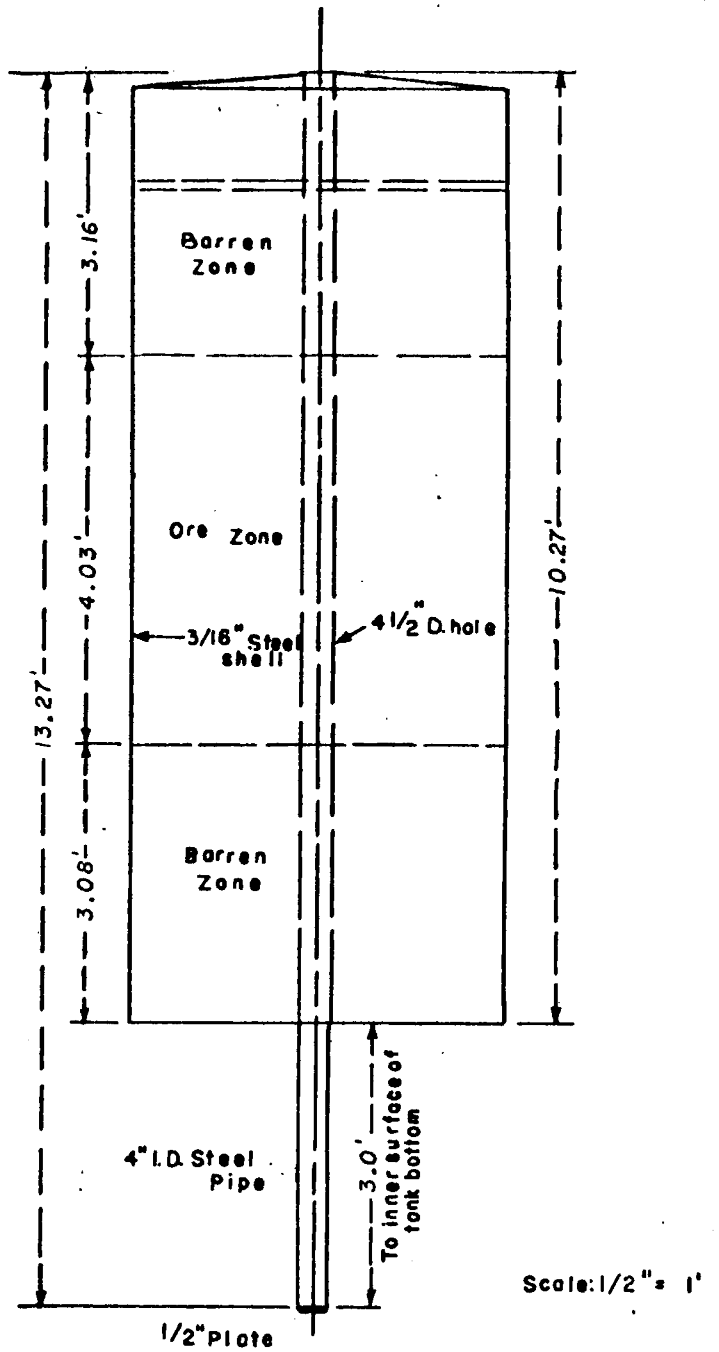


Figure 21

NOTE: Model cast in 4' corrugated pipe

U-3 TEST PIT

Table 14

U-3 TEST PIT

ore zones	ore type & amount	See below
	cement amount	1755 lbs.
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.481 %U_3O_8
	gamma only	0.473 %eU_3O_8
	gamma spec	unknown
	gamma logging	0.459 $\pm$0.0015%eU_3O_8
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	1.667 g/cc
	in situ	unknown
water or H^+	chemical analysis	7.93% L.O.D. at 110°C
	in situ	14.86% (neutron-neutron probe)
Zeq (petrographic analysis)	unknown	
porosity	unknown	
cracks or fractures	unknown	
magnetic susceptibility	unknown	

1925 lbs. of ground ore zone from low grade Texas pit
1653 lbs. of 2.62% eU_3O_8 Schwartzwalder Ore
689 lbs. of 0.287% eU_3O_8 Schwartzwalder Ore
1821 lbs. of ground ore zone from C test pit

U-3 TEST PIT

Sample	chemical % U_3O_8	radiometric % eU_3O_8	% LOD	dry bulk density g/cc
LPI 539	0.480	0.480	8.21	
LPI 540	0.467	0.462	7.25	
LPI 541	0.473	0.452	9.12	1.667
LPI 542	0.497	0.486	7.77	
LPI 543	0.475	0.450	8.24	1.667
LPI 544	0.478	0.468	8.25	
LPI 545	0.495	0.475	8.29	1.667
LPI 546	0.476	0.471	7.40	
LPI 547	0.460	0.457	7.41	
LPI 548	0.494	0.473	8.10	1.667
LPI 549	0.498	0.486	7.47	
LPI 550	0.479	0.476	7.68	
average	0.481	0.470	7.93	1.667

8-5-69 date of analysis

April 9, 1969
Work Request RID 69-1

Addressee: James C. Westbrook, Assistant Manager for Administration

Project Title: Construction of Two Intermediate-Grade Test Pits at Grand Junction

Description of Proposed Facility: These test pits will be patterned after the high-grade test pit with minor exceptions. The ore zone will be four feet thick with a three foot barren zone above and below. The test pits will be contained in steel tanks having watertight sides and bottom.

A specific breakdown of the work to be done is as follows:

1. Fabricate two steel tanks having an inside diameter of four feet and a length of ten feet. The top of the tank will be open. The bottom end of the tank will have a three foot long by four inch I.D. run pipe installed on the central axis of the tank. The run pipe is to be sealed at the bottom. All joints will be watertight. The tank walls and the bottom end plate should be 3/16 inch steel. All sides of the steel should be coated with an appropriate primer followed by a protective paint finish. The finished tanks must be round. (See attached drawing.)

2. The tank contents of both tanks will consist of (1) a bottom barren zone 3 feet thick consisting of a mortar sand grout mix, (2) an ore zone 4 feet thick with an ore grade near 1.30% eU_3O_8 for tank "A" and 0.50% eU_3O_8 for tank "B." The material will consist of finely crushed ore, sand and cement mixed according to directions to be supplied by the Geophysical Branch. Pit "A" will require 5,265 ±5 pounds of ore aggregate with an average grade of 1.73% ±5% eU_3O_8, and pit "B" will require 5,265 ±5 pounds of ore aggregate with an average grade of 0.67% ±5% eU_3O_8. The crushed ore must have a maximum particle size such that it will all pass through a 10 mesh sieve, and (3) a top barren zone 3 feet thick consisting of a mortar sand grout mix.

3. The access hole in the test pit will be 4.5 inches and made with a form pipe having this diameter. Great care must be taken when pouring the ore zone to prevent radioactive material seepage into the hole through the lower barren zone. If necessary, the top of the lower barren zone will have to be sealed at the edges.

4. An overhead mast with a pulley assembly patterned after the "R" test pits is to be installed. All exposed metal is to be painted.

5. The two test pits are to be located immediately south of the C-1 pit.

Justification: During the course of evaluating the high-grade test pits installed at Casper, Wyoming; Grants, New Mexico; and George West, Texas; Geophysical Branch personnel found a significant effect upon gamma-ray logging equipment resulting from a change in the average atomic number of the host rock with a change in the contained uranium. The net effect of this change is to cause an ever increasing underestimation of ore grade when the ore grade measurements are made in the manner currently in use by industry. It is the purpose of these two test pits, as well as existing pits, to establish necessary correction data to be applied to industry gamma-ray logging through the Commission's gamma-ray logging interpretation program.

Method of Project Accomplishment: This project is to be completed through the contractor. The steel tanks will have to be fabricated at a local steel tank fabricating shop. Commission personnel will sample the material loaded into the tank and make certain necessary measurements during the course of construction. If additional details are required, R. F. Droullard should be contacted.

Estimate of Cost: The total estimated cost for the two test pits is about $4,500.

The general category breakdown of this cost is estimated as follows:

1.	Steel tank fabrication	$ 600.00
2.	Ore preparation	1,200.00
3.	Cost of barren zones	200.00
4.	Cost of overhead mast	200.00
5.	Cost of labor for installation	1,400.00
6.	Miscellaneous material	100.00
7.	Contingency	800.00

Ore grade material for these test pits is on hand. It is essential that the ore be in secular equilibrium or very close to it. The ore from Schwartzwalder mine is satisfactory.

Scheduled Starting and Completion Dates: Work can start on this project as soon as it is received by the contractor. We would expect to complete the project by the end of FY 1969.

May 23, 1969
Work Request RID 69-1
Modification No. 1

Addressee: James C. Westbrook, Assistant Manager for Administration

Project Title: Construction of Two Intermediate-Grade Test Pits at Grand Junction

Description of Proposed Facility: These test pits will be patterned after the high-grade test pit with minor exceptions. The ore zone will be four feet thick with a three foot barren zone above and below. The test pits will be contained in steel tanks having watertight sides and bottom.

Item 5 is to be modified as follows:

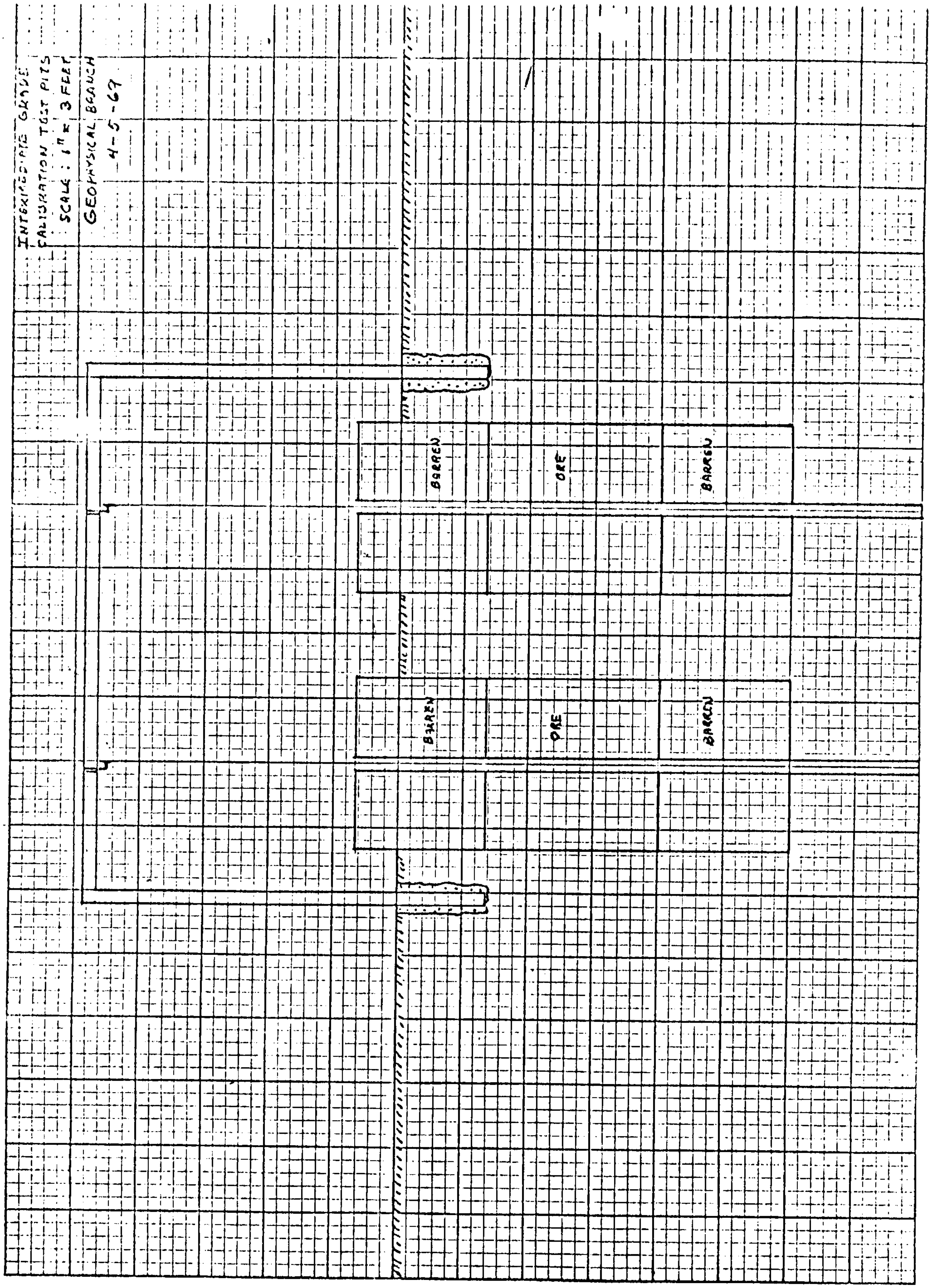
5. Locate the two test pits between the "0" pits and the large tank density pits. This location will require (a) removal and disposal of the three 55 gallon drum models, (b) removal of the portion of the concrete pad that these models are located on, (c) black topping the area for access by trucks during wet conditions. (See attached drawing.)

Estimate of Cost: Add the following estimated cost items:

7.	Contingency - increase amount by	$200.00
8.	Tank site clearance	100.00
9.	220 square yards of blacktop	440.00
10.	Ore for test pits (non-funded item)	600.00

Total estimated cost for the two test pits is $5,240 plus non-funded item of $600 for ore.

Source of Funds: Items to be funded for this project should come from the FY 1969 GPP budget of the Construction and Supply Division. Ore has been acquired from the 1968 GPP funds.



INTERMEDIATE GRADE
CALIBRATION TEST PITS
SCALE: 1" = 3 FEET
GEOPHYSICAL BRANCH
4-5-67
BARREN
ORE
BARREN
BARREN
ORE
BARREN

S MODEL

The S Model test pit, constructed in June, 1965, was a research test pit designed to calibrate a density probe for different borehole sizes. According to R. F. Droullard (personal communication) the test pit is not constructed properly. The concrete in this pit is not uniform because of internal voids and this gives poor density comparisons when attempting to obtain a borehole correction factor. A gamma spectrum analysis was completed on a sample from this test pit on Nov. 26, 1973. Table 15 lists the factors for this pit.

The S Model test pit is not used and has marginal value at the present time.

Gamma Spectrum Analysis

Sample #	ppm eTh	ppm eU	%K	date
7456	6.2	1.9	1.34	11-26-73

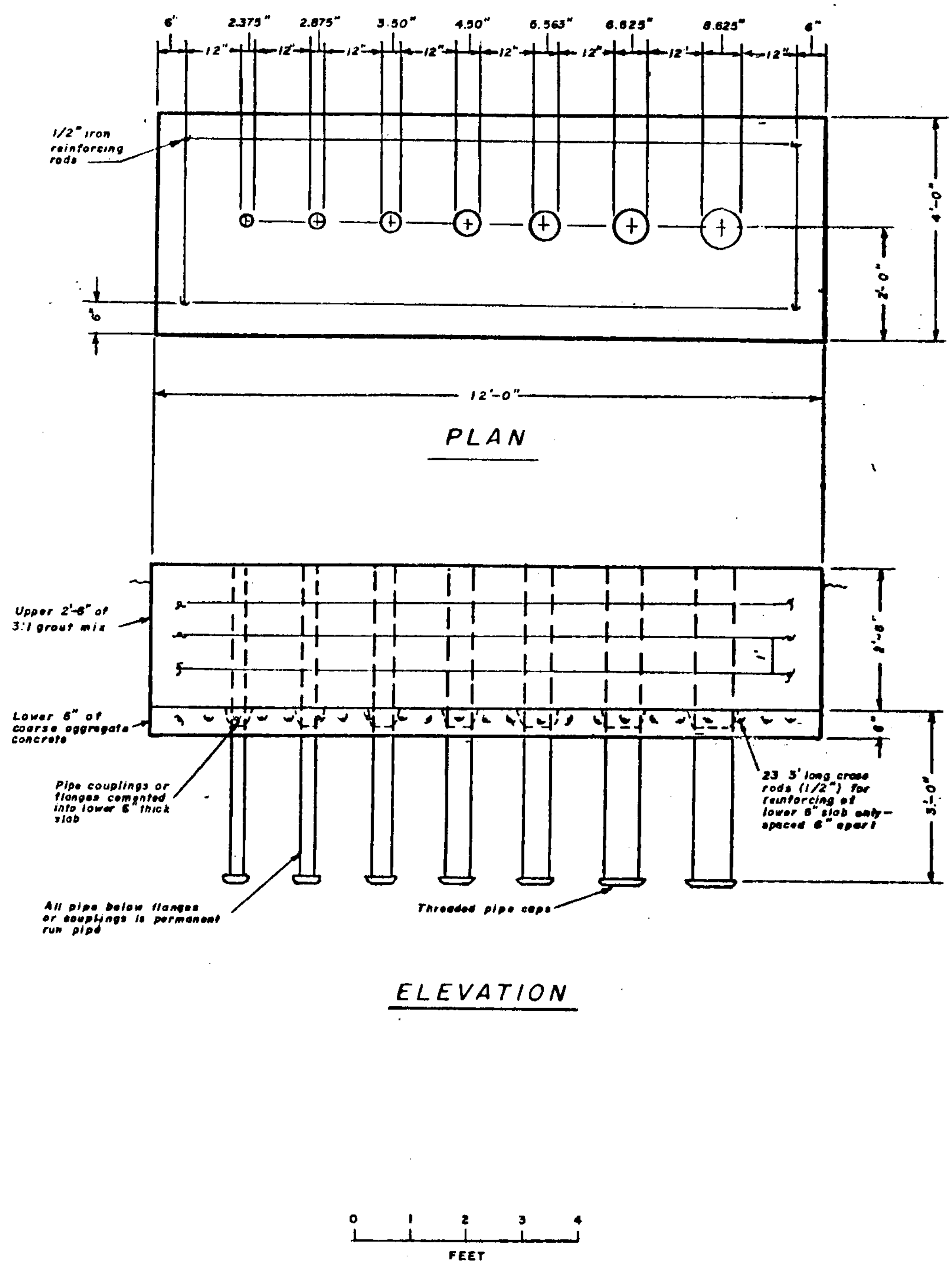


Figure 22

S MODEL FOR HOLE SIZE CALIBRATION

Table 15
S MODEL

ore zones	ore type & amount	None
	cement amount	None
	water amount	None
	sand type & amount	None
barren zone	sand type & amount	unknown (3:1) concrete grout mix & coarse concrete aggregate
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	None
	gamma only	None
	gamma spec	None
	gamma logging	None
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	1.34% K 1.9ppm eU 6.2ppm eTh
	gamma logging	unknown
density	chemical analysis	unknown
	in situ	unknown
water or H^+	chemical analysis	unknown
	in situ	unknown
Zeq (petrographic analysis)	unknown	
porosity	unknown	
cracks or fractures	unknown	
magnetic susceptibility	unknown	

Form No. A-12 (Revised)

WESTERN URANIUM PROJECT
LUCIUS PITKIN, INC.
USAEC Contract No. AT(05-1)-912
Grand Junction, Colorado

S MODEL

CONSTRUCTION WORK ORDER ADVISE

WORK ORDER NO. LP-65-3 DATE February 17, 1965

AUTHORIZED BY R. J. Gidney CSS DATE Req. 11376 2-8-65 FUNDS AUTHORIZED $680.00

DATE TO BEGIN 2-18-65 DATE TO BE COMPLETED 4-1-65

SCOPE OF WORK: Construct test pits for probe calibration in accordance with AEC Form "90" 11376, drawing, and instruction and details from L. Y. Marks or R. F. Droullard, Geophysics Section, PED.

Above work is not subject to the Davis-Bacon Act.

ACCOUNTING DISPOSITION 62-1 CHARGE TO (PLANT PROJECT NO.) 111-65-9

BUDGET CONTROL REPORT

JOB DESCRIPTION Construct Test Pits JOB NO. LP-65-~~2~~ 3

Based upon our latest budget estimate, by Form "90" 11376 dated February 8, 19 65, and changes in the work since that date, our current budget figures as of February 17, 19 65, are as follows:

Budget at . . . . $ 680.00

Changes orders received . . . . $

Changes requested, in process. . . . . $

Received total Budget as of February 17, 1965 $ 680.00

Estimated Date of Completion April 1, 1965

Revised Estimated Date of Completion

APPROVED BY Original Signed By Harold Canning Harold Canning, Office Manager ISSUED BY Original Signed By R. W. Carlitz R. W. Carlitz, Purchasing Agent

DISPOSITION
1 - Procurement File
2 - Operations
3 - Cost Accounting
4 - Fiscal Accounting
5 - Construction & Supply
6 - LPI Payroll

FORM AEC-90 (3-47)

U.S. ATOMIC ENERGY COMMISSION

REQUISITION

ACTION COPY

TO — SEND ALL BUT LAST COPY TO SUPPLYING OFFICE--NO LETTER OF TRANSMITTAL NECESSARY.

LPI

FROM (NAME AND ADDRESS OF REQUISITIONING OFFICE)

Philip H. Dodd, Chief
Technical Services Branch
Production Evaluation Division

SHIP TO (EXACT ADDRESS AND SPECIAL MARKINGS)

L. Y. Marks
Geophysics Section
Technical Services Br.
Production Evaluation Division

PLACE ALL RELATED INFORMATION AND INSTRUCTIONS ON THIS REQUISITION

ITEM NO.	QUANTITY	UNIT	DETAILED DESCRIPTION OF ARTICLES OR SERVICES	ACTION TAKEN (for Supplying Office Use)
1			Have LPI construct a 4'x12'x3' concrete block containing 7 vertical holes of specified sizes and spacings (see attached drawing)- place steel run pipes below this model; and erect an overhead probe suspension rack with pulleys. The model is to be set so that its upper concrete surface is 4" above ground level.	
			See L. Y. Marks or R. F. Droullard for additional details.	
			Funds are to come from FY 1965 Construction.	
			Estimated Materials Cost $480.00	
			" Labor Cost 200.00	
			Estimated Total Cost $680.00	
			Suggested Suppliers:	
			Mt. Garfield Plumbing and Heating - for pipe	
			Grand Junction Steel Fabricating - for reinforcing rod	
			United Redi-Mix - for concrete	

REQUISITION NO. **No. 11376**

Check only if this form is used as a continuation sheet or extract of the requisition number typed above.
☐ CONTINUATION SHEET ☐ EXTRACT

DATE OF REQUISITION
February 8, 1965

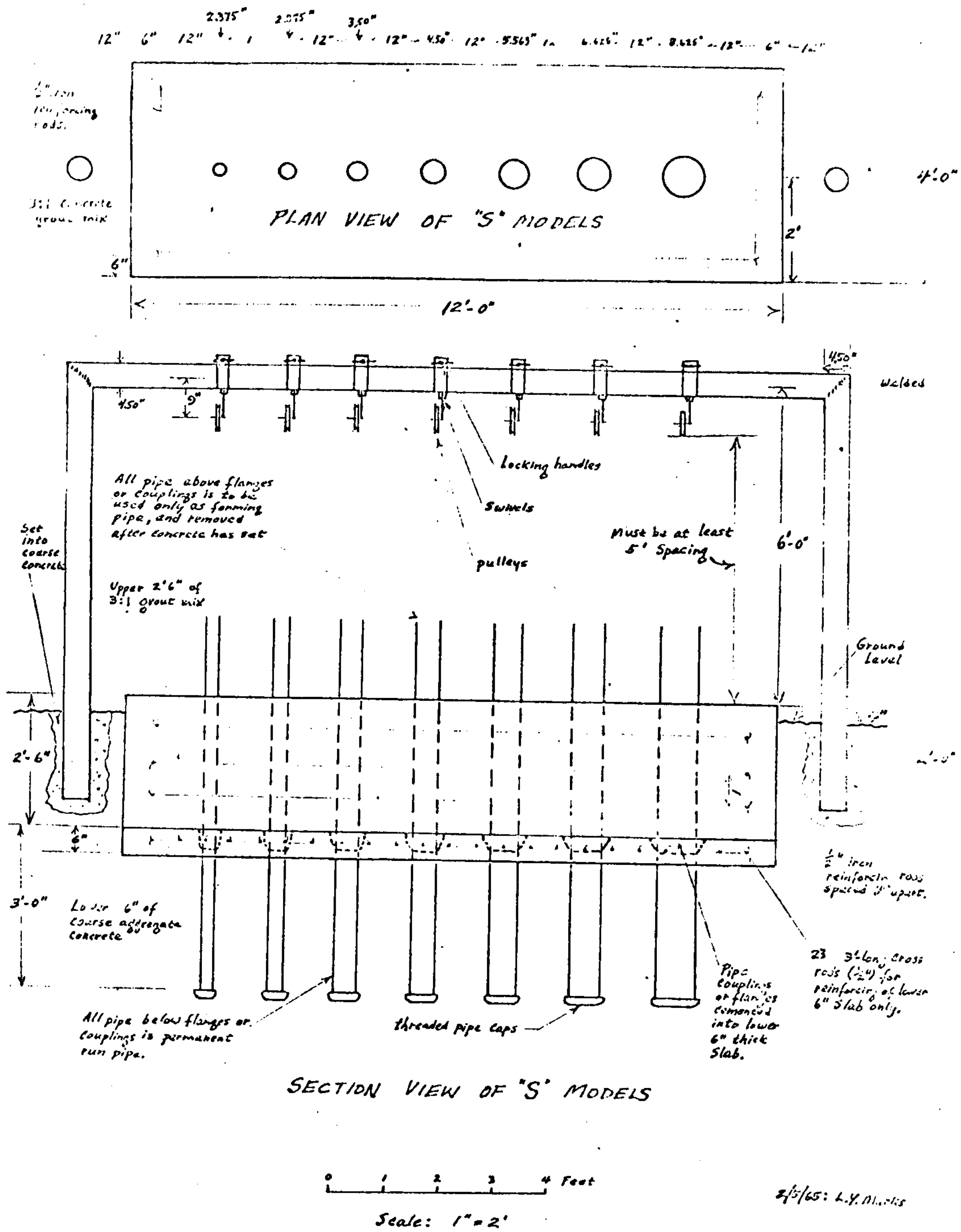
DATE NEEDED (LATEST POSSIBLE DATE)
April 1, 1965

COST SYMBOL (MUST BE SHOWN)

SUBMITTED BY (NAME AND TITLE)
Robert H. Toole, Deputy Director, Production Evaluation Div.

APPROVED BY (NAME AND TITLE)
R. J. Gidney, Director, Construction and Supply Division

FOR SUPPLYING OFFICE USE



GEOPHYSICAL MODELS FOR HOLE SIZE CALIBRATION

T-1 TEST PIT

The T-1 test pit, constructed in June, 1965, is a high grade (0.9400% $eThO_2$) thorium test pit to be used for thorium logging calibration. The type and amount of ore used was prescribed by the AEC geophysics section personnel and no records of these parameters exists at present. The ore zone is contained in a 4 ft. diameter, 3 ft. high steel tank as shown on the schematic. Table 16 lists the factors concerning this test pit.

This test pit could be used for research and/or calibration of new radiometric (gamma spectral probes or neutron activated probes) logging systems where a combination of high grade thorium (1% ThO_2) and low grade uranium (0.02% ThO_2) concentrations are encountered. A gamma spectral or neutron activation analysis hasn't been run on the samples from this test pit. These measurements are needed for the research and calibration activities mentioned.

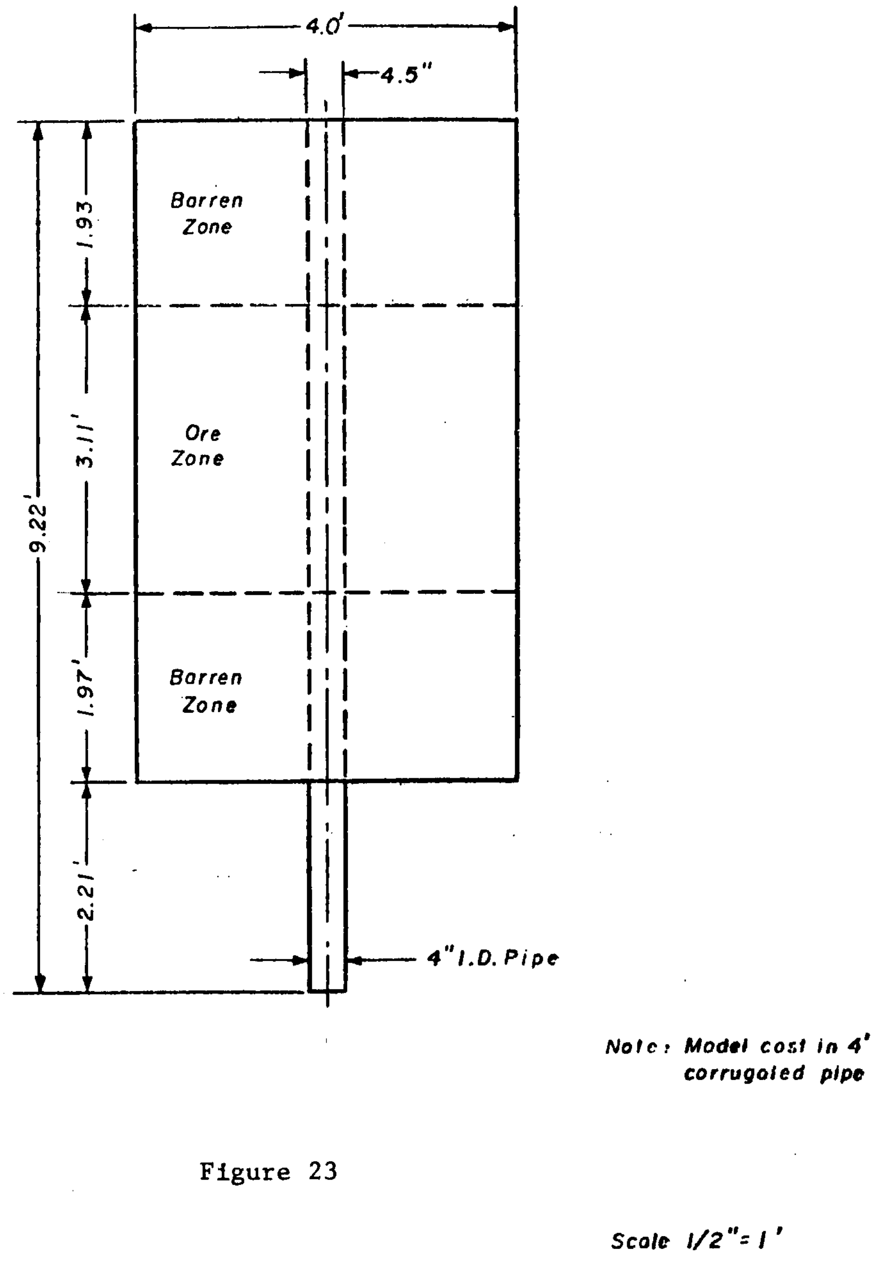


Figure 23

T-1 MODEL.

Table 16

T-1 TEST PIT

ore zones	ore type & amount	unknown grout mix concrete and thorium ore
	cement amount	unknown
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown coarse concrete
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.979% ThO_2 0.018% U_3O_8
	gamma only	0.940% $eThO_2$ 0.398% eU_3O_8
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	2.212 g/cc
	in situ	unknown
water or H^+	chemical analysis	2.58% LOD at 110°C
	in situ	unknown
Zeq (petrographic analysis)	unknown	
porosity	unknown	
cracks or fractures	unknown	
magnetic susceptibility	unknown	

T-1 TEST PIT (Thorium Pit Ore Zone)

Sample	chemical $\%ThO_2$	radiometric $\%eThO_2$	chemical $\%U_3O_8$	radiometric $\%eU_3O_8$	%LOD	bulk density g/cc	grain density g/cc
P8928	1.02	0.95	0.03	0.40	2.53	2.21	2.94
P8929	0.94	0.97	0.03	0.39	2.66	2.21	2.92
P8930	0.96	0.92	0.02	0.39	2.63	2.22	2.92
P8931					2.48	2.22	
P8932	1.00	0.94	0.01	0.40	2.64	2.23	2.92
P8933	0.98	0.93	0.01	0.40	2.71	2.21	2.92
P8934	1.00	0.94	0.02	0.40	2.58	2.20	2.93
P8935					2.57	2.18	
P8936	1.01	0.94	0.02	0.40	2.51	2.21	2.96
P8937	0.92	0.93	0.02	0.40	2.49	2.23	2.91
average	0.979	0.940	0.018	0.398	2.58	2.212	2.928

6-4-65 date of analysis

T-2 TEST PIT

The T-2 test pit, constructed in June, 1965, is a medium grade (0.499% $eThO_2$) thorium test pit to be used for thorium logging calibration. The type and amount of ore used was prescribed by the AEC geophysics section personnel and no records concerning these parameters exists at present. The ore zone is contained in a 4 ft. diameter, 3 ft. high steel tank as shown on the schematic. Table 17 lists the factors concerning this test pit.

This test pit could be used for research and/or calibration of new radiometric (gamma spectral probes or neutron activated probes) logging systems where a combination of medium grade thorium (0.5% ThO_2) and low grade uranium (0.01% U_3O_8) are encountered. A gamma spectral or neutron activation analysis hasn't been run on the samples from this test pit. These measurements are needed for the research and calibration activities mentioned.

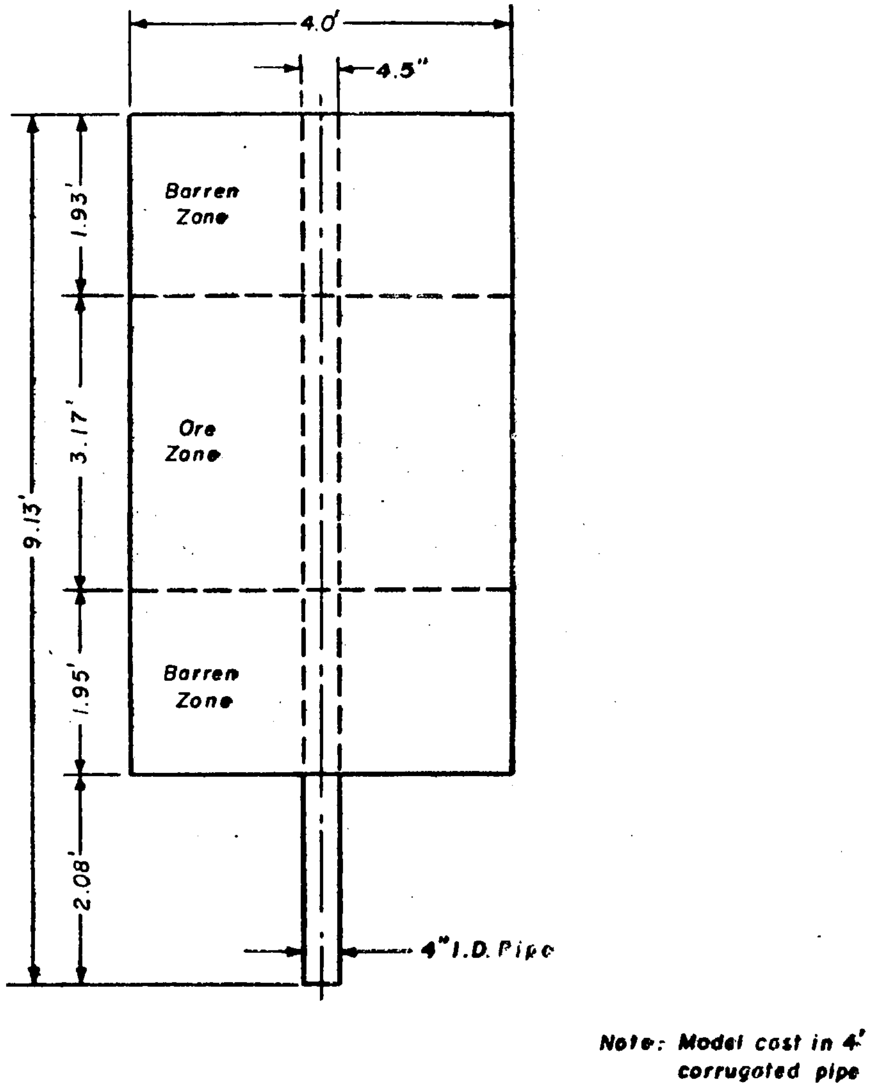


Figure 24

T-2 MODEL

Table 17

T-2 TEST PIT

ore zones	ore type & amount	unknown grout mix concrete and thorium ore
	cement amount	unknown
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown coarse concrete
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.506% ThO_2 0.011% U_3O_8
	gamma only	0.499% $eThO_2$ 0.221% eU_3O_8
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	2.099 g/cc
	in situ	unknown
water or H^+	chemical analysis	2.59% LOD at 110°C
	in situ	unknown
Zeq (petrographic analysis)		unknown
porosity		unknown
cracks or fractures		unknown
magnetic susceptibility		unknown

T-2 TEST PIT (Thorium Pit Ore Zone)

Sample	chemical %ThO_2	radiometric %eThO_2	chemical %U_3O_8	radiometric %eU_3O_8	%LOD	bulk density g/cc	grain density g/cc
P8938	0.51	0.51	0.01	0.22	2.54	2.10	2.78
P8939	0.52	0.48	0.01	0.21	2.61	2.10	2.77
P8940	0.49	0.48	0.01	0.22	2.52	2.09	2.78
P8941					2.63	2.10	
P8942	0.62	0.57	0.01	0.25	2.66	2.10	2.79
P8943	0.46	0.49	0.02	0.22	2.55	2.10	2.78
P8944	0.46	0.47	0.01	0.21	2.53	2.10	2.78
P8945					2.63	2.10	
P8946	0.49	0.49	0.01	0.22	2.58	2.10	2.77
P8947	0.50	0.50	0.01	0.22	2.64	2.10	2.77
average	0.506	0.499	0.011	0.221	2.59	2.099	2.778

6-4-65 date of analysis

T-3 TEST PIT

The T-3 test pit, constructed in June, 1965, is a low grade (0.15% $eThO_2$) thorium test pit to be used for thorium logging calibration. The type and amount of ore used was prescribed by AEC geophysics section personnel and no records of these parameters exists at present. The ore zone is contained in a 4 ft. diameter, 3 ft. high steel tank as shown on the schematic. Table 18 lists the factors of this test pit.

This test pit could be used for research and/or calibration of new radiometric (gamma spectral probes or neutron activated probes) logging systems where a combination of low grade thorium (0.1% ThO_2) and lower grade uranium (0.01% U_3O_8) are encountered. A gamma spectral or neutron activation analysis hasn't been run on the samples from this pit. These measurements are needed for the research and calibration activities mentioned.

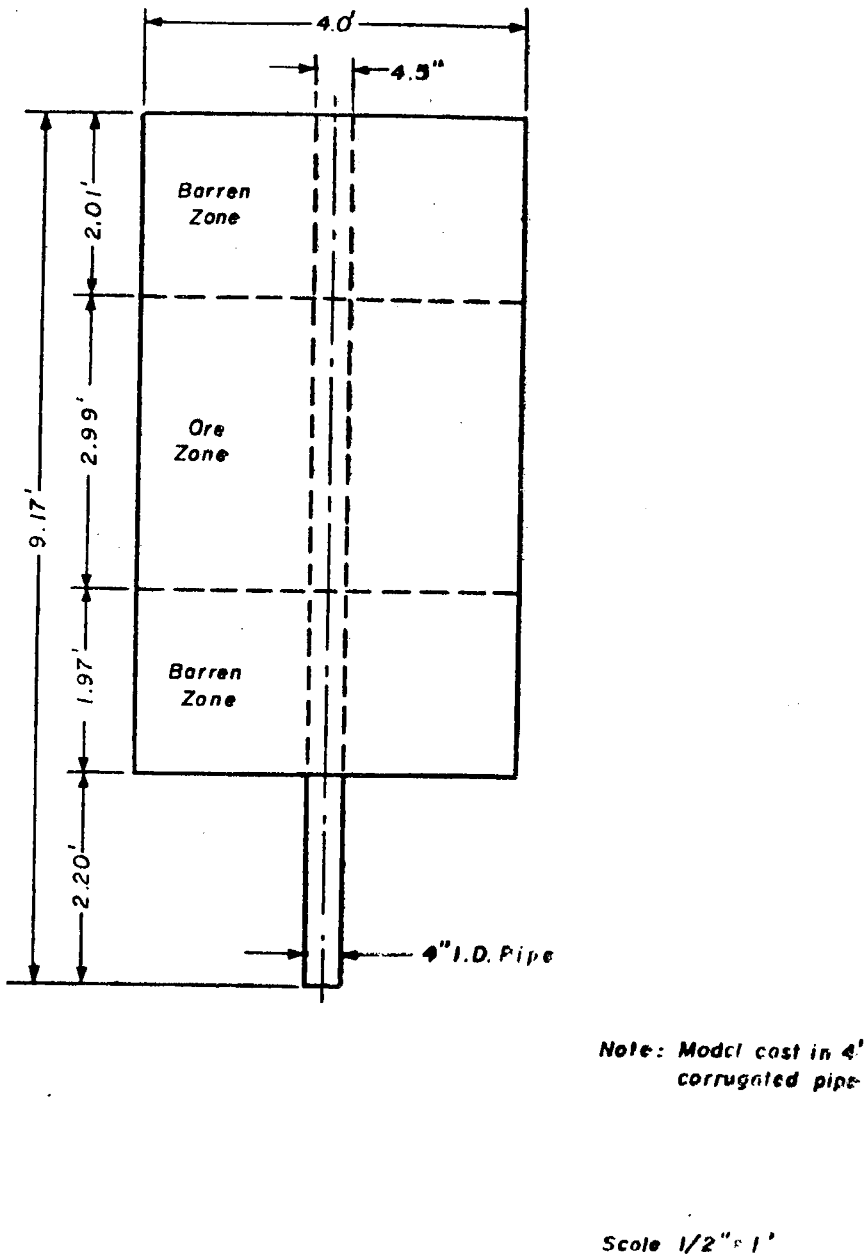


Figure 25

T-3 MODEL

Table 18

T-3 TEST PIT

ore zones	ore type & amount	unknown grout mix concrete and th[illegible]
	cement amount	unknown
	water amount	unknown
	sand type & amount	unknown
barren zone	sand type & amount	unknown coarse concrete
	cement amount	unknown
	water amount	unknown
assay analysis ore zone	chemical	0.093% ThO_2 0.010% U_3O_8
	gamma only	0.105% $eThO_2$ 0.047% eU_3O_8
	gamma spec	unknown
	gamma logging	unknown
assay analysis barren zones	chemical	unknown
	gamma only	unknown
	gamma spec	unknown
	gamma logging	unknown
density	chemical analysis	2.014 g/cc
	in situ	unknown
water or H^+	chemical analysis	4.75% LOD at 110°C
	in situ	unknown
Zeq (petrographic analysis)		unknown
porosity		unknown
cracks or fractures		unknown
magnetic susceptibility		unknown

T-3 TEST PIT (Thorium Pit Ore Zone)

Sample	chemical % ThO_2	radiometric % $eThO_2$	chemical % U_3O_8	radiometric % eU_3O_8	% LOD	Bulk density g/cc	Grain density g/cc
P8903	0.08	0.10	0.01	0.04	4.16	2.06	2.70
P8904	0.10	0.11	0.01	0.05	4.70	2.02	2.71
P8905					4.57	2.02	
P8906	0.09	0.10	0.01	0.05	4.68	2.02	2.70
P8907	0.11	0.11	0.01	0.05	4.50	2.02	2.72
P8908					5.08	1.98	
P8909	0.08	0.10	0.01	0.04	5.21	1.99	2.71
P8910	0.10	0.11	0.01	0.05	5.10	2.00	2.69
average	0.093	0.105	0.010	0.047	4.75	2.014	2.705

5-10-65 date of analysis

FORM AEC-90 (3-47)

U.S. ATOMIC ENERGY COMMISSION

REQUISITION

ACTION COPY

T PITS

TO SEND ALL BUT LAST COPY TO SUPPLYING OFFICE--NO LETTER OF TRANSMITTAL NECESSARY.

LPI

FROM (NAME AND ADDRESS OF REQUISITIONING OFFICE)

Philip H. Dodd, Chief
Technical Services Branch
Production Evaluation Division

SHIP TO (EXACT ADDRESS AND SPECIAL MARKINGS)

Lawrence Marks, Geophysicist
Geophysics Section
Technical Services Br.
Production Evaluation Div.

PLACE ALL RELATED INFORMATION AND INSTRUCTIONS ON THIS REQUISITION

ITEM NO.	QUANTITY	UNIT	DETAILED DESCRIPTION OF ARTICLES OR SERVICES	ACTION TAKEN (for Supplying Office Use)
1			Have LPI construct 3 test models, with a common overhead probe suspension rack containing 3 pulleys, for thorium logging calibration. See accompanying diagram and consult L. Y. Marks and R. F. Droullard for additional details. Each model is to be 4.0' in diameter and 7.0' high, with a 2.0' run pipe below it. The top of each must be 1.0' above ground level. Each must contain a vertical 4.5" smooth-walled hole along its central axis, formed into the concrete. The upper and lower 2.0' high section of each model shall be barren coarse concrete contained in a 4.0' diameter, 2.0' high standard stock tank. The middle 3.0' high zone of each model shall be grout mix concrete and thorium ore blended as prescribed by the Geophysics Section personnel, and will be contained in a 4.0' diameter, 3.0' high steel tank (may need to be custommade).	
			Estimated cost of materials $ 675.00	
			" " " labor 200.00	
			~~Estimated total cost $ 875.00~~	
			LP did this work for PRM PB 3-8-65	
			Suggested suppliers: not used Ray Fiegel Co. or Grand Junction Steel Fabricating Co. for tanks; Mt. Garfield Plumbing and Heating for Pipe and fittings; United Redi-Mix for concrete. All in Grand Junction, Colo.	

REQUISITION NO. No. 11445

SUBMITTED BY (NAME AND TITLE)

RHToole

Robert H. Toole, Deputy Director, PED

APPROVED BY (NAME AND TITLE)

Gidney

R. J. Gidney, Director, Construction and Supply Div.

Check only if this form is used as a continuation sheet or extract of the requisition number typed above.

☐ CONTINUATION SHEET ☐ EXTRACT

DATE OF REQUISITION

3/1/65

DATE NEEDED (LATEST POSSIBLE DATE)

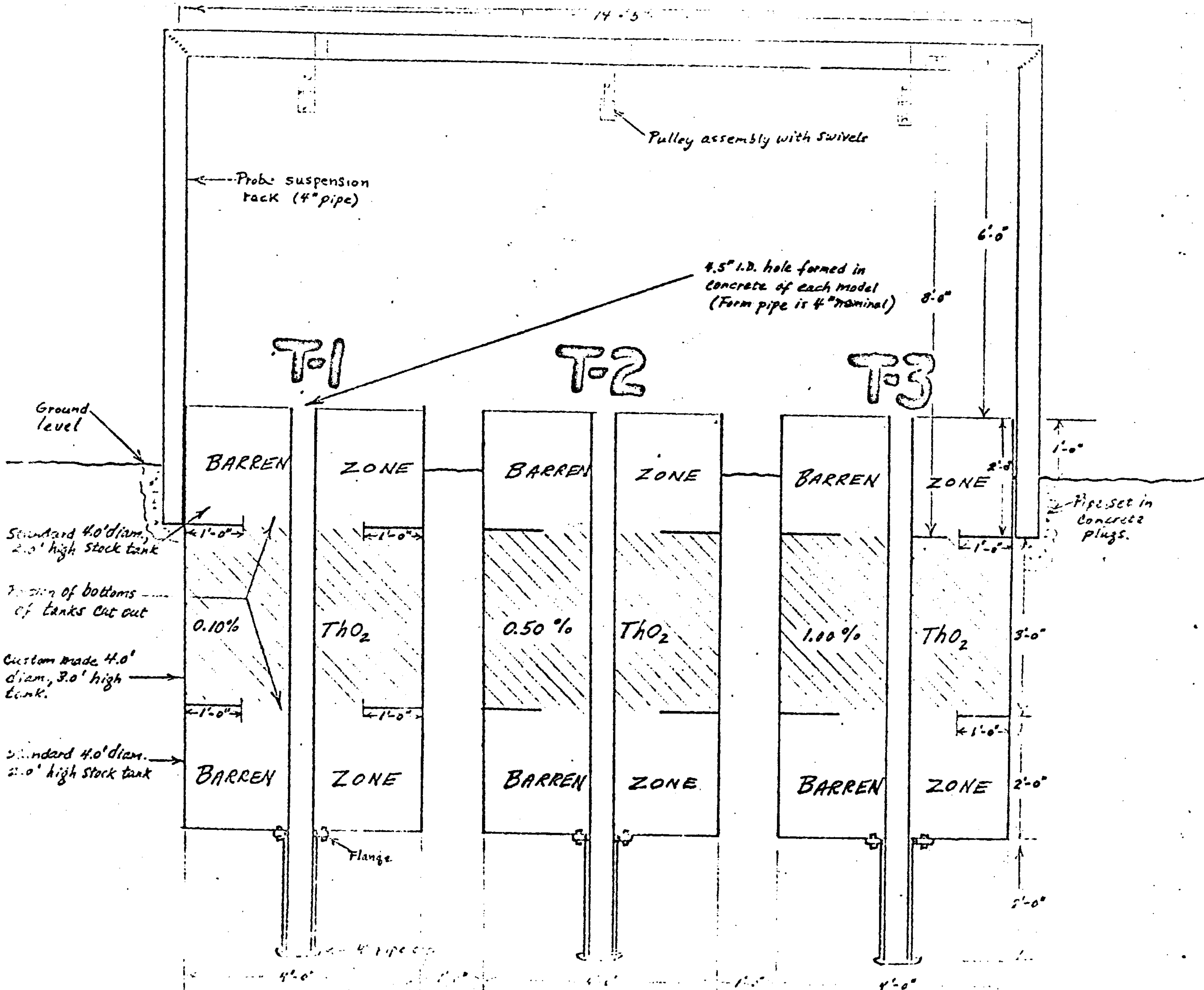
4/15/65

COST SYMBOL (MUST BE SHOWN)

Raw Mat. 3/2/65

FOR SUPPLYING OFFICE USE

LP 65-
82-1



Scale: 1 = 2' THORIUM CALIBRATION MODELS (T SERIES) 2/19/65:L.Y.M.

KUT TEST PITS

The K, U, and T test pits, built in September 1974, are designed primarily as calibration test pits for spectral logging equipment. The U test pit can also be used to calibrate gross gamma ray logging equipment. The gamma spectrum logging systems differentiate between the gamma radiation coming from thorium (Th), uranium (U), and potassium (K). Tables 19, 20, and 21 list the factors regarding these test pits and a report the "Construction of the "KUT" Test Pits", by Knapp and Bush*, describes the details of construction.

An interesting factor about these test pits is their magnetic susceptibility properties (see pp. 167-170). The magnitude of the susceptibility is directly related to the amount of plaster sand added to the various ore and barren zones. In the potassium ore zone, where no sand was used, the magnetic susceptibility is 65×10^{-6} cgs units while in the barren zone of all these test pits, where only sand and cement were used, the magnetic susceptibility has a range of $800-1100 \times 10^{-6}$ cgs units. Since no petrographic analysis was made on the sample from these test pits or on the sand used, the minerals causing these differences in magnetic susceptibility are unknown. The U pit cannot be used as a model indicating actual field susceptibility values because the mixing of uranium ore with sand changes the susceptibility magnitude that would naturally occur.

These pits should be used both for calibration and research of logging equipment.

*Knapp, K. E. and Bush, W. E., April, 1975, "Construction of the "KUT" Test Pits", Lucius Pitkin Report, Grand Junction, Colorado. Copy of this paper included in this report on pages 145-175.

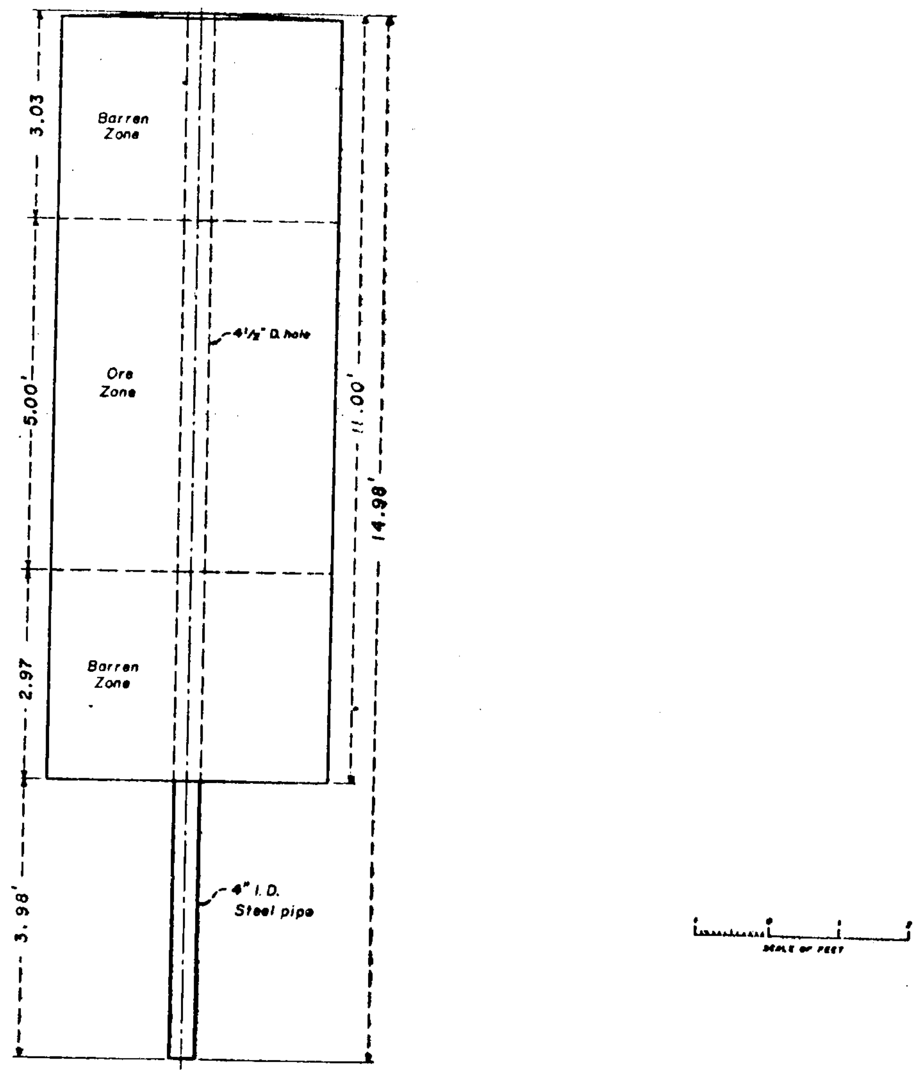


Figure 26

NOTE: Model is cast in 4' corrugated pipe

U MODEL

Table 19

II TEST PIT

ore zones	ore type & amount	1,723 lbs. Climax Ore (0.33% U_3O_8)		
	cement amount	2,193 lbs.		
	water amount	unknown		
	sand type & amount	4,850 lbs. plaster sand		
barren zone	sand type & amount	unknown (high pour redi-mix concrete)		
	cement amount	unknown		
	water amount	unknown		
assay analysis ore zone	chemical	1.27% K 0.0634% U_3O_8 8.0ppm Th		
	gamma only	0.0655% eU_3O_8		
	gamma spec	0.95% K 522ppm U or 0.061% eU_3O_8 18.7 ppm Th		
	gamma logging	unknown		
assay analysis barren zones	chemical	Lower Barren 1.97% K 4.5ppm U 12 ppm Th	Upper Barren 2.03% K 3ppm U 5ppm Th	
	gamma only	unknown	unknown	
	gamma spec	1.99% K 3.5ppm U 8.9ppm Th	1.9% K 3ppm U 8.3ppm Th	
	gamma logging	unknown	unknown	
density	chemical analysis	Upper Barren 2.22 g/cc	Ore Zone 2.56 g/cc	Lower Barren 2.25 g/cc
	in situ	unknown		
water or H^+	% LOD at 110°C chemical analysis	Upper Barren 2.62%	Ore Zone 5.58%	Lower Barren 2.09%
	in situ	unknown		
Zeq (petrographic analysis)		unknown		
porosity		unknown		
cracks or fractures		unknown		
magnetic susceptibility (10^{-6} cgs)		Upper Barren 982	Ore Zone 356	Lower Barren 1084

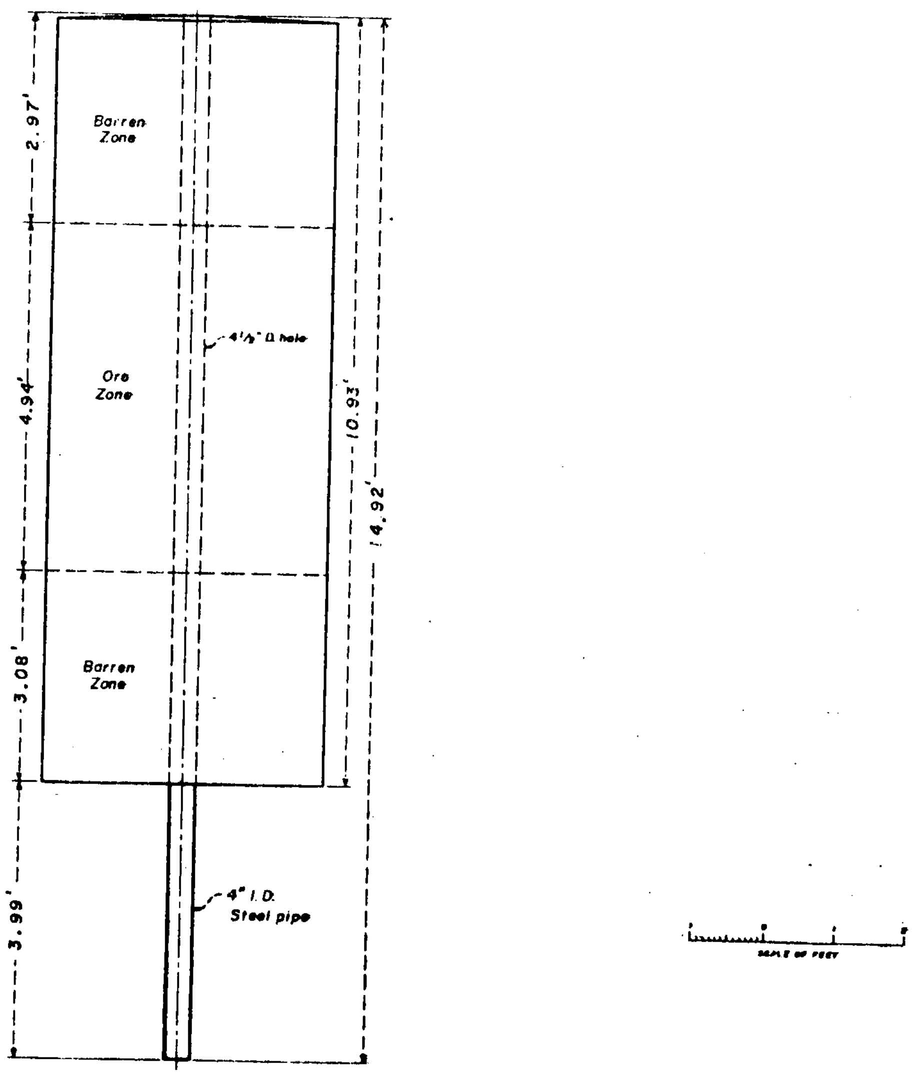


Figure 27

NOTE: Model is cast in 4' corrugated pipe

T-MODEL

Table 20

T TEST PIT

ore zones	ore type & amount	106.33 lbs. monazite sands		
	cement amount	2193 lbs.		
	water amount	unknown		
	sand type & amount	6475 lbs. plaster sand		
barren zone	sand type & amount	unknown (high pour redi-mix concrete)		
	cement amount	unknown		
	water amount	unknown		
assay analysis ore zone	chemical	1.32% K 24 ppm U 502ppm Th		
	gamma only	unknown		
	gamma spec	1.36% K 26.1ppm U 508ppm Th		
	gamma logging	unknown		
assay analysis barren zones	chemical	Upper Barren 1.95% K 2.5ppm U 10.5ppm Th		Lower Barren unknown
	gamma only	unknown		unknown
	gamma spec	1.84% K 3.0ppm U 8.4ppm Th		unknown
	gamma logging	unknown		unknown
density	chemical analysis	Upper Barren 2.20 g/cc	Ore Zone 1.88 g/cc	Lower Barren unknown
	in situ	unknown		
water or H^+	% LOD at 110°C chemical analysis	Upper Barren 2.40%	Ore Zone 5.77%	Lower Barren unknown
	in situ	unknown		
Zeq (petrographic analysis)	unknown			
porosity	unknown			
cracks or fractures	unknown			
magnetic susceptibility (10^{-6} cgs)	Upper Barren 1035	Ore Zone 484	Lower Barren unknown	

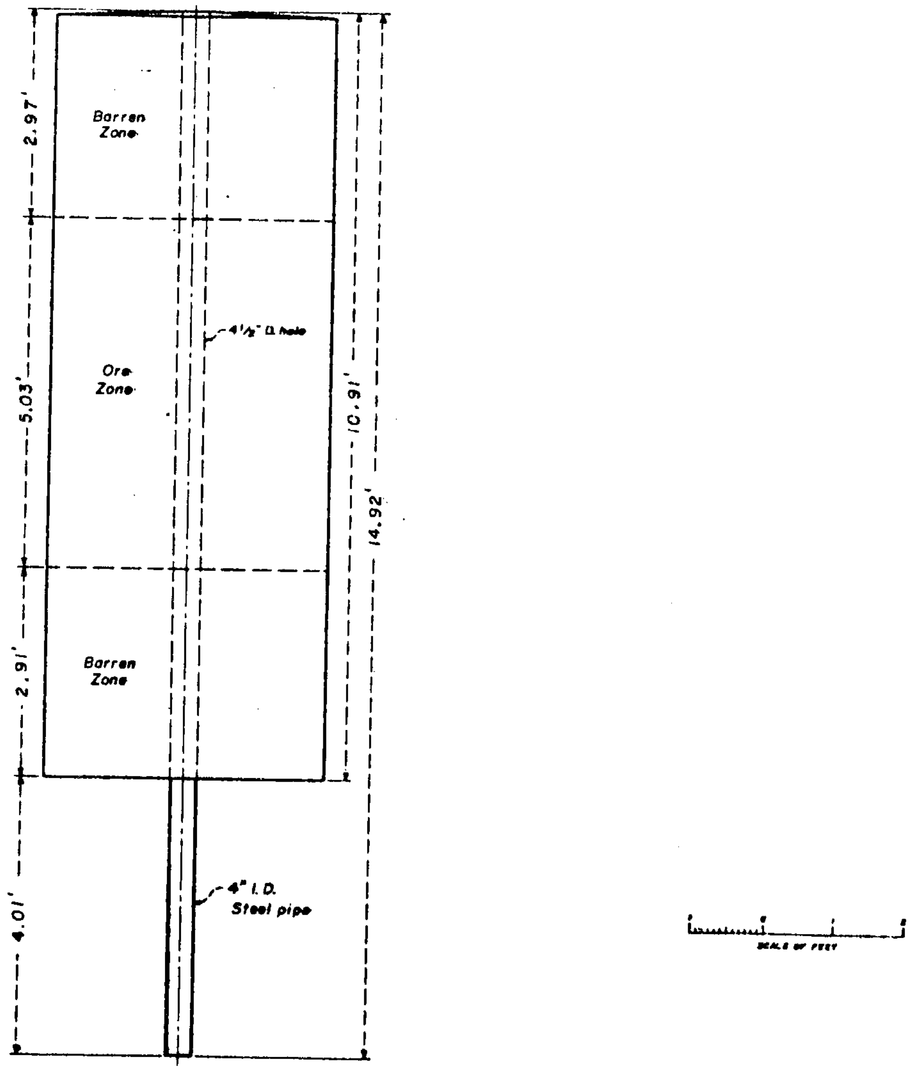


Figure 28

NOTE: Model is cast in 4' corrugated pipe

K MODEL

Table 21

K TEST PIT

ore zones	ore type & amount	4379.7 lbs. feldspar (Canon City) 1855.3 lbs. feldspar (Grand Junction		
	cement amount	2080 lbs.		
	water amount	unknown		
	sand type & amount	None		
barren zone	sand type & amount	unknown (high pour redi-mix concrete)		
	cement amount	unknown		
	water amount	unknown		
assay analysis ore zone	chemical	6.28% K 10ppm U 4ppm Th		
	gamma only	unknown		
	gamma spec	6.30% K 2.9ppm U 2.5ppm Th		
	gamma logging	unknown		
assay analysis barren zones	chemical	Upper Barren 1.77% K 4ppm U 11ppm Th		Lower Barren 1.74% K 3ppm U 7.5ppm Th
	gamma only	unknown		unknown
	gamma spec	1.90% K 2.9ppm U 8.1ppm Th		1.77% K 2.9ppm U 7.5ppm Th
	gamma logging	unknown		unknown
density	chemical analysis	Upper Barren 2.23 g/cc	Ore Zone 1.86 g/cc	Lower Barren 2.24 g/cc
	in situ	unknown		
water or H^+	% LOD at 110°C chemical analysis	Upper Barren 1.98%	Ore Zone 2.88%	Lower Barren 1.78%
	in situ	unknown		
Zeq (petrographic analysis)		unknown		
porosity		unknown		
cracks or fractures		unknown		
magnetic susceptibility (10^{-6} cgs)		Upper Barren 931	Ore Zone 65	Lower Barren 860

Construction KUT Test Pits

by

Kenneth E. Knapp

Warren E. Bush

Operations Division

Lucius Pitkin, Inc.
Grand Junction, Colorado

April, 1975

CONSTRUCTION OF THE "KUT" TEST PITS

Models are required to calibrate spectral logging systems to differentiate between the radiation coming from uranium, thorium, and potassium ("KUT"), in order to determine the grade of low-grade uranium deposits.

By using the same configuration (Appendix A) of the "U" pits, the uranium model can be used both for "KUT" calibration and for the determination of a low grade value to be used with values from the "U" pits.

Preparatory work on the installation of the "KUT" test pits started in June, 1974. This work consisted of the removal from the ground of three "R" pits, which were considered to be obsolete. The new pits were constructed at the site of the "R" pits.

Subsequent excavation (Figure 1) made way for the placement of the three form tanks, 11 feet in length, which were made up of 4-foot diameter corrugated, galvanized culvert, open at the top and closed on the lower end with 3/16-inch sheet metal with a centrally located hole of a size equal to the outside diameter of 4-inch pipe. These tanks were placed over previously located 4-inch diameter vertical run pipes, each having a length of 4 feet 6 inches (see Figures 2, 3, 4 and 5). Following the placement of the tanks, the excavation was backfilled and tamped (Figures 6 and 7). Next, the junction of the tank bottoms and the run pipes were welded and the excess 6 inches (approximately) of pipe was cut off (Figure 8) in each of the tanks.

Form pipes of 4-inch diameter, having been previously turned on a lathe, were placed vertically in the tanks, alignment with run pipes below being assured by three guides welded to the inner surfaces of the lower ends of the form pipes (Figure 9). The junction of the form pipe and the run pipe was then sealed with caulking compound, and a layer of grease was applied to the surface of the form pipe (Figures 10 and 11).

Each tank was filled with an approximate 3-foot high pour of redi-mix concrete, as normally produced by mixing plant. This formed the three lower barren zones. Quart-sized samples (two each) were taken during these pours (Figure 12); in addition, two Gamma-Spec metal cans were filled during the pour for the potassium pit. The upper surface of each of the zones was leveled and smoothed with the tool shown in Figure 13. The form pipes were turned a few degrees once or twice when the concrete started to setup. The following morning the form pipes were pulled from the concrete (Figure 14) and wiped clean to ready them for the next pour.

The uranium ore zone, composed of 0.33 percent U_3O_8 Climax ore, sand, cement and water, (Appendix B) is approximately 5 feet thick. The ore was ground to minus-10 mesh in an Englebach pulverizer (Figures 15 and 16). The pulverized ore and plaster sand were then mixed in a 10-cubic-foot twin shell dry blender for 30 minues (Figure 17). It required seven separate blends. A sample was taken from each of the seven blends, dried, and an analytical sample prepared. The blended sand and ore were then put in the mixer of the cement mixing truck (Figure 18), which was returned to the bulk plant for cement and water. After thorough mixing (20-30 minutes), the batch was poured onto the lower barren zone which had been prepared by placement of the form pipe, painting of the surface with a concrete bonding material to act as a sealant (Figure 19), and caulking of the junction of the form pipe and the concrete barren zone.

The thorium ore zone consisting of monazite sands, plaster sand, cement and water was prepared the same way as the uranium ore zone.

The potassium ore zone is composed of feldspar from Grand Junction and Canon City, cement and water. No plaster sand was added. The feldspar was ground to minus-10 mesh, blended in the 10-cubic-foot blender, then treated as the two other mixes. The upper surface of each of the three ore zones was leveled in the manner described for the lower barren zones (Figure 20). Form pipes were pulled as described above.

During each of the ore zone pours the following samples were taken: ten 1-quart ice cream cartons, three Gamma-Spec metal cans, and three 4x12-inch cylinders (Figures 21, 22, 23). Analyses were then run on the samples according to the schedule as shown in Appendix C and the results are shown in Appendix D.

Form pipes were used again, along with sealant on the surface of the ore zones, for the final pour for each tank, which consisted of another 3-foot high barren zone. Two 1-quart containers were filled for samples during each of the three pours, and two Gamma-Spec metal cans were filled during the pour at the potassium pit. These upper barren zones were given a finished surface which slopes slightly away from the hole in all directions for drainage (Figure 24).

Form pipes were pulled for the final time.

An overhead pipe for the support of pulleys was installed (Figure 25), and the pulleys attached.

The pits were completed at the end of September 1974 (Figure 26).

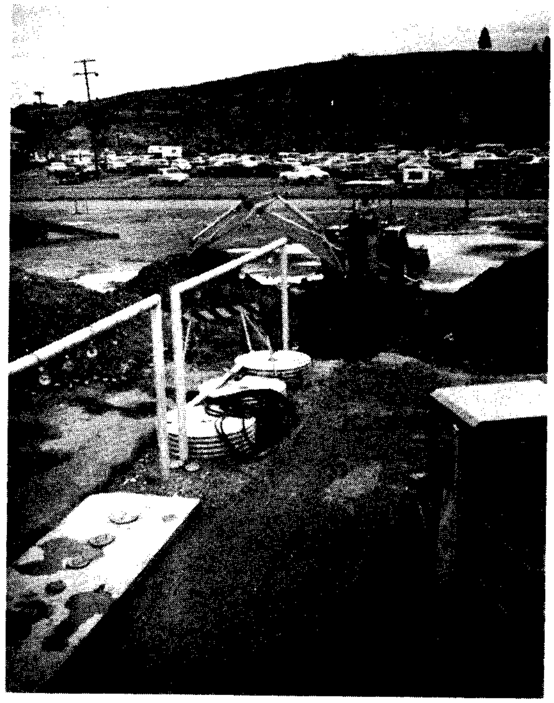
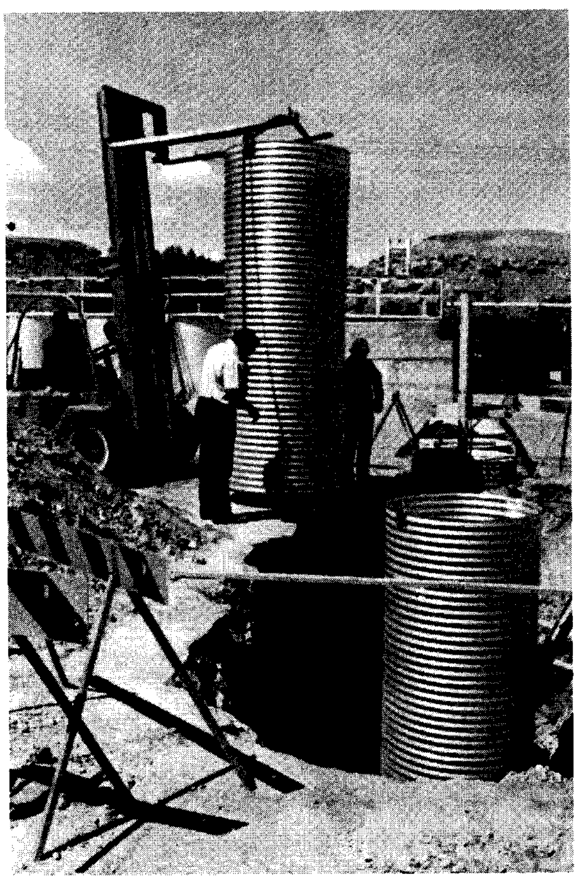


Photo No. 1

Photo No. 2

Figure 3



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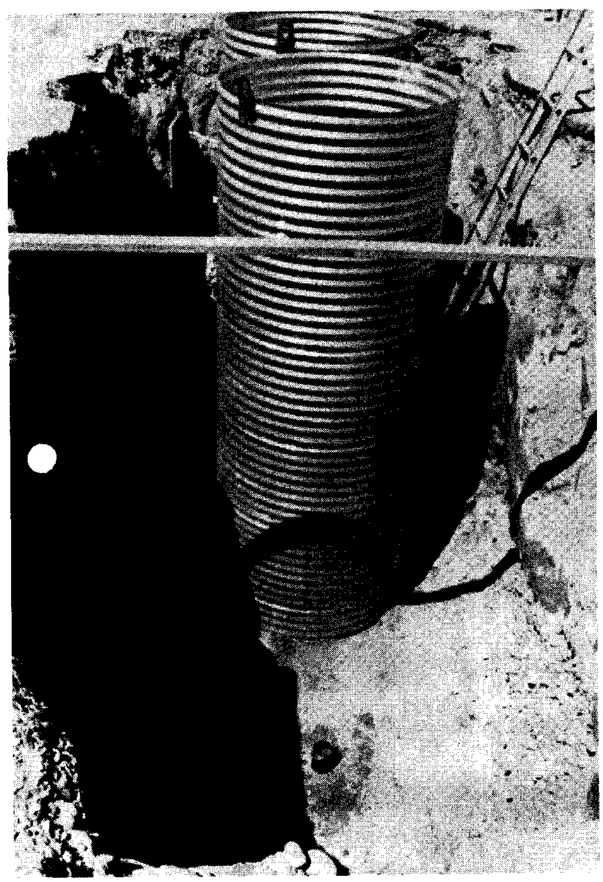
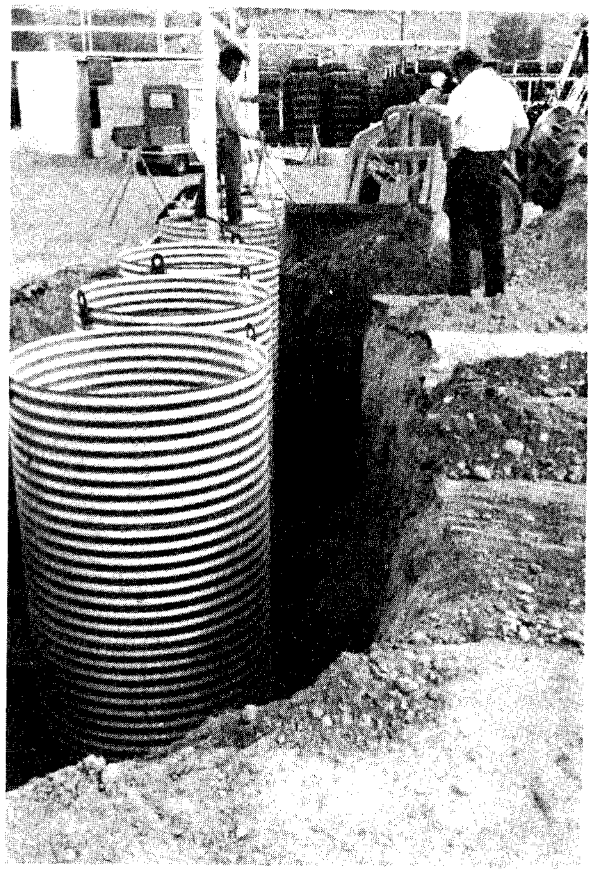


Fiqure 5



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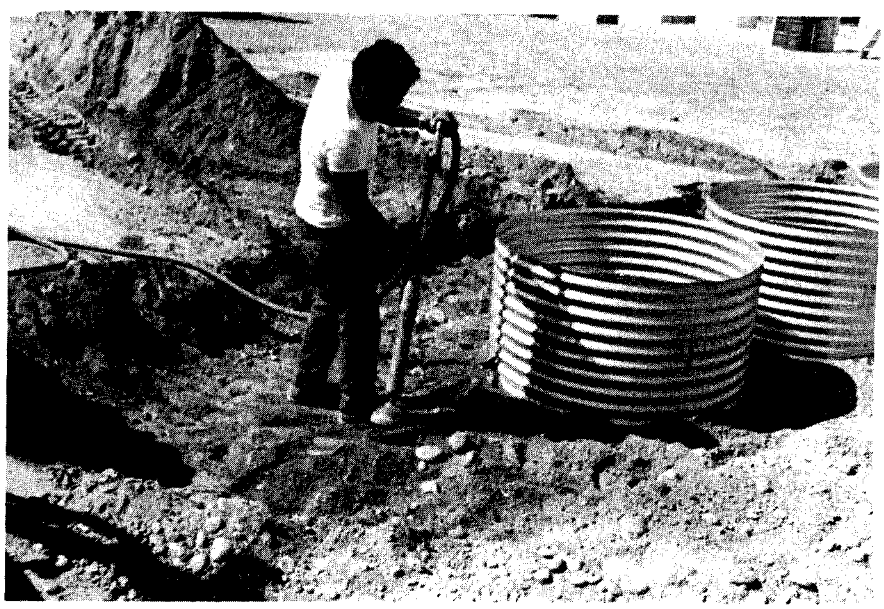
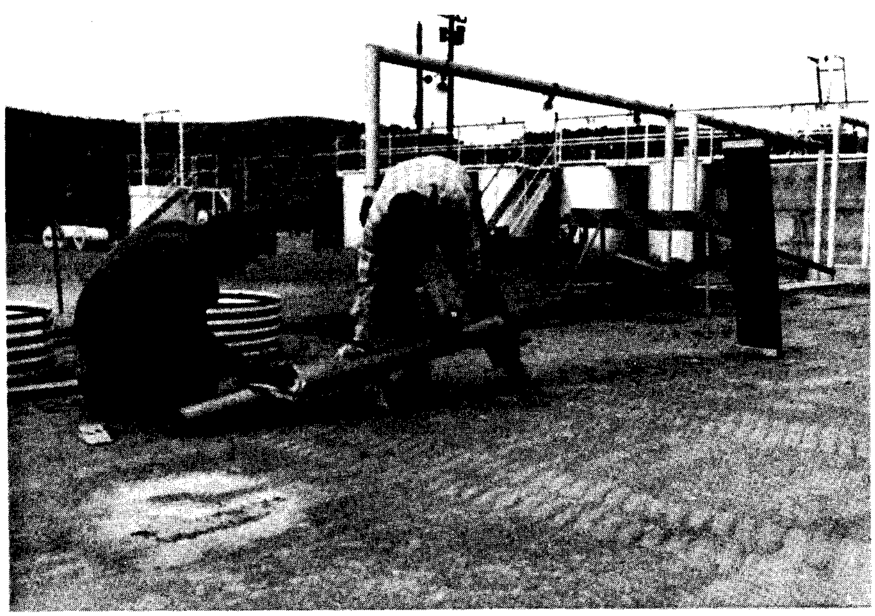


Photo No. 7

Photo No. 8



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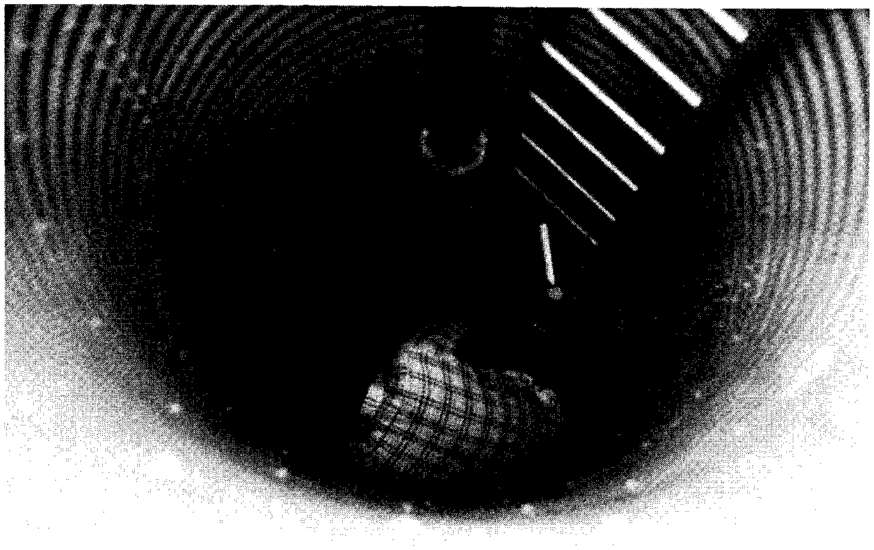

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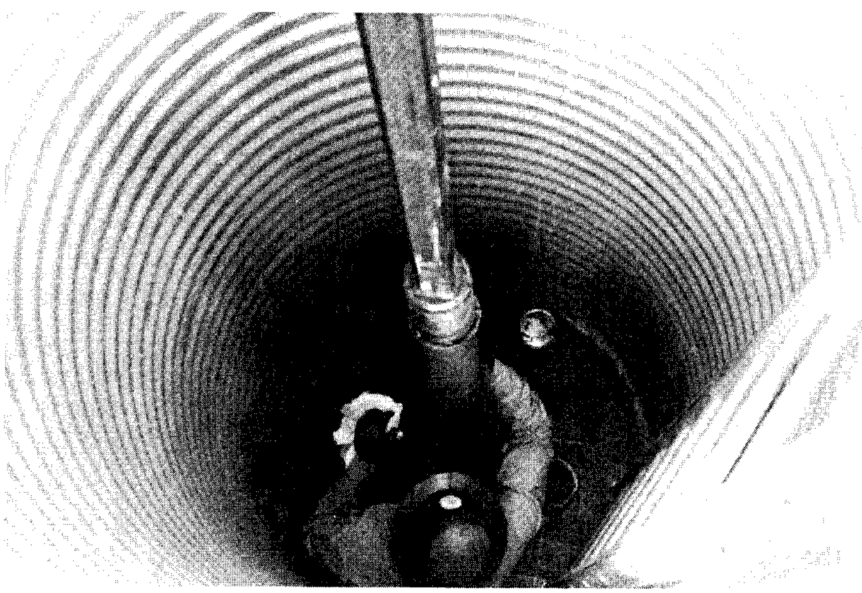

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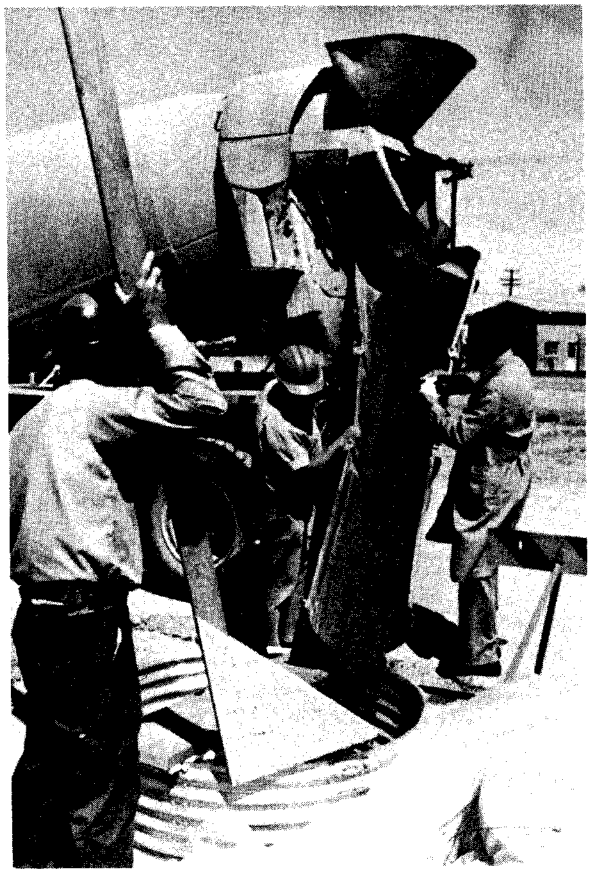

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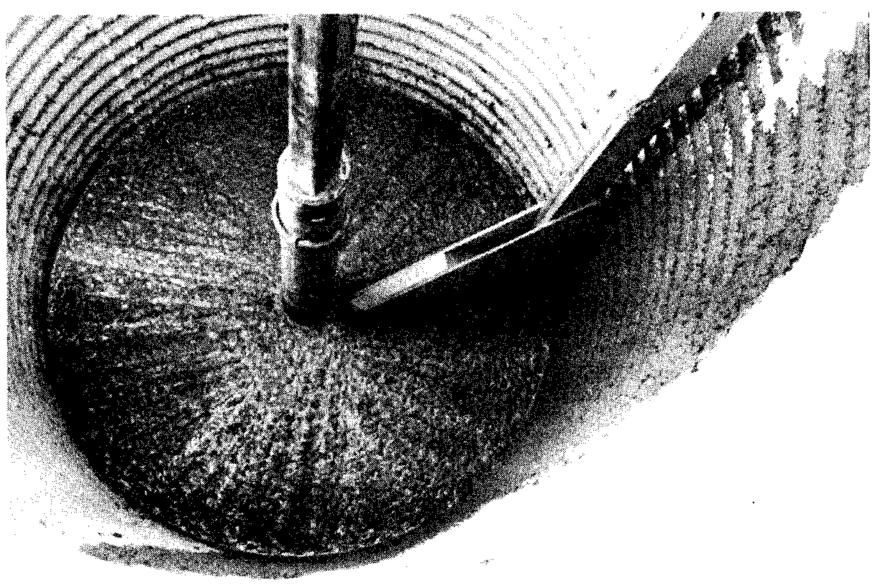
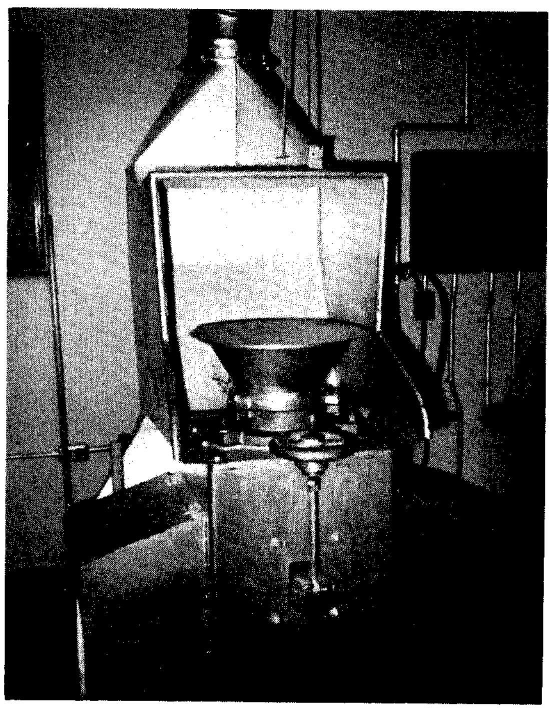


Photo No. 13

Photo No. 14



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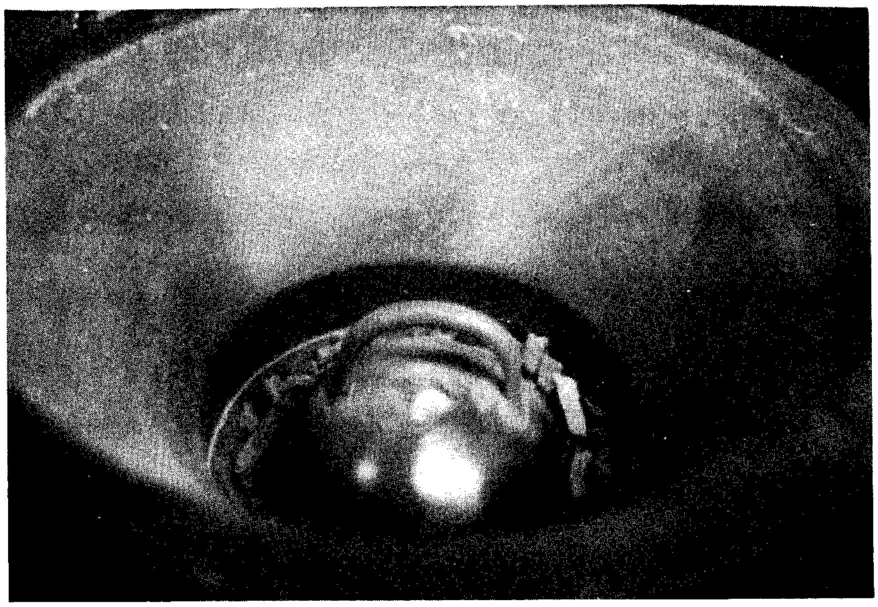

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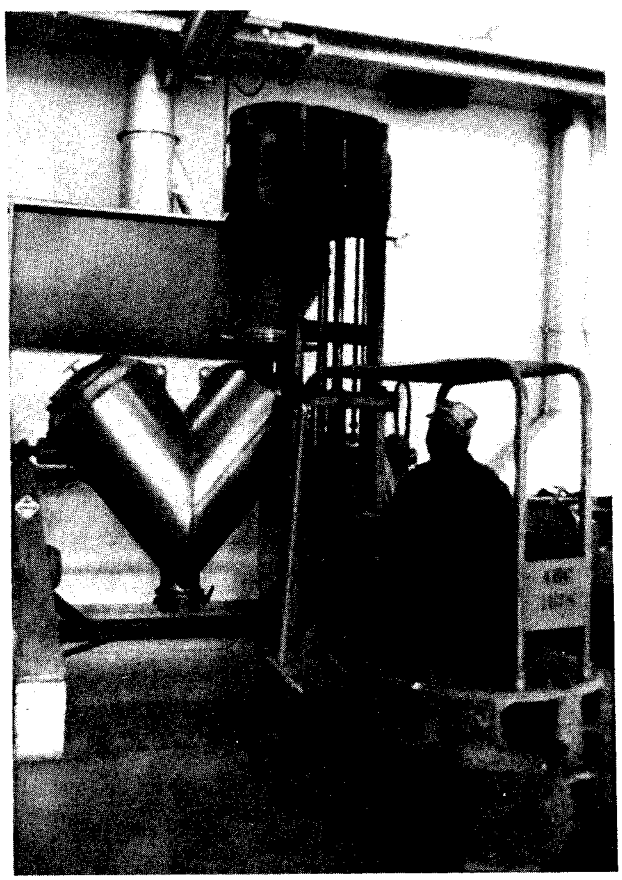

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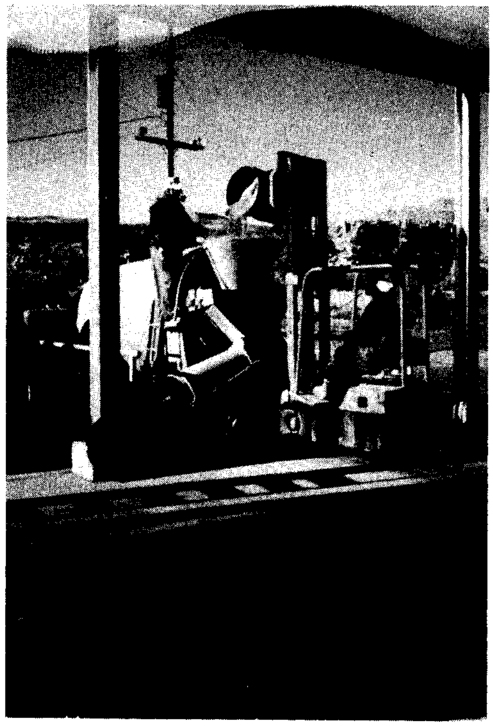

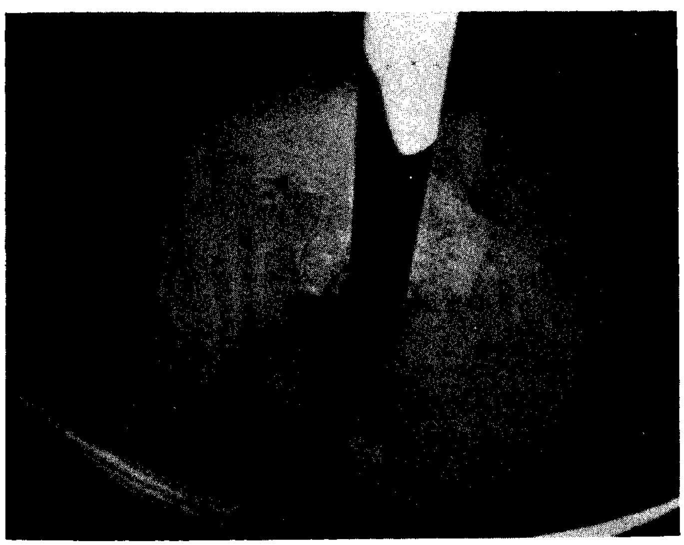

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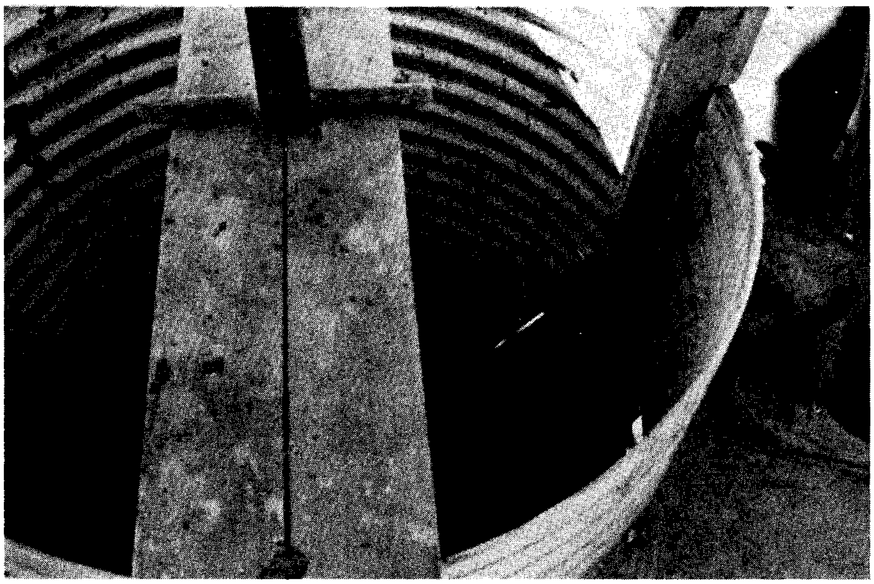

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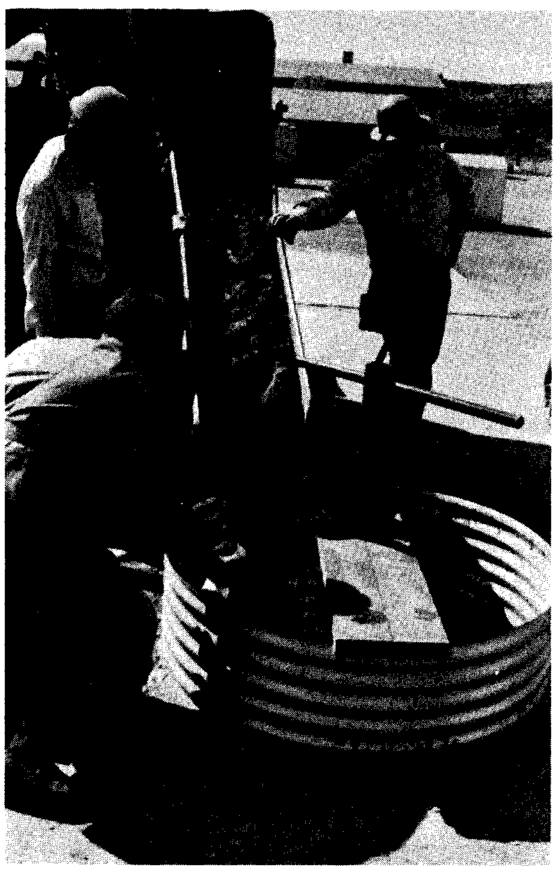

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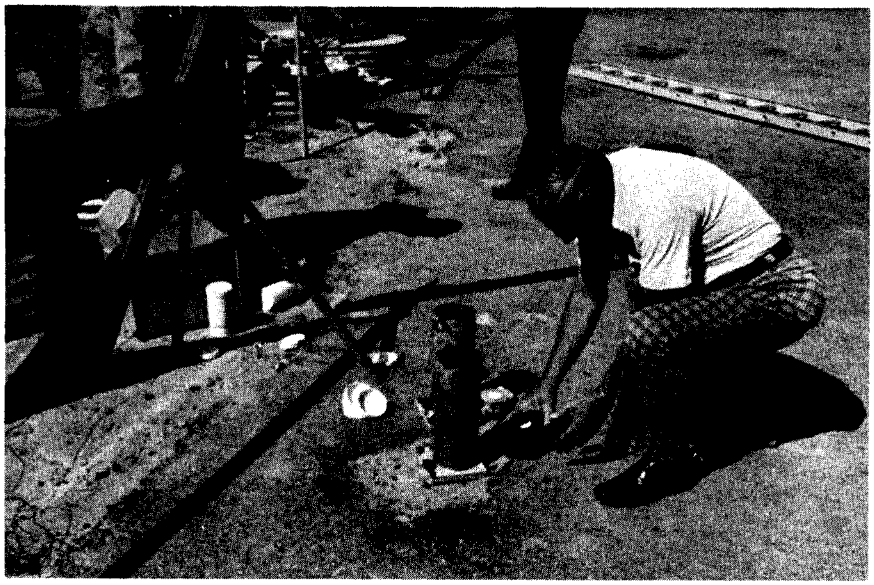

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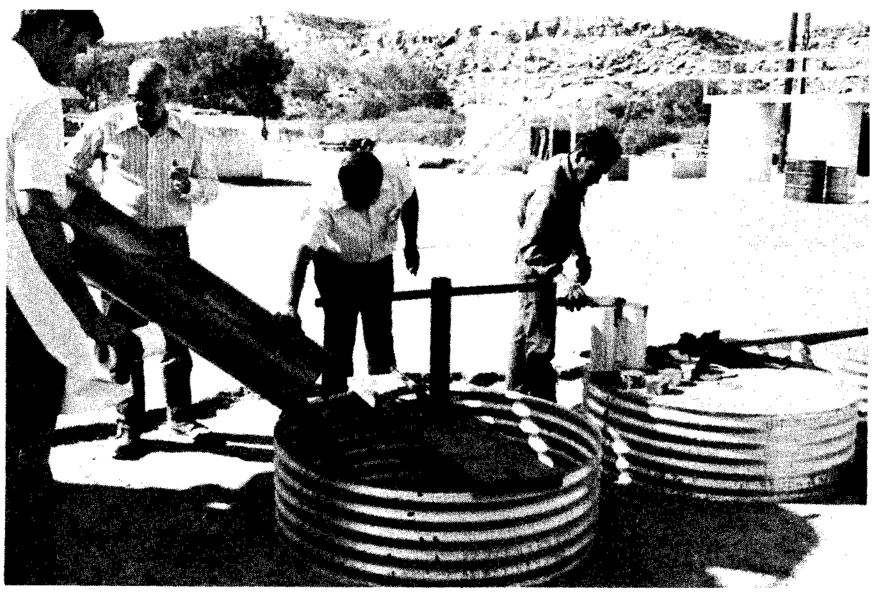
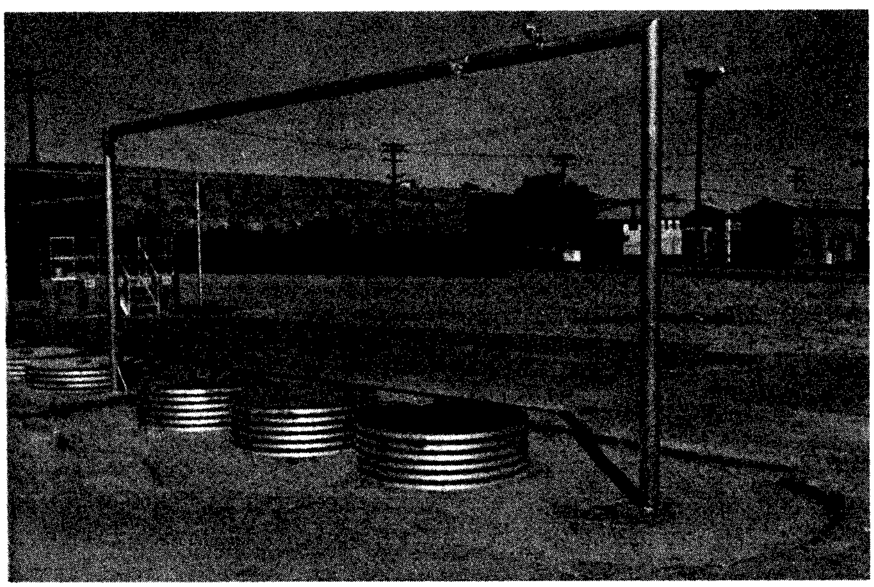


Photo No. 23

Photo No. 24



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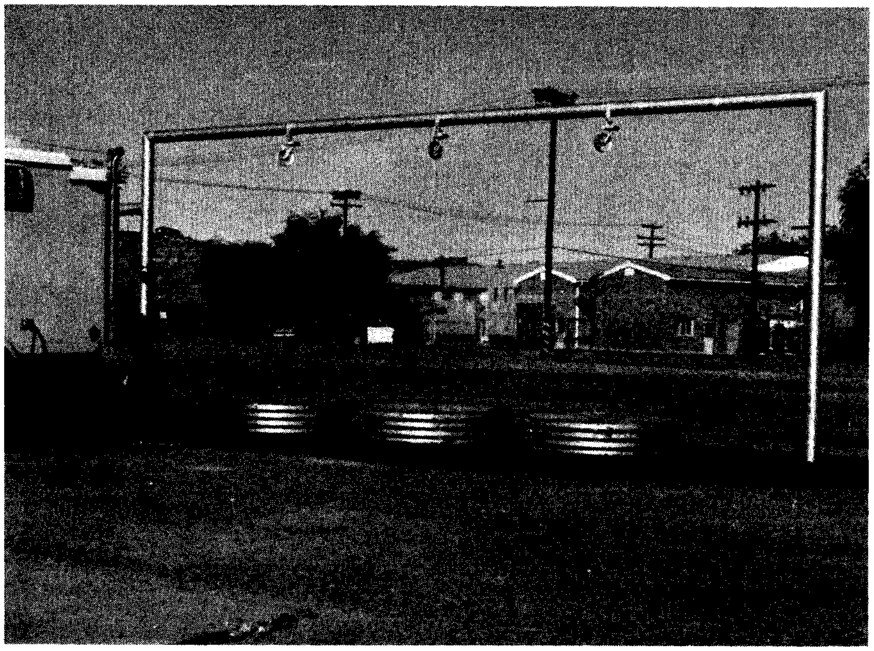

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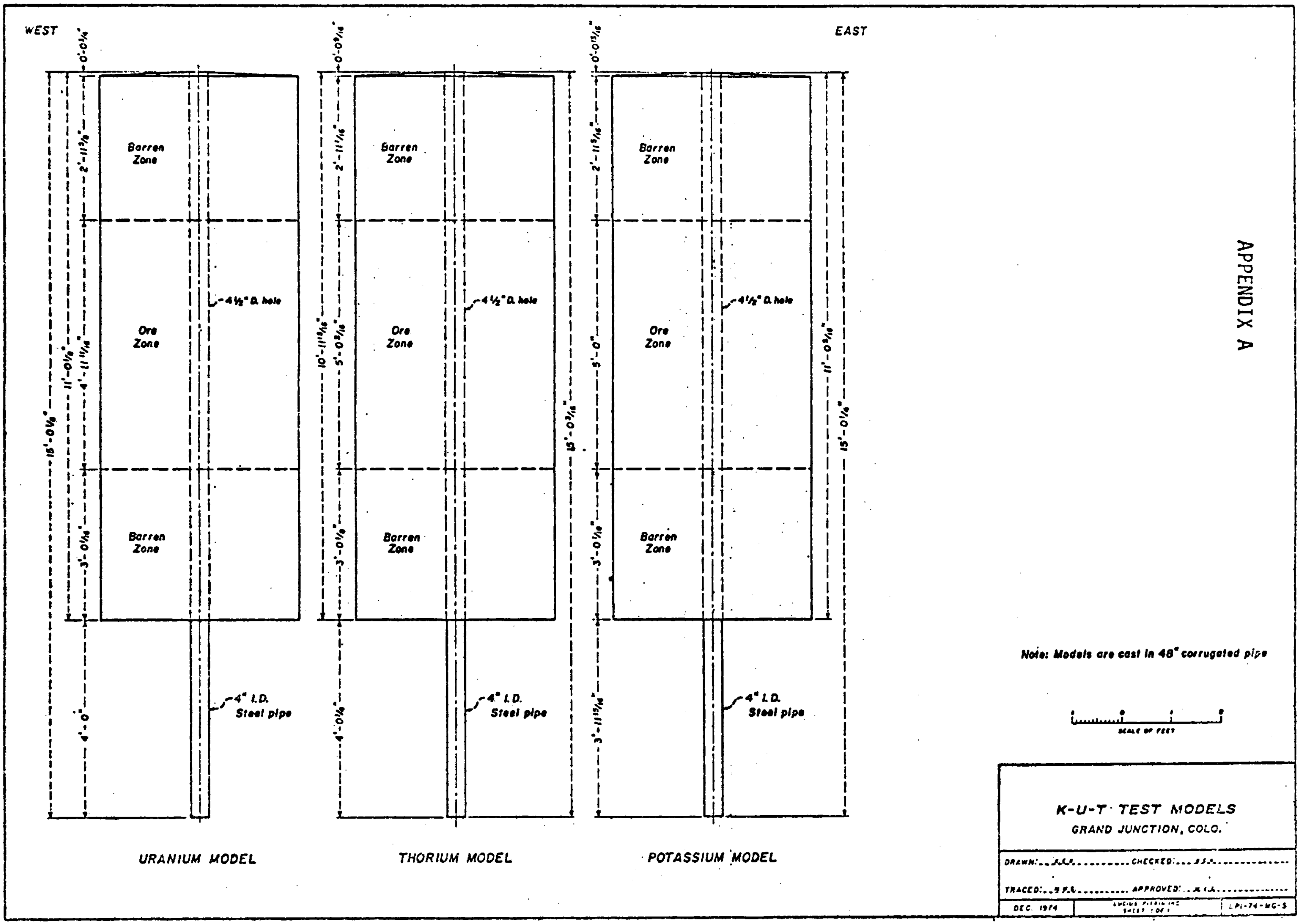
APPENDIX A


WEST
EAST
Barren Zone
Ore Zone
Barren Zone
4½" D. hole
4" I.D. Steel pipe
URANIUM MODEL
THORIUM MODEL
POTASSIUM MODEL
Note: Models are cast in 48" corrugated pipe
SCALE OF FEET
K-U-T TEST MODELS
GRAND JUNCTION, COLO.
DRAWN:
CHECKED:
TRACED:
APPROVED:
DEC. 1974

APPENDIX B

'KUT' PITS

Composition	Lbs. Dry Weight	Lbs. Wet Weight	% H_2O	%U	%Th	%K
Potassium pit ore zone poured August 26, 1974						
Feldspar (Grand Junction)	1,855.3	1,857	0.09			7.11
Feldspar (Canon City)	4,379.7	4,383.7	0.09			8.47
Cement	2,080.					
Uranium pit ore zone poured August 6, 1974						
Climax Ore	1,723	1,737	0.80	0.28		
Sand (Plaster)	4,858	5,000	2.85			
Cement	2,193					
Thorium pit ore zone poured August 8, 1974						
Monazite Sands	106.03	106.33	0.28		4.55	
Sand (Plaster)	6,475	6,665	2.85			
Cement	2,193					

APPENDIX C

'KUT' TEST PIT SAMPLES AND ASSAYS

Samples taken from each of the ore zones

1. 10 - 1-qt. ice cream cartons
2. 3 - Gamma Spec metal cans
3. 3 - 4" x 12" cylinders

Samples taken from the upper and lower barren zones of the K model

1. 2 - 1-qt. ice cream cartons
2. 2 - Gamma Spec metal cans

A. Sample Preparation and Analyses to be done on the samples

1. Ice cream cartons

   a. After setting for 30 days or more remove from carton, weigh, and dry at 110° C to a constant weight. Calculate loss on drying.

   b. Measure sample and calculate volume.

   c. From volume and weight calculate density.

   d. If densities check, pulverize sample to 10-mesh and dry at 110° C. Calculate any additional loss on drying. If densities do not check, save 3 samples for bulk density measurements by the volume displacement method.

   e. Prepare 2 150-gram, 100-mesh analytical samples.

   f. 10-mesh sample. (Ceramic Plates)

      (1) Prepare a gamma spec can. Seal the cans and let set for at least four hours before running. Continue the gamma spec analyses at weekly intervals for four weeks. Keep track of the approximate time of running. Additional runs may be necessary for statistical results. Obtain gross count.

      (2) Run magnetic susceptibility.

   g. Keep one analytical sample from each container in reserve. On the other sample run:

(1) Chemical uranium, potassium and thorium

(2) Emission Spec

(3) "Gamma only"

(4) H_2 and H_2O by Leco furnace and moisture train.

(5) Grain Density

2. Gamma Spec Metal Cans

   After letting set thirty days or more, seal the cans and run gamma spec analyses on them. Run in same series with cylinder samples and prepared sample. Wait four hours or more after sealing before first run, then run weekly for four weeks, keeping the approximate time of the run. Obtain gross count.

3. Cylinder Sample

   After 30 days or more remove from cylinder, measure and weigh. Calculate density. Have the Petrology Section cut or break a piece from the center of the cylinder that will fit in a metal gamma spec can. Run as in 2 above.

   Dry end pieces and determine dry density. Submerge end pieces in water for 30 days and determine water pickup.

4. Prepared Sample

   Make three samples from each ore zone using the ore (ore and sand mix) and cement in the same proportions as the pit mix. Blend for fifteen minutes. Can samples and run as in 2 above. Prepare analytical sample out of rejects.

SAVE ALL REJECTS.

APPENDIX D

Table 1

The analyses of the dry samples from ice cream cartons are as follows:

Method	% K	ppm U	ppm Th	% LOD	g/cc Density
POTASSIUM PIT					
Gamma Spec	6.30	2.9	2.5		
Chemical	6.28	10.	4.	2.88	1.86
URANIUM PIT					
Gamma Spec	.95	522	18.7		
Chemical	1.27	537	8.	5.58	1.89
Gamma Only		555			
THORIUM PIT					
Gamma Spec	1.36	26.1	508		
Chemical	1.32	24.	502	5.77	1.88
BARREN ZONES					
Gamma Spec	1.88	3.	8.		
Chemical	1.88	3.	10.	2.15	2.23

APPENDIX D

Table 2

Potassium Pit-Ore Zone-Dry Samples

Sample No.	%LOD	Bulk Density g/cc	Grain Density g/cc	Magnetic Suscept. Cgs X 10^{-6}	Chemical %K	Chemical ppm U	Chemical ppm Th	Gama Spec Analysis* %K	Gama Spec Analysis* ppm U	Gama Spec Analysis* ppm Th
10401	2.89	1.88	2.58	60	6.46	8	4	6.13 ± .03	2.8 ± .2	2.4 ± .3
10402	3.18	1.85	2.55	61	6.34	12	3	6.34 ± .04	3.0 ± .3	2.7 ± .6
10403	2.89	1.85	2.58	63	6.22	11	2	6.47 ± .06	2.9 ± .3	2.4 ± .8
10404	3.10	1.84	2.58	61	6.23	9	4	6.31 ± .07	2.9 ± .3	2.8 ± .3
10405	2.75	1.86	2.58	63	6.20	9	4	6.07 ± .06	2.8 ± .2	2.4 ± .5
10406	2.84	1.86	2.59	65	6.30	9	4	6.43 ± .06	3.0 ± .3	2.4 ± .4
10407	2.90	1.86	2.56	68	6.14	9	4	6.24 ± .09	2.9 ± .2	2.5 ± .6
10408	2.77	1.87	2.57	65	6.27	10	4	6.36 ± .06	3.0 ± .3	2.1 ± .6
10409	2.78	1.84	2.56	68	6.32	9	6	6.22 ± .03	2.8 ± .3	2.6 ± .4
10410	2.73	1.87	2.57	71	6.30	9	6	6.40 ± .06	3.0 ± .2	2.4 ± .5
Average	2.88	1.86	2.57	65	6.28	10	4	6.30 ± .02	2.9 ± .1	2.5 ± .2

*Average of 10 runs
95% Confidence Limits

APPENDIX D

Table 3

Uranium Pit-Ore Zone-Dry Samples

Sample No.	%LOD	Bulk Density g/cc	Grain Density g/cc	Magnetic Suscept. Cgs X 10^{-6}	Chemical % K	Chemical $\%U_3O_8$	Gamma Only $\%U_3O_8$	Chemical ppm TH	Gamma Spec Analysis* %K	Gamma Spec Analysis* ppm U	Gamma Spec Analysis* ppm Th
10421	5.55	1.88	2.58	357	1.24	.063	.067	7	0.99 ± .10	526 ± 4	18.7 ± 1.0
10422	5.23	1.90	2.54	358	1.28	.063	.066	10	0.99 ± .08	515 ± 4	18.8 ± .5
10423	5.37	1.88	2.58	356	1.28	.065	.062	8	0.90 ± .12	536 ± 5	19.0 ± .7
10424	5.67	1.89	2.55	367	1.29	.066	.073	8	0.92 ± .14	511 ± 9	18.3 ± 1.0
10425	5.78	1.87	2.57	371	1.26	.065	.066	9	0.90 ± .08	546 ± 5	19.6 ± .7
10426	5.46	1.90	2.56	346	1.26	.066	.066	8	1.03 ± .10	530 ± 3	18.8 ± .8
10427	5.52	1.90	2.53	349	1.26	.063	.068	8	0.97 ± .10	521 ± 4	18.8 ± .8
10428	5.89	1.90	2.58	358	1.25	.061	.064	8	0.94 ± .14	513 ± 3	18.8 ± .6
10429	5.95	1.92	2.57	346	1.28	.061	.060	9	0.83 ± .15	517 ± 3	18.1 ± .5
10430	5.42	1.91	2.54	359	1.28	.061	.063	9	1.04 ± .12	509 ± 4	18.1 ± .9
Average	5.58	1.89	2.56	356	1.27	.063	.065	8	.95 ± .03	522 ± 1	18.7 ± .2

*Average 10 runs
95% Confidence Limits

APPENDIX D

Table 4

Thorium Pit-Ore Zone-Dry Samples

Sample	%LOD	Bulk Density g/cc	Grain Density g/cc	Magnetic Suscept. Cgs X 10^{-6}	Chemical %K	Chemical ppm U	Chemical ppm Th	Gamma Spec Analysis* %K	Gamma Spec Analysis* ppm U	Gamma Spec Analysis* ppm Th
10411	6.17	1.90	2.58	480	1.36	22	501	1.39 ± .05	26.5 ± 1.0	508 ± 3
10412	6.09	1.89	2.56	467	1.36	25	507	1.33 ± .03	25.9 ± .9	506 ± 4
10413	5.38	1.90	2.55	514	1.36	25	497	1.36 ± .06	25.6 ± 1.0	501 ± 3
10414	5.60	1.89	2.66	501	1.39	24	531	1.38 ± .03	26.2 ± .5	514 ± 4
10415	5.90	1.88	2.56	477	1.36	23	498	1.40 ± .09	25.9 ± .8	502 ± 4
10416	5.72	1.87	2.60	484	1.30	24	472	1.38 ± .09	25.0 ± .3	499 ± 4
10417	5.64	1.86	2.56	466	1.27	23	435	1.31 ± .04	26.4 ± 1.0	507 ± 3
10418	6.20	1.87	2.58	475	1.24	20	519	1.36 ± .07	25.9 ± .6	498 ± 3
10419	5.23	1.89	2.60	495	1.27	25	545	1.34 ± .07	26.9 ± 1.1	536 ± 4
10420	5.76	1.90	2.58	476	1.27	25	519	1.38 ± .08	26.4 ± .7	511 ± 4
Average	5.77	1.88	2.58	484	1.32	24	502	1.36 ± .02	26.1 ± .2	508 ± 1

*Average 10 runs
95% Confidence Limits

APPENDIX D

Table 5

Barren Zones-Dry Samples

Location	Sample No.	%LOD	Bulk Density g/cc	Grain Density g/cc	Magnetic Suscept. Cgs X 10^{-6}	Chemical % K	Chemical ppm U	Chemical ppm Th	Gamma Spec Analysis %K	ppm U	ppm Th
Lower Barren Potassium Pit	10431	1.77	2.23	2.65	791	1.74	3	7	1.77	3.0	7.3
Lower Barren Potassium Pit	10432	1.78	2.24	2.65	929	1.74	3	8	1.77	2.8	7.6
Upper Barren Potassium Pit	10433	2.04	2.23	2.69	915	1.76	4	12	1.87	2.9	8.1
Upper Barren Potassium Pit	10434	1.89	2.23	2.68	931	1.78	3	12	1.96	2.9	8.2
Upper Barren Potassium Pit	10435	2.01	2.23	2.65	948	1.78	4	10	1.88	2.9	8.0
Lower Barren Uranium Pit	10436	1.98	2.26	2.65	1,098	1.98	6	12	2.03	3.8	9.1
Lower Barren Uranium Pit	10437	2.19	2.24	2.64	1,069	1.96	3	12	1.95	3.2	8.7
Upper Barren Uranium Pit	10438	2.58	2.21	2.64	1,013	2.07	3	8	1.87	3.1	8.2
Upper Barren Uranium Pit	10439	2.65	2.23	2.69	951	1.98	3	7	1.93	2.8	8.3
Upper Barren Thorium Pit	10440	2.59	2.19	2.67	1,004	1.90	2	12	1.83	2.9	8.1
Upper Barren Thorium Pit	10441	2.22	2.21	2.63	1,065	2.00	3	9	1.85	3.0	8.6

APPENDIX D

Table 6

Potassium Pit-Ore Zone

	Gamma Spec %K	Gamma Spec ppm U	Gamma Spec ppm Th	Density Dry g/cc	Density Wet g/cc
Gamma Spec Metal Cans (Wet)	5.35	2.3	2.4		
Cylinder (Wet)	4.97	2.2	2.1	1.89	2.08
Prepared Sample Feldspar+Cement (Dry)	6.35	3.1	2.6		

Uranium Pit-Ore Zone

Gamma Spec Metal Cans (Wet)	1.18	400	14.8		
Cylinder (Wet)	1.10	416	14.7	1.93	2.07
Prepared Sample Ore+Sand+Cement (Dry)	1.30	548	18.3		

Thorium Pit-Ore Zone

Gamma Spec Metal Cans (Wet)	1.14	20.7	407		
Cylinder (Wet)	1.08	20.8	408	1.88	2.05
Prepared Sample Ore+Sand+Cement (Dry)	1.40	31.9	627		

Upper Barren Zone

Gamma Spec Metal Cans (Wet)	1.57	2.4	7.2		

APPENDIX D

Table 7

REQUISITION NUMBER -1 SEMIQUANTITATIVE EMISSION SPECTROGRAPHIC ANALYSIS
DATE 02/05/75 ELEMENT COMPARISON IN PERCENT

LPI NO.	10401	10402	10403	10404	10405	10406	10407
AL	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000
B	.0030	.0040	.0040	.0040	.0030	.0040	.0030
BA	0	0	0	.0300	.0100	.0100	.0100
BE	.0005	.0005	.0005	.0005	.0005	.0005	.0005
CA	8.0000	8.0000	8.0000	8.0000	8.0000	8.0000	8.0000
CO	0	0	0	0	0	0	0
CR	0	0	.0010	.0010	.0010	.0010	.0010
CU	.0020	.0040	.0040	.0040	.0050	.0050	.0040
FE	.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
GA	.0001	.0001	.0001	.0001	.0001	.0001	.0001
GE	.0010	.0010	.0010	.0010	.0010	.0020	.0010
K	2.5000	3.0000	4.0000	3.0000	5.0000	4.0000	3.0000
LI	0	0	.0003	.0001	.0005	.0003	.0001
MG	.2000	.2000	.2000	.3000	.3000	.3000	.3000
MN	.1000	.1000	.1000	.1500	.1500	.1000	.1000
NA	1.5000	1.5000	2.0000	1.5000	2.0000	1.0000	.8000
NI	.0010	.0020	.0010	.0010	.0010	.0020	.0010
P	.1500	.1000	.1000	.1000	.1000	.1000	.1000
PB	.0030	.0040	.0040	.0040	.0040	.0040	.0040
RB	.0100	.0100	.0100	.0100	.0200	.0100	.0100
SI	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999
SN	0	.0010	0	0	.0020	0	0
SR	.0700	.0800	.0800	.1000	.1000	.0800	.1000
TH	0	0	0	0	0	0	0
TI	.0200	.0200	.0200	.0200	.0300	.0200	.0200
V	.0030	.0030	.0040	.0030	.0040	.0030	.0040
Y	.0010	.0010	.0010	.0010	.0010	.0010	.0010
YB	0	0	0	0	0	0	0
ZN	.0400	.0400	.0400	.0400	.0400	.0400	.0400
ZR	.0010	.0010	.0010	.0010	.0010	.0010	.0010

LPI NO.	10408	10409	10410	10411	10412	10413	10414
AL	10.0000	10.0000	10.0000	5.0000	5.0000	5.0000	6.0000
B	.0040	.0040	.0040	.0030	.0050	.0050	.0070
BA	.0100	.0100	.0100	.0300	.1000	.0500	.0500
BE	.0005	.0005	.0005	.0002	.0003	.0002	.0002
CA	8.0000	8.0000	8.0000	7.0000	7.0000	7.0000	7.0000
CO	0	0	0	.0010	.0010	.0010	.0010
CR	.0010	.0010	.0010	0	0	.0010	.0010
CU	.0060	.0040	.0040	.0040	.0030	.0040	.0040
FE	.9000	1.0000	1.0000	3.0000	2.5000	2.0000	2.0000
GA	.0001	.0001	.0001	.0001	.0001	.0001	.0001
GE	.0010	.0010	.0010	0	0	0	0
K	4.0000	3.0000	3.5000	.4000	.5000	.5000	.5000
LI	.0001	.0001	.0001	0	.0001	.0001	.0001
MG	.2000	.3000	.2000	.4000	.4000	.4000	.4000
MN	.1000	.1000	.1000	.1000	.1000	.1000	.1000
NA	1.0000	.8000	1.0000	.2000	.2000	.2000	.2000
NI	.0010	.0010	.0020	.0030	.0030	.0030	.0030
P	.1000	.1000	.1000	.1500	.1500	.1000	.1500
PB	.0040	.0040	.0040	.0030	.0040	.0040	.0040
RB	.0100	.0100	.0100	0	0	0	0
SI	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999
SN	0	0	0	.0090	.0080	.0060	.0100
SR	.0800	.1000	.1000	.0500	.0800	.0700	.0800
TH	0	0	0	.0900	.0900	.0900	.0800
TI	.0200	.0200	.0100	.2000	.2500	.1500	.1500
V	.0030	.0050	.0040	.0050	.0050	.0050	.0050
Y	.0010	.0010	.0010	.0030	.0070	.0070	.0060
YB	0	0	0	.0001	.0001	.0001	.0001
ZN	.0400	.0400	.0400	.0400	.0400	.0400	.0400
ZR	.0010	.0010	.0010	.0400	.0500	.0600	.0400

ELEMENTS NOT FOUND:
AG AS AU BI CD CE CS DY ER EU GD HF HG HO IN IR LA LU MO NB ND OS PD PR PT RE RH RU SB SC SE SM TA TB TE
TL TM U W

X.9999 DESIGNATES A CONCENTRATION GREATER THAN X PERCENT.

APPENDIX D

Table 8

REQUISITION NUMBER -1 SEMIQUANTITATIVE EMISSION SPECTROGRAPHIC ANALYSIS
DATE 02/05/75 ELEMENT COMPARISON IN PERCENT

LPI NO.	10415	10416	10417	10418	10419	10420	10421	10422	10423	10424	10425	10426	10427	10428
AL	5.0000	6.0000	3.0000	5.0000	4.0000	4.0000	6.0000	5.0000	5.0000	2.0000	4.0000	5.0000	5.0000	4.0000
B	.0050	.0050	.0040	.0050	.0050	.0040	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0050
BA	.0400	.0400	.0300	.0400	.0300	.0500	.0400	.0400	.0300	.0300	.0300	.1000	.0300	.0300
BE	.0002	.0005	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0003	.0002	.0002
CA	7.0000	8.0000	8.0000	8.0000	8.0000	8.0000	7.0000	7.0000	8.0000	8.0000	8.0000	8.0000	8.0000	8.0000
CO	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
CR	.0010	.0010	.0010	.0010	0	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
CU	.0060	.0040	.0040	.0050	.0040	.0050	.0040	.0040	.0040	.0050	.0040	.0040	.0050	.0040
FE	2.0000	2.0000	2.0000	2.5000	2.0000	2.0000	2.0000	2.0000	2.0000	1.5000	2.0000	2.0000	2.0000	2.0000
GA	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
K	.5000	.6000	.6000	.5000	.4000	.4000	.4000	.4000	.4000	.4000	.4000	.4000	.4000	.4000
LI	.0001	.0003	.0003	.0001	0	.0001	.0001	.0001	.0001	.0001	.0001	0	0	.0002
MG	.4000	.4000	.3000	.4000	.4000	.4000	.5000	.5000	.5000	.4000	.5000	.4000	.5000	.5000
MN	.1000	.1000	.1000	.1500	.1000	.1000	.1500	.1000	.1000	.1000	.1000	.1000	.1000	.1000
MO	0	0	0	0	0	0	.0005	.0005	.0005	.0005	.0005	.0005	.0005	.0005
NA	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000
NB	0	0	0	.0080	0	0	0	0	0	0	0	0	0	0
NI	.0030	.0030	.0030	.0040	.0030	.0040	.0040	.0050	.0050	.0050	.0030	.0040	.0050	.0030
P	.1000	.1500	.1000	.1500	.1500	.1500	.0500	.0500	.0500	.0500	.0500	.0500	.0500	.0500
PB	.0040	.0040	.0040	.0040	.0040	.0050	.0050	.0050	.0050	.0050	.0050	.0050	.0060	.0040
SI	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999
SN	.0070	.0070	.0060	.0300	.0080	.0060	0	0	0	0	0	0	0	0
SR	.0800	.0800	.1000	.0800	.0600	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0700
TH	.0800	.0800	.0800	.1000	.0800	.1000	0	0	0	0	0	0	0	0
TI	.1500	.1500	.1500	.1500	.1500	.2000	.1500	.1500	.1500	.1500	.1500	.1500	.1500	.1000
V	.0050	.0050	.0040	.0050	.0060	.0050	.2000	.2000	.2000	.1500	.2000	.2000	.2000	.2000
W	.0070	.0060	.0070	.0080	.0070	.0080	.0010	.0020	.0010	.0010	.0010	.0020	.0020	.0010
YB	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
ZN	.0500	.0500	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0500	.0400
ZR	.0400	.0400	.0500	.0600	.0500	.0400	.0070	.0080	.0070	.0070	.0070	.0070	.0080	.0070

ELEMENTS NOT FOUND:
AG AS AU BI CD CE CS DY ER EU GD GE HF HG HO IN IR LA LU ND OS PD PR PT RB RE RH RU SB SC SE SM TA TB TE
TL TM U W

X.9999 DESIGNATES A CONCENTRATION GREATER THAN X PERCENT.

APPENDIX D

Table 9

REQUISITION NUMBER *1 SEMIQUANTITATIVE EMISSION SPECTROGRAPHIC ANALYSIS
DATE 02/05/75 ELEMENT COMPARISON IN PERCENT

LPI NO.	10429	10430	10431	10432	10433	10434	10435	10436	10437	10438	10439	10440
AL	4.0000	4.0000	10.0000	10.0000	8.0000	9.0000	8.0000	8.0000	9.0000	9.0000	10.9999	10.9999
B	.0050	.0050	.0050	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040
BA	.0300	.0300	.0400	.0500	.0500	.0400	.0500	.0700	.0500	.0600	.0500	.0500
BE	.0002	.0002	.0002	.0003	.0002	.0002	.0002	.0003	.0002	.0002	.0003	.0002
CA	8.0000	8.0000	8.0000	7.0000	7.0000	7.0000	7.0000	7.0000	8.0000	7.0000	7.0000	7.0000
CO	.0010	.0010	0	0	0	0	0	0	0	0	.0010	.0010
CR	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
CU	.0040	.0040	.0040	.0050	.0040	.0050	.0040	.0040	.0040	.0040	.0050	.0040
FE	1.5000	1.5000	6.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	3.5000	3.5000
GA	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0005	.0001
K	.4000	.7000	.8000	.5000	.4000	.4000	.4000	.4000	1.5000	.4000	.5000	.4000
LI	.0001	.0003	.0001	.0001	.0001	0	0	.0001	.0003	.0001	.0001	0
MG	.4000	.5000	.5000	.6000	.5000	.5000	.4000	.4000	.4000	.5000	.7000	.6000
MN	.1000	.1000	.1000	.1000	.1500	.1500	.1500	.1500	.1500	.1500	.1000	.1000
MO	.0005	.0005	0	0	0	0	0	0	0	0	0	0
NA	.2000	.2000	.4000	.3000	.3000	.3000	.3000	.3000	.6000	.3000	.2000	.2000
NI	.0050	.0050	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
P	.0500	.0500	.1000	.1000	.1000	.0500	.0500	.0500	.0500	.0500	.0500	.0500
PB	.0050	.0050	.0020	.0020	.0010	.0020	.0020	.0020	.0020	.0020	.0030	.0020
SB	0	0	0	0	0	0	.0008	0	0	0	0	0
SI	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999	10.9999
SN	0	.0010	0	.0010	0	.0030	.0010	0	0	0	0	0
SR	.0700	.1000	.0800	.0700	.0700	.0800	.0600	.0700	.1000	.0700	.0700	.0600
TI	.1500	.1500	.1500	.2000	.2500	.2500	.2000	.2500	.2500	.2500	.2500	.2000
V	.2000	.2000	.0070	.0080	.0080	.0080	.0070	.0070	.0060	.0070	.0080	.0080
Y	.0010	.0010	.0010	.0010	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
YB	.0001	.0001	0	0	0	0	0	0	0	0	0	0
ZN	.0400	.0400	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300	.0300
ZR	.0080	.0060	.0080	.0070	.0080	.0080	.0070	.0080	.0070	.0070	.0060	.0060

ELEMENTS NOT FOUND:
AG AS AU BI CD CE CS DY ER EU GD GE HF HG HO IN IR LA LU NB ND OS PD PR PT RB RE RH RU SC SE SM TA TB TE
TH TL TM U W

X.9999 DESIGNATES A CONCENTRATION GREATER THAN X PERCENT.

APPENDIX D

Table 10

REQUISITION NUMBER -1 SEMIQUANTITATIVE EMISSION SPECTROGRAPHIC ANALYSIS
DATE 02/07/75 ELEMENT COMPARISON IN PERCENT

LPI NO.	10441
AL	10.0000
B	.0040
BA	.0500
BE	.0003
CA	7.0000
CR	.0010
CU	.0040
FE	3.0000
GA	.0001
K	.4000
MG	.5000
MN	.1000
NA	.2000
NI	.0010
P	.0700
PB	.0020
SI	10.9999
SR	.0600
TI	.2500
V	.0060
Y	.0020
ZN	.0300
ZR	.0070

ELEMENTS NOT FOUND:
AG AS AU BI CD CE CO CS DY ER EU GD GE HF HG HO IN IR LA LI LU MO NB ND OS PD PR PT RB RE RH RU SB SC SE
SM SN TA TB TE TH TL TM U W YE

X.9999 DESIGNATES A CONCENTRATION GREATER THAN X PERCENT.

SUMMARY OF TEST PIT DATA

Test Pit	Diameter Ft.	Ore Zone Thickness Ft.	Ore Zone Chem-$\%U_3O_8$	Ore Zone Radiometric-$\%eU_3O_8$	Intended use of Logging Model	Recommended Use of Logging Model
C	7.0	6.39	0.282	0.280	Calibration of gross gamma logging equipment	Research
R	4.0	1.97	6.536	0.496	Research for disequilibrium	Research
P-D	5.0	1.93	0.05	0.50	Research on water in ore zone	Research
P-W	5.0	2.04	0.044	0.362-wet 0.489-dry	Research on water in ore zone	Research
N-1	5.0	1.17	0.1936	0.2480	Calibration of gross gamma logging equipment	Research
N-2	5.0	1.04	0.3794	0.4296	Calibration of gross gamma logging equipment	Research
N-3	5.0	4.15	0.1855	0.240	Calibration of gross gamma logging equipment	Research or Abandon
N-4	5.0	Z2 1.0? Z1 2.31	0.8875 0.1920	0.9183 0.2459	Calibration of gross gamma logging equipment	Research
N-5		Z6 0.50 Z5 0.74 Z4 1.10 Z3 0.54 Z2 0.57 Z1 0.47	1.6308 0.1714 Barren 0.9096 0.0840 0.1960	1.7145 0.2192 Barren 0.9464 0.1303 0.2500	Calibration of gross gamma logging equipment	Research
Old H_2O	6X10 rectangle	2.0	Unknown	Unknown	Correction factors for borehole water, casing, hole size	Abandon
New H_2O	4.5X12 rectangle	4.0	0.321	0.320	Correction factors for borehole water, casing, hole size	Correction factors&calibration
U-1	4.0	4.18	2.435	2.422	Calibration of gross gamma logging equipment-used for correction of deadtime only	Calibration
U-2	4.0	4.06	1.233	1.229	Calibration of gross gamma logging equipment-used for correction of deadtime only	Calibration
U-3	4.0	4.03	0.481	0.473	Calibration of gross gamma logging equipment-used for correction of deadtime only	Calibration

Test Pit	Diameter Ft.	Ore Zone Thickness Ft.	%eK	ppmeU	ppmeTh	Intended use of Logging Model	Recommended Use of Logging Model
S Model	4X12 rectangle		1.34	1.9	6.2	Density probe hole size calibration	Research

Test Pit	Diameter Ft.	Ore Zone Thickness Ft.	$\%ThO_2$	$\%U_3O_8$	$\%eThO_2$	$\%eU_3O_8$	Intended use of Logging Model	Recommended Use of Logging Model
T-1	4.0	3.11	0.979	0.018	0.940	0.398	Calibration of gross gamma logging equipment for thorium	Research&possibly calibration
T-2	4.0	3.17	0.506	0.011	0.499	0.221	Calibration of gross gamma logging equipment for thorium	Research&possibly calibration
T-3	4.0	2.99	0.093	0.013	0.105	0.047	Calibration of gross gamma logging equipment for thorium	Research&possibly calibration

Test Pit	Diameter Ft.	Ore Zone Thickness Ft.	% K	ppm U	ppm Th	% eK	ppm eU	ppm eTh	Intended use of Logging Model	Recommended Use of Logging Model
U	4.0	5.00	1.27	537	8	0.95	522	18.7	Calibration of spectral gamma and gross gamma logging equipment	Calibration & Research
T	4.0	4.94	1.32	24	502	1.36	26.1	508	Calibration of spectral logging equipment	Calibration & Research
K	4.0	5.03	6.28	10	4	6.30	2.9	2.5	Calibration of spectral logging equipment	Calibration & Research