WIPP Library

NVO-410-2

CARLSBAD SITE ROLL-UP PROGRAM

On-Site Radiological Safety Report

By
John T. Tappan
Jerry J. Lorenz

Radiological Sciences Department
Site Facilities Division
Reynolds Electrical & Engineering Co., Inc.

LEGAL NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Work Performed Under Contract AT(26-1)-410
for
The United States Atomic Energy Commission
by
Reynolds Electrical & Engineering Co., Inc.

Mercury, Nevada
July 1969

690701

CONTENTS

		Page
	Title Page	i
	Legal Notice	ii
	Contents	iii
	Figures	iv
I	Introduction	1
II	Restoration Procedures, Findings, and Results	2
III	Final Preparations	22
Appendix		
A	RADIATION AND TOXIC GAS DETECTION INSTRUMENTS	23

FIGURES

		Page
1	Evaporation Pond - Contaminated Soil Removed	3
2	Evaporation Pond - After Backfill	3
3	Shaft Collar - Contaminated Material	5
4	Shaft Collar - Contaminated Soil	5
5	Contaminated Waste Dump - Surveying Exploratory Trench	7
6	Contaminated Waste Dump - Trench Bottom and Sides Identified	7
7	Contaminated Waste Dump - Disposal Pit Locations	8
8	Contaminated Waste Dump - Scrap Material from Burial Pit #3	10
9	Contaminated Waste Dump - After Backfill	10
10	Contaminated Waste Dump - Composite Sample Analyses Data	11
11	Coach Drift Disposal - Axial Vane Fan on Coach GZ Pipe	12
12	Coach Drift Disposal - Conveyor Belt Operations	12
13	Shaft Collar - Dumping Contaminated Soil into a Special Metal Chute	14
14	Shaft Collar - Special Metal Chute Used to Dump Contaminated Materials into Shaft Opening	14
15	Shaft Area Clean-Up - Chipping the Shaft Collar	16
16	Shaft Area Clean-Up - Dynamiting the Shaft Collar	16
17	Carlsbad Salt Muck Pile - Exploratory Drilling Program	18
18	Carlsbad Salt Muck Pile - Exploratory Drilling Program Sample Analyses Results	19

I. INTRODUCTION

The Carlsbad Site, located approximately [illegible] Carlsbad, New Mexico, was established in [illegible] as a nuclear [illegible]. Due to its desirable geological characteristics and [illegible] considerations, this site was selected for the [illegible] experiment in the newly formed Plowshare Program. Project [illegible] it was named, became the first attempt to use nuclear devices [illegible] for peaceful purposes. This experiment was conducted on December 10, 1961. A second Plowshare event, Project Coach, was to have [illegible] Project Gnome at the Carlsbad Site, but was never executed.

Subsequently, the Atomic Energy Commission decided to [illegible] Carlsbad Site to the public domain. In order to do so, [illegible] of contaminated material had to be removed and disposed of. This was done under the surveillance of the Reynolds Electrical & Engineering Company's Radiological Sciences Department during the months of [illegible] through November 1968.

The objective of the Carlsbad Roll-Up Program was to remove and dispose of all surface contamination to whatever depth it was in excess of 0.1 mR/hr as measured with an open shield GM tube instrument. At the end of the program, no contact surface contamination was detected in excess of the established limit of 0.1 mR/hr.

During a critical evaluation of the Carlsbad Site [illegible] the Radiological Sciences Department, it was decided that [illegible] contamination might be present in the salt muck [illegible] approval, the salt muck pile was subjected to [illegible] and sampling during the four-day period [illegible] 3, 1969 to determine the degree of [illegible] dependence and results of this investigation [illegible]

[illegible] is to [illegible]

II. [illegible]ORATION PROCE[illegible]RES. [illegible]

[illegible] LIQUID WASTE TANK DISPOSAL ([illegible]00,000-gallon [illegible])

1. Procedures

The top section of the tank was removed and [illegible] the bottom on the SE and NW sides to enhance ventilation. [illegible] uid was then pumped from the tank into an adjoining [illegible] pond. After the remaining sediment was shoveled [illegible] the tank and disposed of in the shaft, the top, bottom, and [illegible] vertical side sections were disassembled. The [illegible] was segregated from the uncontaminated metal and [illegible] packaged and discarded into the mine shaft. [illegible] from the area where the tank had been, and the [illegible] were then removed and deposited in the shaft.

2. Findings and Results

a) The ^{3}H concentration of liquid contained in the bottom of the tank was 9.2×10^{-2} µCi/cc.

b) Twenty-four 55-gallon drums of sediment measuring to 10 mR/hr were removed from the tank bottom.

c) The tank top and the two upper vertical side sections [illegible] less than 0.05 mR/hr.

d) The lower vertical side section and the tank [illegible] taminated to 15 mR/hr.

e) Soil removed from where the tank [illegible] 2 mR/hr.

f) The [illegible] tank fill line was [illegible]

g) [illegible] biological [illegible]

[illegible] DISPOSAL

1. Procedures

The liquid from the evaporation [illegible] was [illegible] cavity through the old vent [illegible] was then removed, packaged, and [illegible] uncontaminated water was applied to [illegible] inated soil from the sides and bott[illegible] into the shaft.

Figure 1. Evaporation Pond - Contaminated Soil Removed

Figure 2. Evaporation Pond - After Backfill

2. Findings and Results

a) The ^{3}H concentration in the liquid from the evaporation pond measured 1.12×10^{-1} μCi/cc.

b) The water-tight lining measured to 15 mR/hr.

c) Soil was excavated to a depth of twelve feet where an apparent leak in one corner of the water-tight lining resulted in contamination to 10 mR/hr. (See Figure 1.) The excavated area was then back-filled and mounded to avoid settling out as a low spot. (See Figure 2.)

d) A detailed radiological survey of the surrounding area and top of the back-filled area revealed all measurements were less than 0.1 mR/hr.

C. DECONTAMINATION OF MISCELLANEOUS STORAGE AREAS AND FACILITIES

1. Procedures

Detailed radiological surveys were performed of all existing facilities, storage areas, and the sites of past activities. All contaminated materials were collected and transported to the shaft area for disposal or decontamination. (See Figures 3 and 4.)

2. Findings and Results

a) Materials measuring to 12 mR/hr were removed from the scrap metal storage pit.

b) Ten spools of electrical cables measuring to 0.6 mR/hr and four spots of soil measuring to 1.5 mR/hr were taken from the electrical cable storage area.

c) The signal cable bundles extending west from the shaft into the desert for approximately 1.5 miles were contaminated to 5 mR/hr. Reduction to less than 0.1 mR/hr was accomplished through removal of plastic wrapping tape.

d) Twenty-three separate items (hand tools [illegible]) measuring to 7 mR/hr were taken from the [illegible].

e) A spot on the concrete floor of the warehouse facility, which measured to 0.6 mR/hr, was eliminated by chipping out about a half inch layer of concrete.

f) One dump truck, four mine cars, one hoist muck bucket, and one hoist man cage measuring to 1.5 mR/hr were taken from the warehouse storage yard and were disassembled, as required, to facilitate disposal in the shaft. Six spots of soil measuring to 1.5 mR/hr were also taken from the warehouse storage yard.

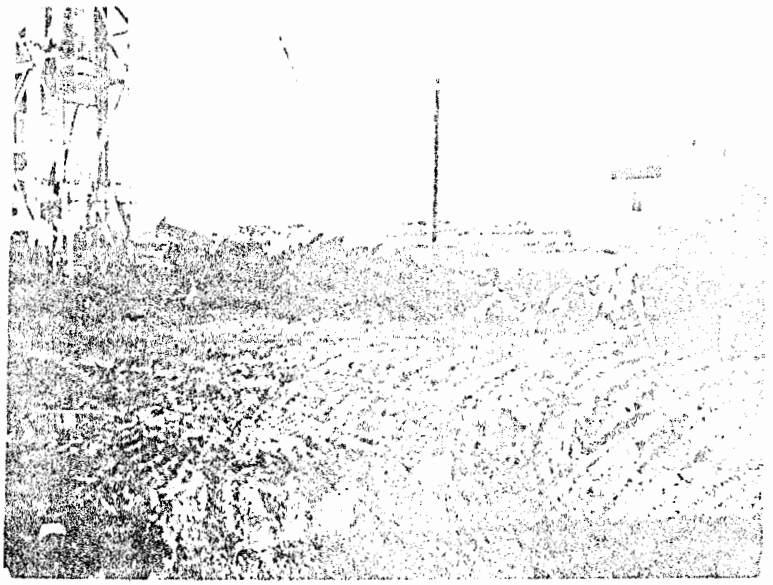


Figure 3. Shaft Collar - Contaminated Material

Figure 4. Shaft Collar - Contaminated Soil

g) Two house trailers were contaminated to 80 mR/hr. The contaminated portions of the flooring were removed.

h) Two pieces of conduit measuring to 12 mR/hr were extracted from the concrete floor of the restroom facility and a USGS Butler building near the CP area. This material was evidently used in the original construction of these facilities.

i) Detailed radiological surveys were performed of all miscellaneous storage areas and facilities after decontamination. No measurements exceeded 0.1 mR/hr.

D. CONTAMINATED WASTE DUMP CLEAN-UP

1. Procedures

The rectangular fenced dump area measuring approximately 500 feet by 300 feet was trenched using a back-hoe machine to determine the exact location of unknown quantities of radioactive materials (metal, wood, salt muck, insulated wiring, etc.) which had been buried in this area over a period of time extending from post Gnome to Coach abandonment. (See Figures 5 and 6.) The soil and salt muck was sifted using a back-hoe machine to segregate metal and other large items to facilitate disposal operations. Uncontaminated water was applied to the soil to eliminate airborne debris. The remaining contaminated materials were excavated and disposed of in the shaft and Coach drift.

2. Findings and Results

a) Four separate disposal pits were uncovered within the fenced area during the exploratory trenching (Figure 7).

b) Pieces of metal and other large materials sifted from the soil and salt muck measured to 200 mR/hr. (See Figure 8.)

c) Soil/salt muck samples collected from Pit #4 revealed:

Depth from Surface	γ Activity μCi/gm (^{137}Cs)	^{3}H Activity μCi/cc	^{3}H Activity μCi/gm
2 feet	7.37×10^{-4}	4.11×10^{-1}	2.63×10^{-1}
4 feet	1.21×10^{-4}	5.82×10^{-1}	3.29×10^{-1}
6 feet	4.78×10^{-5}	2.21×10^{0}	1.63×10^{-1}
8 feet	2.44×10^{-5}	3.30×10^{0}	2.26×10^{-1}
10 feet	3.05×10^{-6}	4.36×10^{0}	4.45×10^{-1}
12 feet	3.22×10^{-6}	3.03×10^{0}	2.91×10^{-1}

Figure 5. Contaminated Waste Dump - Surveying Exploratory Trench

Figure 6. Contaminated Waste Dump - Trench Bottom [illegible]

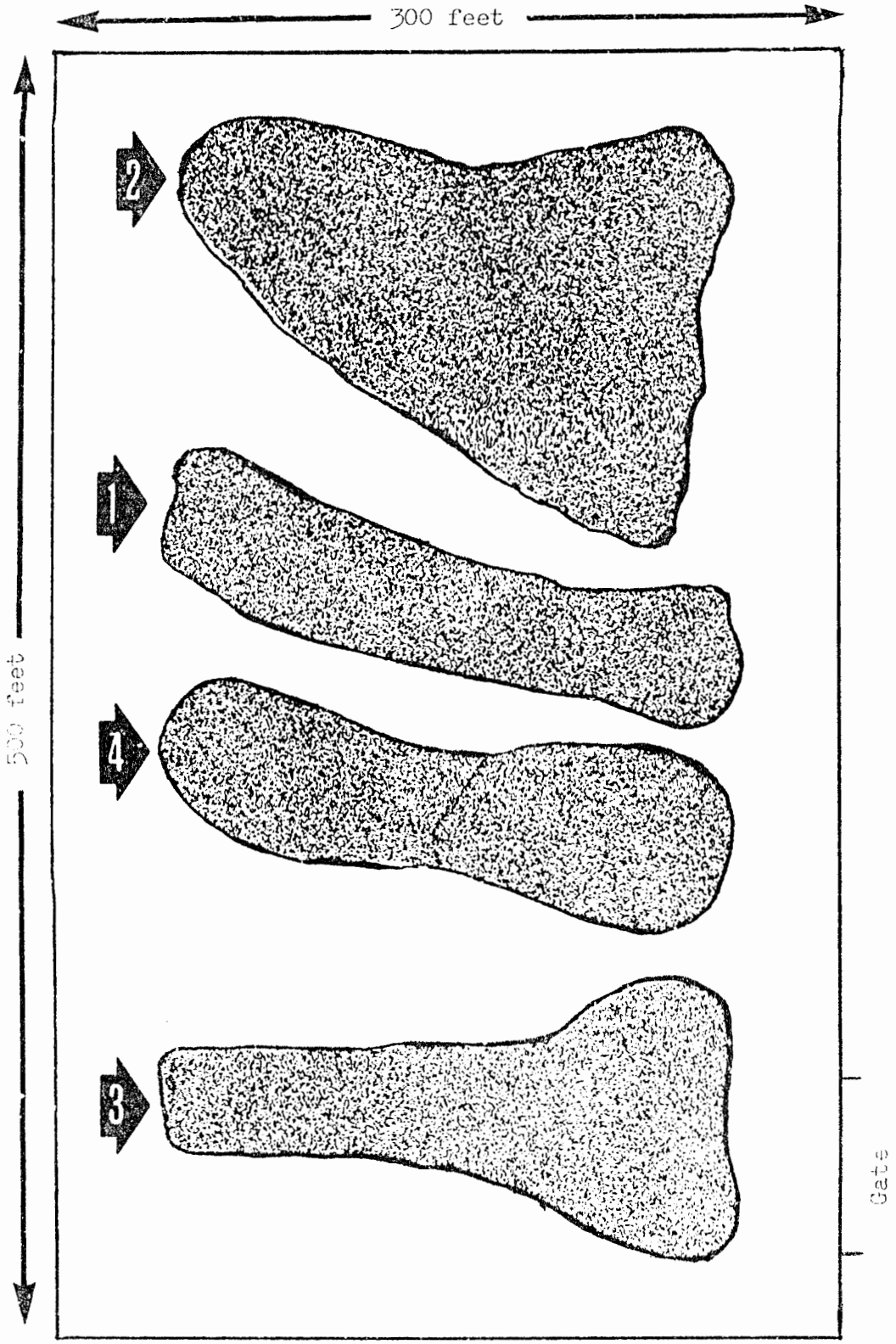


Figure 7. Contaminated Waste Dump - Disposal Pit Locations

d) Daily soil/salt muck samples collected during excavation and subsequent disposal of materials from Pits #1 and #2 were combined. Analyses made of this composite sample showed the following activity concentrations:

2.0×10^{-3} μCi/gm gross gamma (predominantly ^{137}Cs)

7.0×10^{-1} μCi/cc ^{3}H (measured in water extracted from sample)

3.84×10^{-2} μCi/gm ^{3}H (calculated from water content of sample)

1.12×10^{-5} μCi/gm ^{89}Sr

4.27×10^{-6} μCi/gm ^{90}Sr

e) In an effort to determine the total radioactivity contained in the remaining materials being discarded, a soil/salt muck sample was collected from each individual dump truck load of materials transported for disposal. These samples were combined on a daily basis to represent the total materials disposed during that day. The results of these composite sample analyses are shown in Figure 10.

f) All excavated areas were back-filled and mounded with uncontaminated soil. (See Figure 9.)

g) Radiological survey measurements of the surrounding area and on top of the back-filled area were less than 1.0 mR/hr except for a section of the roadway leading from the waste dump to the shaft area which was contaminated to 2.5 mR/hr. After decontamination, the entire area measured less than 0.1 mR/hr.

h) Continuous high-volume air samples collected downwind from the soil excavation operations evidenced only normal background radiation.

E. COACH DRIFT DISPOSAL OPERATIONS AND SURFACE AREA CLEAN-UP

1. Procedures

An axial vane fan was emplaced on the Coach ground zero cable hole to create negative pressure throughout the Coach drift, thereby facilitating maximum material capacity. (See Figure 11.)

A metal grizzly type hopper was installed near the vent hole to accept materials for disposal.

A conveyor belt extending to the vent hole opening was positioned below the hopper. (See Figure 12.)

Figure 8. Contaminated Waste Dump - Scrap Material from Burial Pit #3

Figure 9. Contaminated Waste Dump - After Backfill

Figure 10

Contaminated Waste Dump - Composite Sample Analyses Data

Collection Date	Location Collected	Location Disposal	Activity* γ μCi/gm	Activity* β μCi/gm	Activity* ^{3}H μCi/gm
10-01-68	Pit #3	Shaft	1.24×10^{-4}	2.54×10^{-5}	5.87×10^{-2}
10-02-68	Pit #3	Shaft	3.99×10^{-5}	6.70×10^{-6}	3.45×10^{-2}
10-03-68	Pit #3	Shaft	4.72×10^{-4}	3.15×10^{-4}	2.44×10^{-1}
10-04-68	Pit #3	Shaft	4.72×10^{-4}	1.75×10^{-4}	2.86×10^{-1}
10-07-68	Pit #3	Shaft	2.70×10^{-4}	3.97×10^{-5}	6.52×10^{-2}
10-08-68	Pit #3	Shaft	1.85×10^{-4}	2.77×10^{-5}	1.48×10^{-2}
10-09-68	Pit #3	Shaft	8.53×10^{-5}	9.83×10^{-6}	9.82×10^{-2}
10-10-68	Pit #3	Shaft	3.15×10^{-4}	3.95×10^{-5}	6.62×10^{-1}
10-14-68	Pit #4	Coach Drift	4.01×10^{-5}	8.04×10^{-6}	5.04×10^{-1}
10-15-68	Pit #4	Coach Drift	1.58×10^{-4}	4.20×10^{-5}	5.86×10^{-1}
10-16-68	Pit #4	Coach Drift	8.66×10^{-4}	2.73×10^{-4}	1.97×10^{0}
10-17-68	Pit #4	Coach Drift	1.73×10^{-4}	6.19×10^{-4}	3.10×10^{-1}
10-18-68	Pit #4	Coach Drift	2.54×10^{-4}	5.51×10^{-5}	5.18×10^{-1}
10-21-68	Pit #4	Coach Drift	1.42×10^{-4}	1.46×10^{-5}	1.93×10^{-1}
10-22-68	Pit #4	Coach Drift	2.48×10^{-4}	5.75×10^{-5}	1.01×10^{-1}
10-23-68	Pit #4	Coach Drift	4.03×10^{-4}	4.29×10^{-5}	8.59×10^{-1}
10-24-68	Pit #2	Coach Drift	1.55×10^{-4}	4.31×10^{-5}	2.67×10^{-2}
10-25-68	Pit #2	Coach Drift	3.45×10^{-4}	5.15×10^{-5}	1.42×10^{-1}
10-28-68	Pit #2	Coach Drift	3.83×10^{-4}	4.77×10^{-5}	1.42×10^{0}
10-29-68	Pit #2	Coach Drift	9.88×10^{-5}	2.68×10^{-5}	8.87×10^{-1}
10-30-68	Pit #2	Coach Drift	2.97×10^{-4}	1.86×10^{-5}	3.34×10^{-2}

*Gamma activity was predominantly ^{137}Cs. All samples were analyzed for gross alpha activity and results were $<1.0 \times 10^{-7}$ μCi/gm (detection limit).

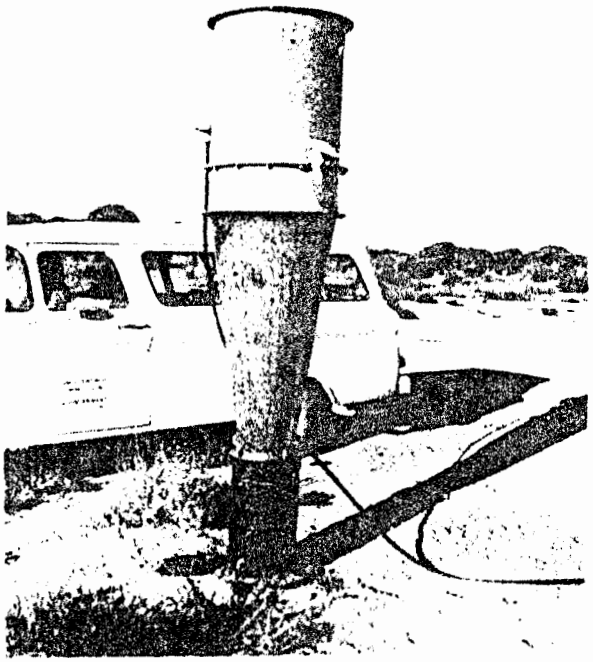


Figure 11. Coach Drift Disposal - Axial Vane Fan on Coach GZ Pipe

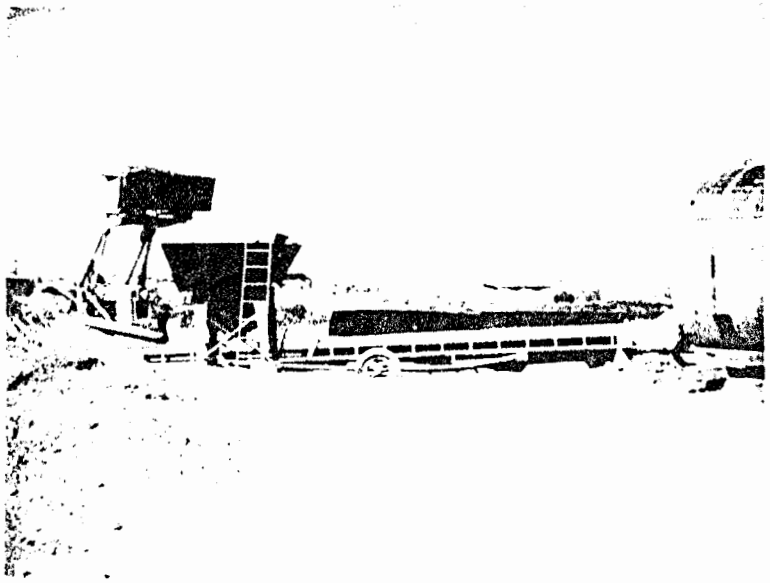


Figure 12. Coach Drift Disposal - Conveyor Belt Operations

A metal tank containing brine was used for flushing material down the vent hole and for washing materials throughout the Coach drift.

Upon completion of disposal operations, a detailed radiological survey was performed of the surface area surrounding the Coach vent hole and all remaining contaminated materials measuring in excess of 0.1 mR/hr were removed and discarded in the shaft.

2. Findings and Results

a) A drierite type air sample collected at the axial vane fan exhaust upon the fan's activation revealed airborne ^3H measuring 5.44×10^{-6} μCi/cc. An additional drierite sample collected after a calculated complete change of air in the Coach drift revealed airborne ^3H measuring 3.52×10^{-7} μCi/cc.

b) Routine urine samples collected from personnel involved in the material disposal operations revealed only normal background radiation.

c) A radiological survey of the surface area upon completion of disposal operations indicated contamination to 1.5 mR/hr on the ground surrounding the metal hopper and the vent hole. After this contamination was removed and discarded in the shaft, a final survey showed the entire area measuring less than 0.1 mR/hr.

F. SHAFT AND ASSOCIATED SURFACE AREA CLEAN-UP

1. Procedures

The hoist man cage was lowered to the bottom of the shaft sump to ensure proper operation of the hoist and to determine structural conditions. All bulky materials were lowered to the bottom of the shaft with a hoist using a self-releasing hook to prevent premature plugging of the shaft. Contaminated debris was loaded in dump trucks using an end-loader machine. The materials were then transported to the shaft collar where they were dumped into a special metal chute (Figures 13 and 14) which was hinged at one end to allow the materials to drop slowly into the shaft opening. A perforated 1 1/2 inch water line was used to sprinkle fresh water over the shaft opening during all dumping operations to prevent the escape of small contaminated particles.

After all known contaminated materials had been disposed of in the shaft, the shaft headframe was dismantled and the upper five foot portion of the concrete shaft collar was removed to facilitate the installation of a new concrete plug. A key was then blasted in the concrete collar to accept a permanent plug. After the contaminated soil and broken concrete around the shaft collar was excavated and disposed of in the shaft, the shaft was filled with uncontaminated soil to within five feet of the surface and a permanent plug was formed by filling the remainder of the shaft with concrete.

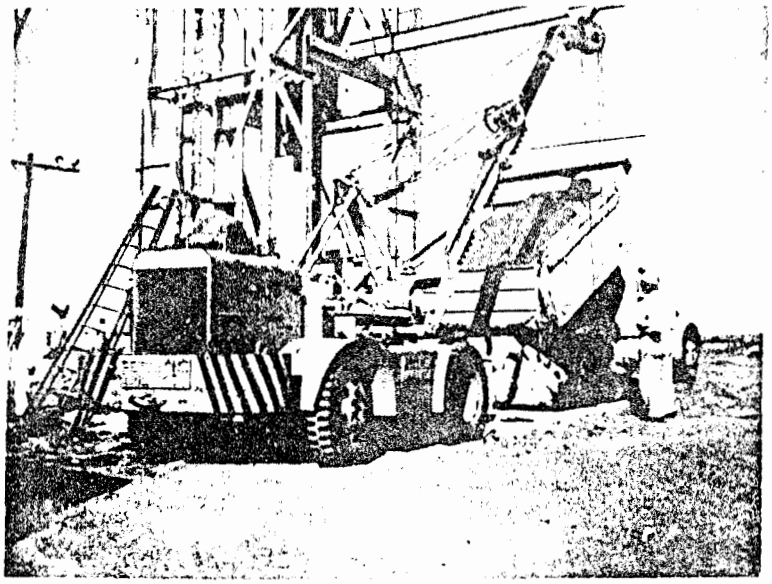


Figure 13. Shaft Collar - Dumping Contaminated Soil into a Special Metal Chute

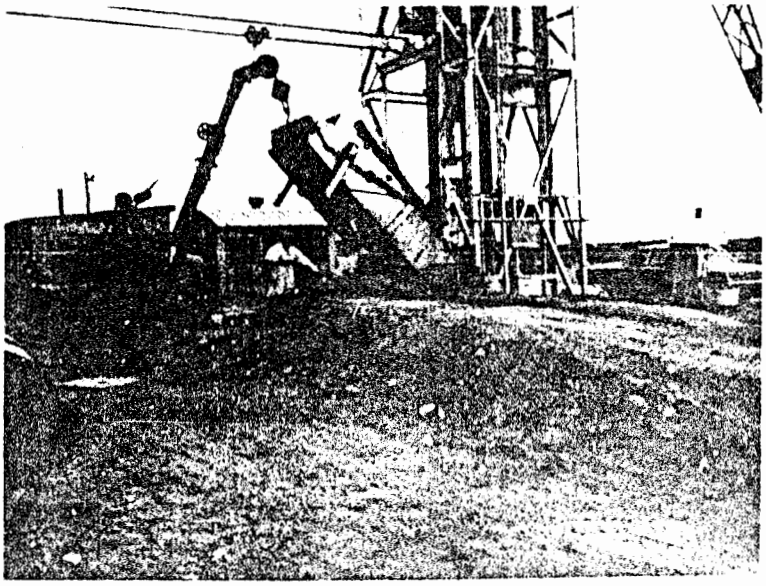


Figure 14. Shaft Collar - Special Metal Chute Used to Dump Contaminated Materials into Shaft Opening

2. Findings and Results

a) A water sample collected from the bottom of the man cage that was lowered into the shaft sump revealed a ^{3}H concentration of 3 $\mu Ci/cc$.

b) Continuous high volume air samples collected over the shaft during all disposal operations indicated only normal background radiation.

c) The lower eight-foot section of the shaft head frame was contaminated to 3.5 mR/hr. This section was cut off and disposed in the shaft. Numerous grease spots on the remainder of the head frame measured to 8 mR/hr. These spots were removed by scraping with a putty knife which allowed the head frame to be cleared for off-site release.

d) The horizontal surface of the concrete shaft collar was contaminated to 6 mR/hr. This surface was removed with a pavement breaker and disposed of in the shaft. (See Figure 15.) The remainder of the concrete collar was drilled and blasted off with dynamite to a depth of approximately five feet. This formed a key to accept a permanent concrete plug. (See Figure 16.) The resulting debris was cleaned up and disposed of in the shaft.

e) The soil immediately around the shaft collar was contaminated to 10 mR/hr. This soil was removed and disposed of in the shaft.

f) A detailed radiological survey of the vicinity after plugging the shaft and back-filling around the plug revealed the entire area measuring less than 0.1 mR/hr.

G. SALT MUCK PILE EXPLORATION

1. Procedures

Seventy-nine holes were drilled through the salt muck pile at the locations illustrated in Figure 17. As each hole was drilled, the resulting debris was monitored and samples were collected from within the first foot of debris and at additional three-foot intervals. A 360° open shield extension probe was also lowered into all drilled holes to locate any radiologically contaminated layers.

2. Findings and Results

a) The radiation measurements of 0.1 mR/hr and above, detected during the extended probe portable instrument survey, are shown in Figure 17.

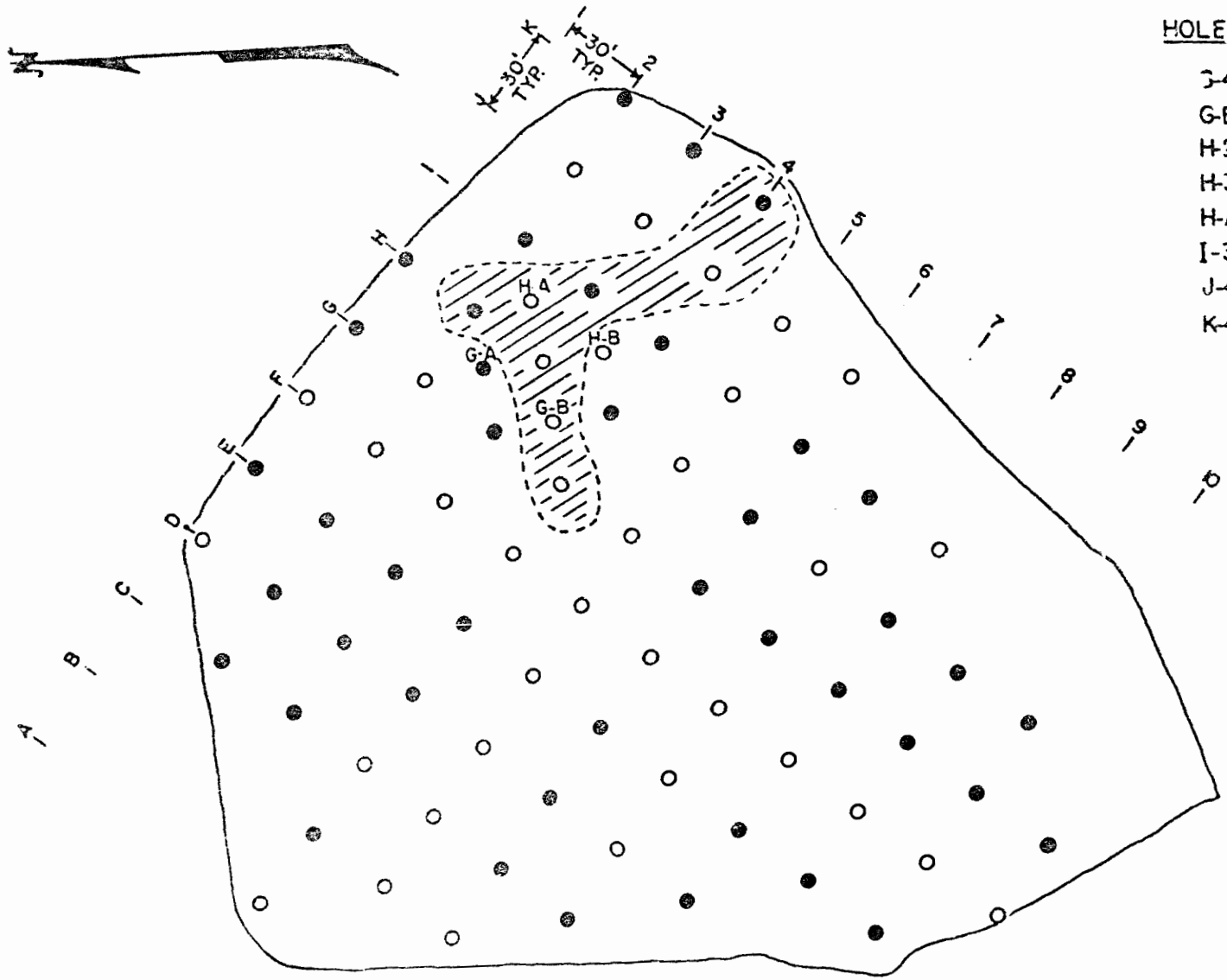
b) Due to the prohibitive costs involved in analyzing all of the samples collected, a representative cross-section of samples was selected for laboratory analysis. To further reduce the quantity of samples requiring analysis, certain groups of samples were

Figure 15. Shaft Area Clean-Up - Chipping the Shaft Collar

Figure 16. Shaft Area Clean-Up - Dynamiting the Shaft Collar

thoroughly mixed for composite analysis. All samples, however, were retained pending any positive analytical results that would necessitate further evaluation. The results of laboratory sample analyses presented in Figure 18 provide a representative cross-section of the radioactive contamination present in the salt muck pile.

e) The AEC/NVOO, considering the amount of overburden and the quantity of material involved, decided that the radioactivity discovered within the salt muck pile was sufficiently low in radioactive content to present no significant environmental or health hazard.



CONTAMINATION

Per Portable Instrument Survey

HOLE No.	DEPTH	mR/hr
J-4	14 ft.	0.1
G-B	7-14 ft.	0.3
H-2	10-11 ft.	0.1
H-3	10-14.5 ft.	0.1
H-A	9-15 ft.	1.5
I-3	15.5-16 ft.	0.1
J-4	9-10 ft.	2.5
K-4	8-8.5 ft.	0.1

CONTAMINATED AREA

EDGE OF MUCK PILE GROUND LEVEL

● 2" DRILL HOLE

○ 2" DRILL HOLE-SALT SAMPLES COLLECTED

Figure 17. Carlsbad Salt Muck Pile - Exploratory Drilling Program

Figure 18. Carlsbad Salt Muck Pile - Exploratory Drilling Program Sample Analyses Results

Hole Number	Sample Depth	Analysis Type	Activity $\mu Ci/gm$	Significant Gamma Isotopes	% 2 Sigma Error
H-A	1 Ft	Gamma	7.91×10^{-6}	^{137}Cs	$\pm$ 1.3
H-A	1 Ft	Beta	1.93×10^{-5}		$\pm$ 23.0
H-A	1 Ft	^{3}H	$<2.0 \times 10^{-4}$		--
H-A	4 Ft	Gamma	4.75×10^{-7}	Bkgd	$\pm$ 10.0
H-A	4 Ft	Beta	1.53×10^{-5}		$\pm$ 26.5
H-A	4 Ft	^{3}H	$<1.9 \times 10^{-4}$		--
H-A	7 Ft	Gamma	2.57×10^{-6}	^{40}K	$\pm$ 2.6
H-A	7 Ft	Beta	3.10×10^{-5}		$\pm$ 17.3
H-A	7 Ft	^{3}H	$<2.0 \times 10^{-4}$		--
H-A	10 Ft	Gamma	1.81×10^{-6}	^{40}K	$\pm$ 3.2
H-A	10 Ft	Beta	3.22×10^{-5}		$\pm$ 16.9
H-A	10 Ft	^{3}H	$<2.0 \times 10^{-4}$		--
H-A	10 Ft	^{90}Sr	5.91×10^{-6}		--
H-A	13 Ft	Gamma	6.84×10^{-5}	^{137}Cs & ^{40}K	$\pm$ .4
H-A	13 Ft	Beta	1.53×10^{-4}		$\pm$ 7.2
H-A	13 Ft	^{3}H	1.25×10^{-3}		$\pm$ 29.1
H-A	16 Ft	Gamma	2.58×10^{-5}	^{137}Cs	$\pm$ .7
H-A	16 Ft	Beta	7.09×10^{-5}		$\pm$ 10.9
H-A	16 Ft	^{3}H	3.09×10^{-4}		$\pm$ 74.6
G-B	1 Ft	Gamma	4.96×10^{-7}	Bkgd	$\pm$ 36.4
G-B	1 Ft	Beta	1.93×10^{-5}		$\pm$ 23.0
G-B	1 Ft	^{3}H	$<2.0 \times 10^{-4}$		--
G-B	4 Ft	Gamma	4.76×10^{-7}	Bkgd	$\pm$ 16.6
G-B	4 Ft	Beta	1.61×10^{-5}		$\pm$ 25.7
G-B	4 Ft	^{3}H	$<2.0 \times 10^{-4}$		--
G-B	7 Ft	Gamma	1.56×10^{-6}	Bkgd	$\pm$ 4.4
G-B	7 Ft	Beta	3.00×10^{-5}		$\pm$ 17.6
G-B	7 Ft	^{3}H	$<2.0 \times 10^{-4}$		--
G-B	10 Ft	Gamma	1.11×10^{-4}	^{137}Cs	$\pm$ .3
G-B	10 Ft	Beta	1.62×10^{-4}		$\pm$ 7.0
G-B	10 Ft	Alpha	$<8.8 \times 10^{-7}$		--
G-B	10 Ft	^{3}H	2.29×10^{-3}		$\pm$ 20.4
G-B	10 Ft	^{90}Sr	5.16×10^{-5}		--

Figure 18 (Contd)

Number	Sample Depth	Analysis Type	Activity $\mu Ci/gm$	Significant Gamma Isotopes	% 2 Sigma Error
G-B	13 Ft	Gamma	4.72×10^{-6}	^{137}Cs & ^{40}K	± 1.1
G-B	13 Ft	Beta	3.67×10^{-5}		± 15.7
G-B	13 Ft	^{3}H	$<2.0 \times 10^{-4}$		--
F-Row	1 Ft Composite	Gamma	2.28×10^{-6}	^{137}Cs & ^{40}K	± 2.2
F-Row	1 Ft Composite	Beta	1.81×10^{-5}		± 23.9
F-Row	1 Ft Composite	^{3}H	$<2.1 \times 10^{-4}$		--
F-Row	4 Ft Composite	Gamma	1.21×10^{-6}	^{137}Cs & ^{40}K	± 3.9
F-Row	4 Ft Composite	Beta	1.93×10^{-5}		± 23.0
F-Row	4 Ft Composite	^{3}H	$<2.0 \times 10^{-4}$		--
F-Row	7 Ft Composite	Gamma	5.39×10^{-7}	Bkgd	± 15.9
F-Row	7 Ft Composite	Beta	1.38×10^{-5}		± 28.4
F-Row	7 Ft Composite	^{3}H	$<2.0 \times 10^{-4}$		--
F-Row	10 Ft Composite	Gamma	1.33×10^{-6}	^{40}K	± 6.6
F-Row	10 Ft Composite	Beta	2.61×10^{-5}		± 19.1
F-Row	10 Ft Composite	^{3}H	$<2.0 \times 10^{-4}$		--
J-4	Composite-Total Hole	Gamma	5.49×10^{-6}	^{137}Cs & ^{40}K	± 1.1
J-4	Composite-Total Hole	Beta	3.67×10^{-5}		± 15.7
J-4	Composite-Total Hole	^{3}H	$<2.0 \times 10^{-4}$		--
5-Row	1 Ft Composite	Gamma	9.02×10^{-7}	^{40}K	± 6.9
5-Row	1 Ft Composite	Beta	2.28×10^{-5}		± 20.8
5-Row	1 Ft Composite	^{3}H	$<2.0 \times 10^{-4}$		--

Instrument	Meter Range & Scales	Radiation Measured
Jordan Rad-Gun Model AGB-10KG-SR (Ion Chamber)	0.01 mR/hr to 10,000 R/hr Three logarithmic scales: 0.01 mR/hr to 10 mR/hr 0.01 R/hr to 10 R/hr 10 R/hr to 10,000 R/hr	gamma
Eberline PAC-3G (Gas Proportional)	0 to 100,000 c/m/61cm^2 Three linear scales: 0 to 1000 c/m/61cm^2 0 to 10,000 c/m/61cm^2 0 to 100,000 c/m/61cm^2	alpha
Eberline PAC-1s	0 to 1,000,000 c/m/59cm^2 Four linear scales: 0 to 1000 c/m/59cm^2 0 to 10,000 c/m/59cm^2 0 to 100,000 c/m/59cm^2 0 to 1,000,000 c/m/59cm^2	alpha

Unit	Description
Remote Area Monitoring Station (RAMS)	This unit utilizes a Tracerlab TA-6 (GM) tube gamma detector in conjunction with a Model 261 direct readout meter. The readout ranges are 0 to 10 R/hr and 0 to 100 R/hr.
Radector Monitoring Station (RMS)	This unit utilizes a Jordan gamma detector with a Neher-White ion chamber. The instrument has two range scales, mR/hr and R/hr, with a maximum full scale reading capability of 500 R/hr, 1000 R/hr, or 10,000 R/hr.
Remote Area Recording Station (RARS)	This unit utilizes an Esterline-Angus recorder with Radector electronics and a Neher-White ion chamber.
M.S.A. Carbon Monoxide Tester	This instrument utilizes an aspirator bulb to draw air through a glass tube containing a chemical indicator. The indicator material changes color in the presence of carbon monoxide. The color is compared with a color chart calibrated in percentages of carbon monoxide present in the tested environment.

Appendix A (Contd)

Unit	Description
Draeger Multi-Gas Detector, Model 31	This instrument utilizes a hand-operated bellows pump to pass air through glass tubes containing chemical indicators. The chemicals change color in the presence of toxic gases.
Fyrite Oxygen Indicator	This instrument consists of an hourglass shaped tube containing a liquid chemical which expands in the presence of atmospheric oxygen to give a reading corresponding to the percentage of oxygen in the ambient atmosphere. The instrument indicates from 0% to 21% oxygen.
M.S.A. Explosimeter	This has a battery operated detector calibrated to give the concentration of flammable gases and vapors in the ambient atmosphere. The instrument has a meter scale which indicates from 0% to 100% of the lower explosive limit