REPORT OF RADIOACTIVE RESIDUES REMAINING IN THE SOURCE TUBES AT PARSIPPANY, NEW JERSEY

for

ISOMEDIX, INC.
25 Eastmans Road
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by

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OBJECTIVE

To store the waste residues remaining on the property after termination of an active hot cell operation in a radiologically and environmentally sound manner, such that the usefulness of the site is maintained for a compatible industrial activity, and that post-lease risk of exposure to radioactive material is reduced to the lowest practicable level.

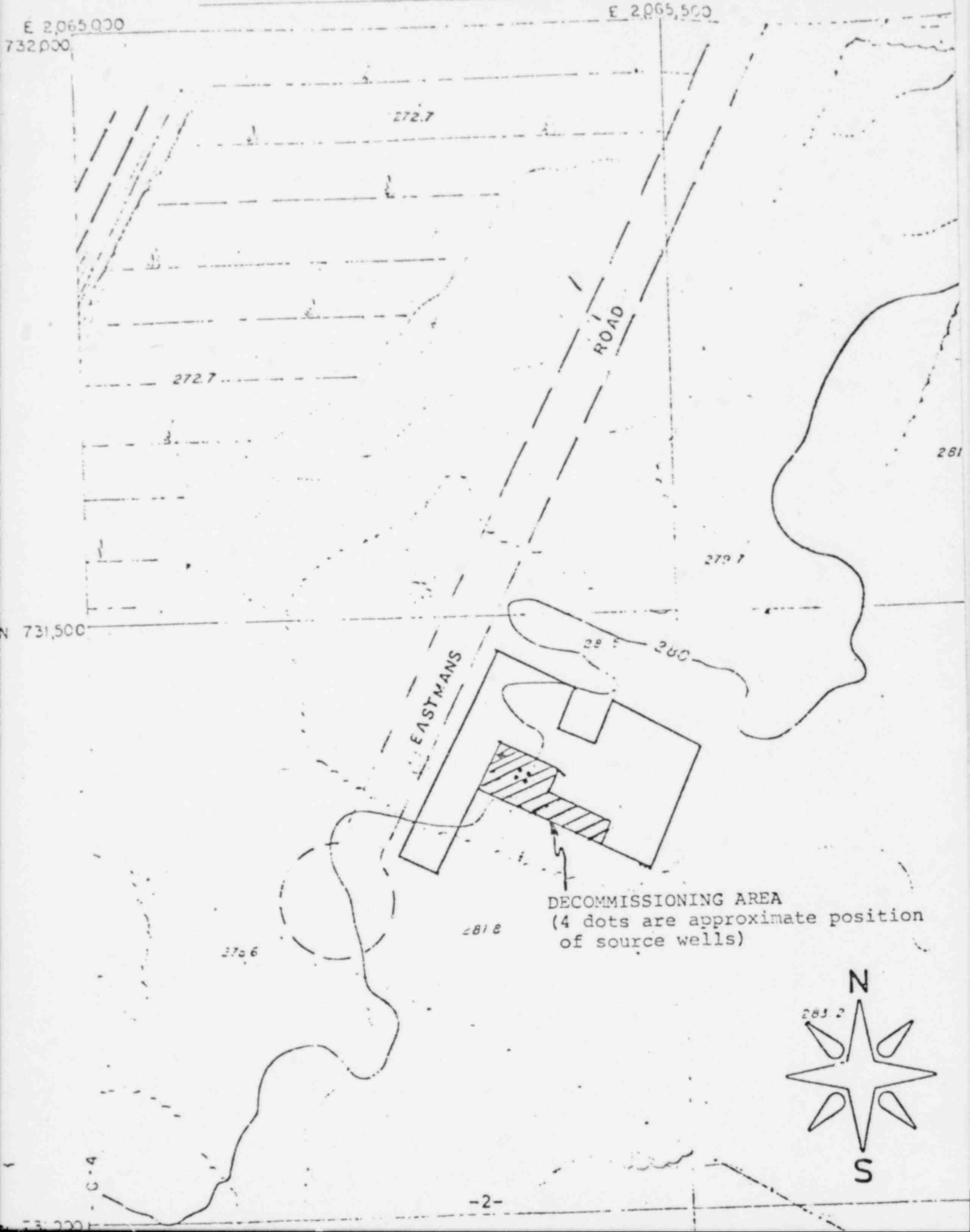
HISTORY OF THE PROPERTY

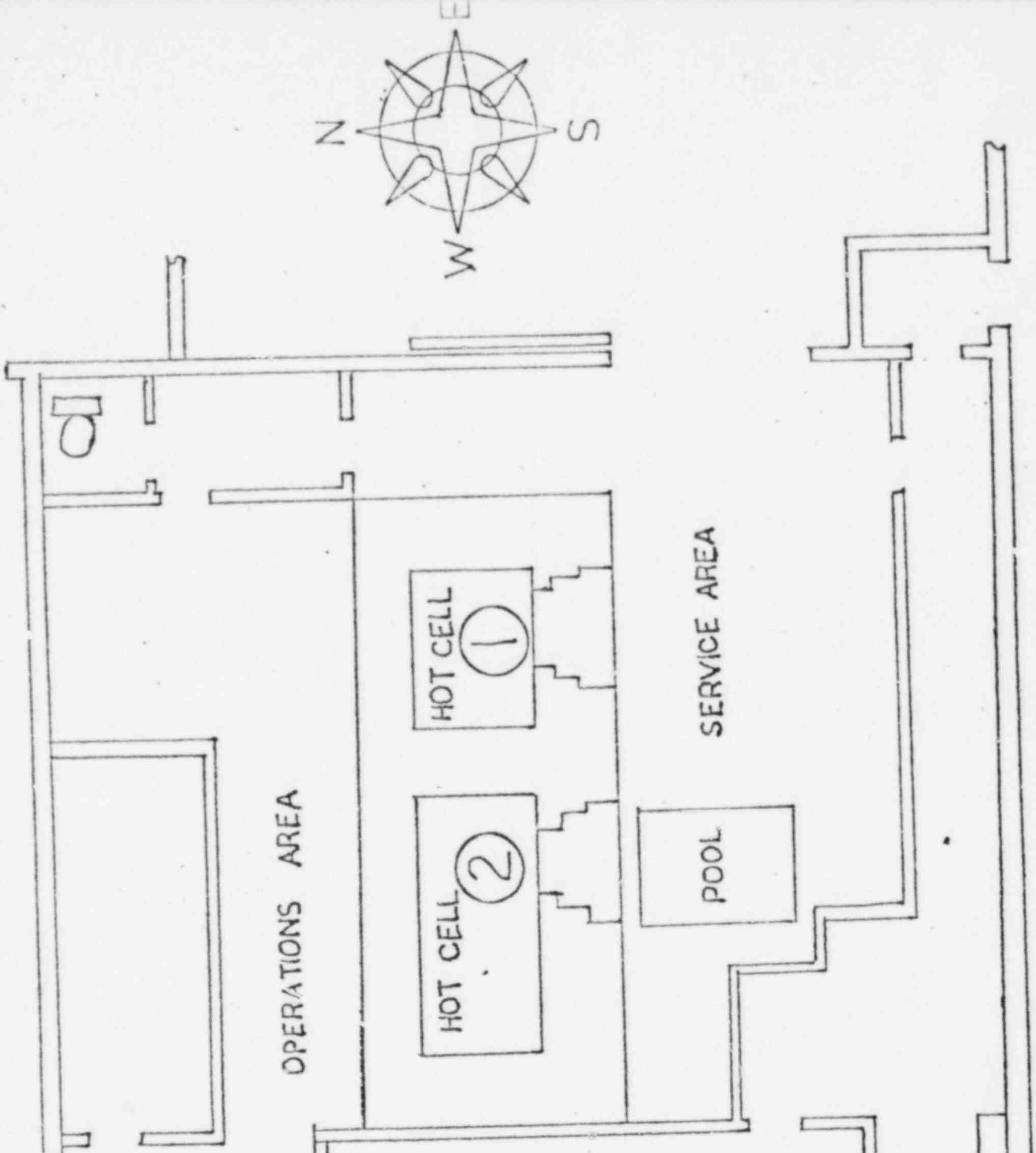
The following is a brief history of the site as told to Chem-Nuclear Systems by Isomedix on December 27, 1979. Footnotes are added by Chem-Nuclear Systems for clarification.

> "The present building was completed and occupied in about July 1969 by Radiation Machinery Corp. (RMC). The cell was used for loading cesium sources (ORNL Special Form) into self-contained irradiators. Sources were stored in Well #4.[1]
>
> In early-1970, RMC was on the verge of bankruptcy and was purchased by Radiational International, Inc. Cesium was stored in Well #4, and about 150,000 ci of cobalt-60 was stored in water-filled Well #1. This continued until late-1972, when Isomedix, Inc. was formed, and the above sequence continued. On several occasions, the cobalt was stored for short priods in Well #2, but the primary storage was in Well #1. This continued until 1979.
>
> Approximately 3 years ago, a leaking cobalt-60 source was detected in Cell 2, where a second source of cobalt was being utilized as a service irradiator. During preliminary cleanup operations, Cell 1 was used as a storage area for both liquid and solid wastes generated from the cleanup. We are aware that at one point, at least, water containing cobalt-60 (from samples of pool water, resins, etc.) was spilled in sufficient quantity to have run into Well #1, probably Wells #2 and #4, and possibly Well #3. The cells were inactivated, and little was done to decontaminate the wells until the present effort with CNS.[2]
>
> During 1979, Cell 1 was also used to disassemble the source racks from both Cells 1 and 2. Inasmuch as all sources in Cell 1 (approximately 125) had been contaminated by virtue of having been in contaminated water, it is likely that dust and oxides generated by handling also contributed to contaminating the wells, walls, etc. in Cell 1."

1. Refer to Map of Source Wells.
2. CNS refers to Chem-Nucl ar Systems, Inc.

TOPOGRAPHICAL LAYOUT, ISOMEDIX, INC. COMPLEX





ISOMEDIX INC. WEST END

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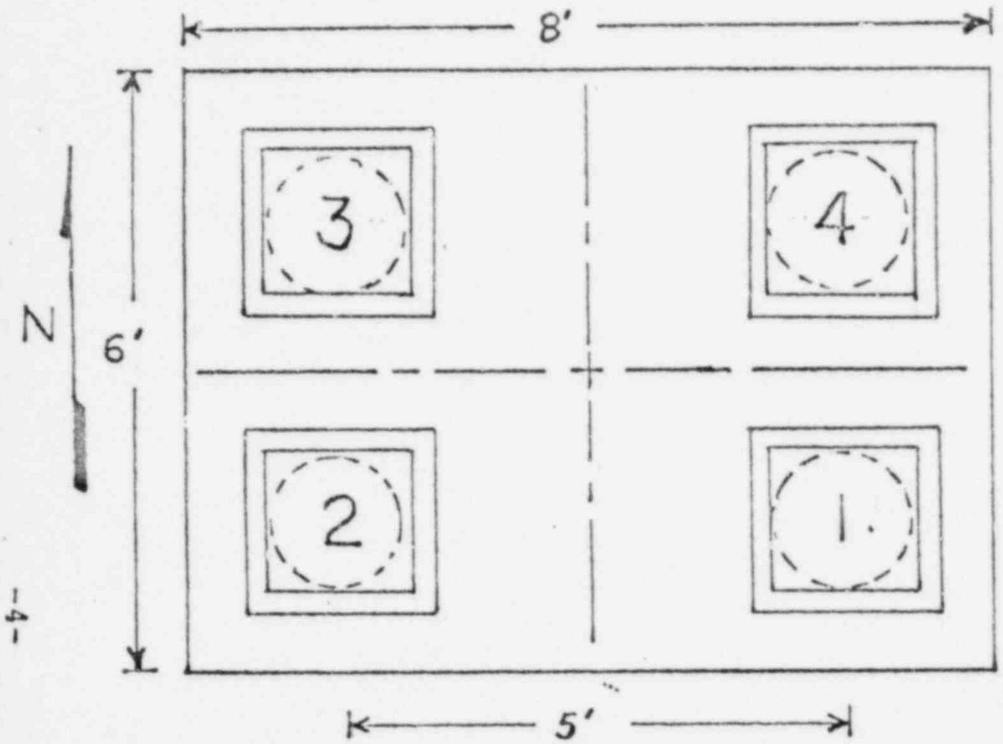
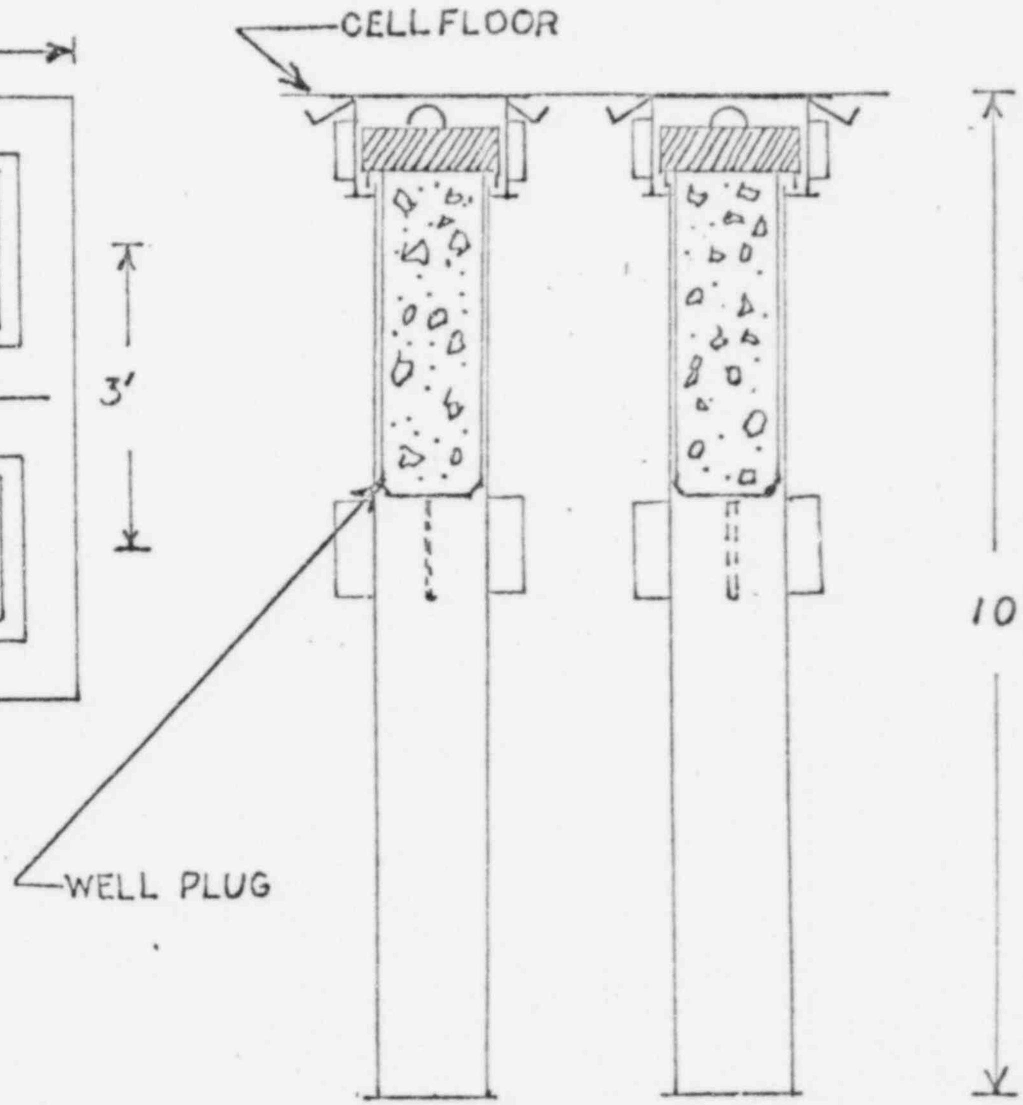


TOP VIEW CELL FLOOR

½" = 1'



SIDE VIEW TUBES

HOT CELL #1 INTERIOR

DEVELOPMENT OF PLAN

The procedure to be used in developing a plan are: (1) to evaluate the practical options for managing the waste, (2) to discuss options with individuals involved including the responsible governmental agency, (3) to select a disposal procedure, (4) to notify the responsible agency and obtain the necessary approvals and permits as required, (5) to implement plan, and (6) to obtain assurance from the agencies involved that the planned action has been satisfactorily completed.

Some of the options available are:

1. Removal of the Source Wells - This, due to the construction of the well, proves to be impracticable.

2. Decontamination of the Source Wells - Decontamination of the wells has already been achieved to the lowest practicable point and further attempts show that the waste can be considered fixed.

3. On-site Disposal by Burial - This method shows it to be a viable option.

SUPPORT INFORMATION

Construction of the Source Wells' Tubes

The source wells are made of steel extending 10 feet into a 12-foot thick reinforced concrete block monolith.

The tubes themselves consist of a 12-3/4" OD x .250" W x 9'-9 1/2" bottom tube with a 1/4" x 14" x 14" bottom plate. Two inches from the top of the tube is welded an outside plate 1/4" x 20" x 20". Onto this plate is welded an 18" OD x .250" W x 10-1/2" tube that brings the structure to the top of the cell floor. A cover is then hinged over the top of the well.

Also, there are 16 steel rebar fastening plates welded to the tubes (locations of 8 are shown in the diagram). Due to the rebar fasteners and the bottom plate, it is physically impossible to pull the tubes from the monolith, even after removal of the concrete down to the top of the bottom tubes.

WORK PERFORMED ON SOURCE WELLS IN CELL #1

8-28-79	Removed two plugs and two stainless steel liners from source wells in Cell #1.
8-29-79	Removed remaining two plugs and one stainless steel liner from source wells in Cell #1.
8-31-79	Commenced scrubbing source wells in Cell #1 using soap, water and soft bristle brush--initial rad levels in Cell #1 +900 mR/hr.
9-4-79	Continuing scrubdown of first well, using magnet to pick up corrosion chips at bottom of well.
9-5-79	Removed scrubbing water from first source well--rad levels now 60 to 150 mR/hr.
9-6-79	Using magnet to remove debris from all four source wells in Cell #1.
9-11-79	Continuing to scrub and clean source wells.
9-12-79	Continuing to clean source wells--first wells now reading 20 mR/hr average, with hot spot on bottom of 100 mR/hr.
9-13-79	Using wire brush in Cell #1 to clean out source wells.
9-14-79	Continuing to clean wells in Cell #1; some progress noted--average in first well approximately 10 mR/hr, with 80 mR/hr hot spot on bottom.
9-17-79	Continuing to clean and scrub wells.
9-18-79	Continuing to clean source wells.
9-19-79	Vacuumed out bottom of all source wells; new readings taken (maximum obtained). #1 max, 60 mR/hr #4 max, 8 mR/hr #2 max, 4 mR/hr #3 max, 1.2 mR/hr
9-25-79	Removed lead rings from around top of source wells in Cell #1.
9-28-79	Chipped floor in Cell #1 to reduce background for more accurate reading from source wells.
10-2-79	Performed rad level check of Cell #1. Discovered metal framing around top of source wells less than 50 mR/hr.
10-3-79	Decided to try to pull out source wells by chipping around top of framing through floor and pulling out with a crane; no prints available.

10-4-79	Blueprints found for Cell #1 liners and discovered it would be impossible to pull liners.
10-19-79	Vacuumed out and cleaned source wells in preparation for Electro-Con^R.
10-20-79	Commenced Electro-Con^R of source wells. Discovered paint layer under corrosion layer.
10-21-79	Continued Electro-Con^R of source wells--doubtful efficiency due to paint layer.
10-22-79	Continued Electro-Con^R; finished all four source wells. New rad level readings as follows: #1 max, 5 mR/hr #4 max, 5 mR/hr #2 max, 2 mR/hr #3 max, .8 mR/hr
10-23-79	Soaked source well #4 with acid overnight to see if it would remove paint--poor results. Removed residue from bottom of source wells.
10-24-79	Soaked left rear source well #3 with acid to try to remove paint. Some success accomplished in Electro-Con^R of wells #1 and #4 again.
10-25-79	Built new electrode for Electro-Con^R of source wells.
10-26-79	Attempted to Electro-Con^R well #4.
10-27-79	After Electro-Con^R of source well #4, reading is now 1.8 mR/hr max.
10-29-79	Again Electro-Con^R of source well #4 shows small change in reading to 1.5 mR/hr max. After Electro-Con^R of source well #1, no change in reading, 5 mR/hr.
10-30-79	After Electro-Con^R of source well #2, readings reduced to 1 mR/hr. Cleaned out all source wells and took rad levels. They were as follows: #1, 4 mR/hr #4, 1.5 mR/hr #2, 1 mR/hr #3, .4 mR/hr
10-31-79	Attempted to sandblast bottom of source wells starting with #1; however, no success realized due to well filling with sand too fast.
11-5-79	Attempted unsuccessfully to sandblast source well #1 using vacuum cleaner to keep bottom clean.

11-6-79 Used chipping hammer to vibrate bottom of source wells to see if it would knock any activity loose--no success.

12-4-79 Put 1 gallon of muriatic acid in the bottom of each source well to try to remove hot spots on bottom of wells.

12-5-79 Rad levels on bottom of source wells after removing acid were as follows:

#1, 5 mR/hr
#4, 1.8 mR/hr
#3, .8 mR/hr
#2, .4 mR/hr

12-6-79 Took gross smears, using rags, of bottom and sides of source wells. They are as follows:

#1, side	- .1 mR	#4, side	- .2 mR
bottom	- .2 mR	bottom	- .2 mR
#3, side	- .2 mR	#2, side	- .2 mR
bottom	- .3 mR	bottom	- .2 mR

12-10-79 Removing sand from Cell #1 in preparation of removing top framing on source wells.

12-13-79 Started removal of top of source wells.

1-6-80 Source well tops removed.

1-7-80 All source wells reading <1000 DPM by smears.

1-8-80 Detailed survey of source wells.

1-11-80 Commenced chipping floor to reduce Cell #1 radiation dose levels.

ON-SITE STABILIZATION

As can be seen from the chronological history of decontamination attempts, there is still some fixed radioactive material remaining in the source well.

The location of this material is shown by Charts 1 through 4.

The proposed plan of stabilization is to cement the well up to the cut off end of the bottom tube; to weld a plate over the cut off end of the bottom tube; and to fill the remaining excavated area to floor level with concrete. This effectively encapsulates the radioactive material in the well. Also, this insures that the material is: (1) at a minimum depth of 2 feet and an average depth of greater than 5 feet; (2) could not be removed from its location without great effort by either man or nature.

DETERMINATION OF ACTIVITY

The fixed radioactive material was determined to be mainly located in the crevice located at the bottom of the tube and the remaining as a homogeneous flux layer on the walls of the tube. Co^{60} is the only isotope present as shown by Teledyne Isotope Analysis Report.

The dose rate of the radioactive material in the crevice was determined by the centerline reading at position 13 during the survey. Since the probe was in the center of a circular line source, it was assumed that the dose rate seen by the probe could be considered as a point source at the radius of the circle; thereby allowing the dose rate at one meter to be determined and the contribution to the dose rate at all levels of measurement determined.

The contributed dose rate from the bottom source was then subtracted from the readings obtained at various levels (see charts 5-8).

The activity of the source well was determined by finding the activity of a point source and a line source and summing the two.

The bottom dose rate (point 13) was substituted into the formula.

$(DR_1)(r_1^2) = (DR_2)(r_2^2)$ FORMULA 1

Where:

DR_1 = dose rate at point 13
r_1 = 6"
r_2 = 1 meter
DR_2 = dose rate at 1 meter

Then DR_2 was used to find the number of millicuries of Co^{60} in the crevice by substituting the value into the following formula:

$mR/hr = \frac{n\,\Gamma}{s^2}$ FORMULA 2

Where:

mR/hr = DR_2
n = number of millicuries
Γ = $R\text{-}cm^2/hr\text{-}mCi$*
s = distance in meters

*This value is found in Radiological Health Handbook, revised January 1970, page 131. The value is divided by 10 to give mCi at 1 meter required for answer.

Since s = 1 meter, the activity can be easily found by dividing.

$$\frac{DR_2}{1.32^*} = n \qquad \text{FORMULA 3}$$

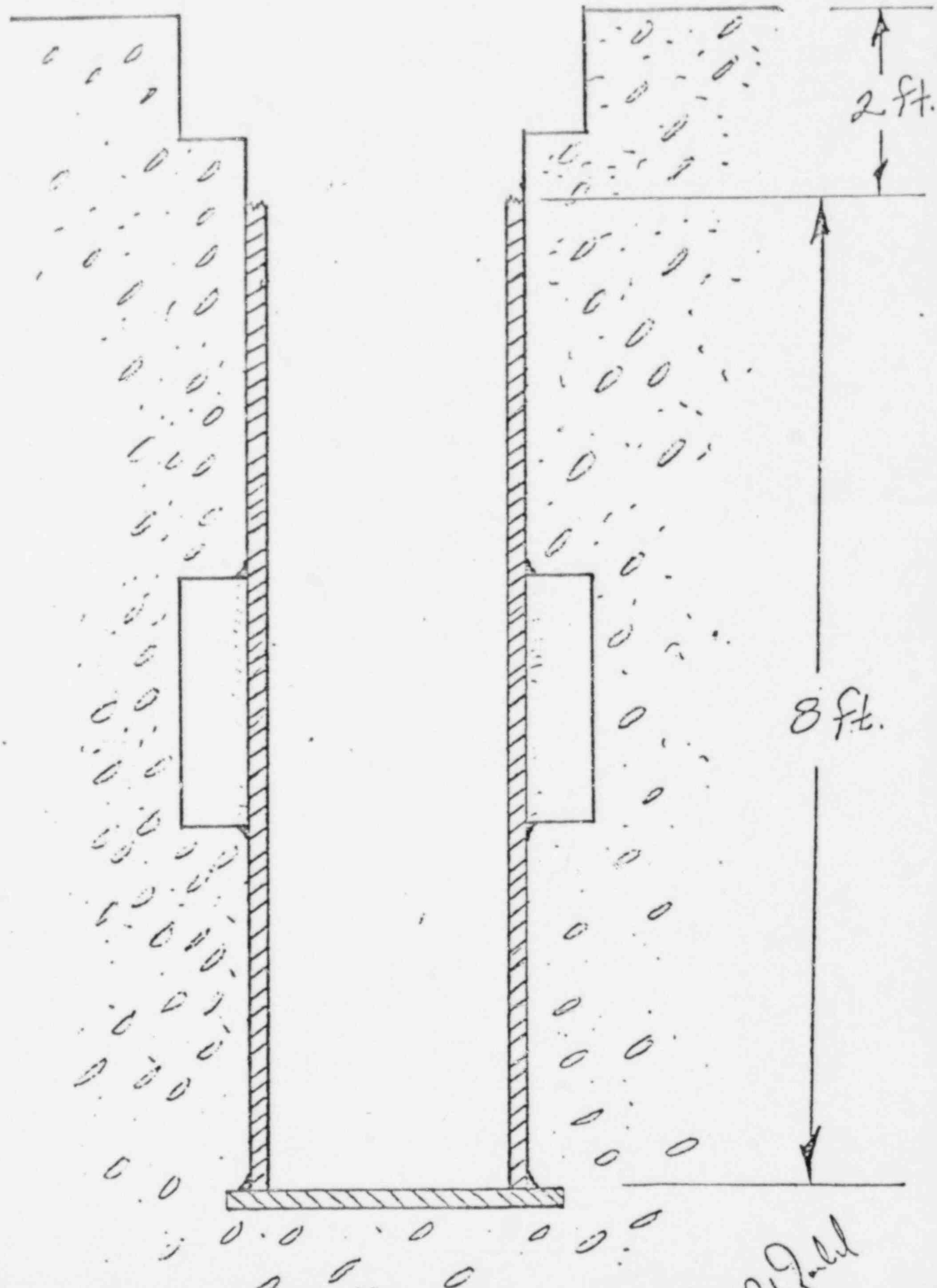
The activity of the rest of the tube can be calculated by assuming the corrected dose rate average for the rest of the tube to be a homogeneous line source. Then the dose rate can be calculated at 5 feet which is equal to L/2 by use of $DR_1r_1 = DR_2r_2$ (Formula 4). The material can then be assumed as a point source, and the dose rate, if it were a point source, could be calculated at one meter by use of Formula 1.

Once this value is obtained, it also can be substituted into Formula 4, and the activity of Co^{60} can be determined.

The total activity is shown in Chart 9.

*$\Gamma/10$ for Co^{60}

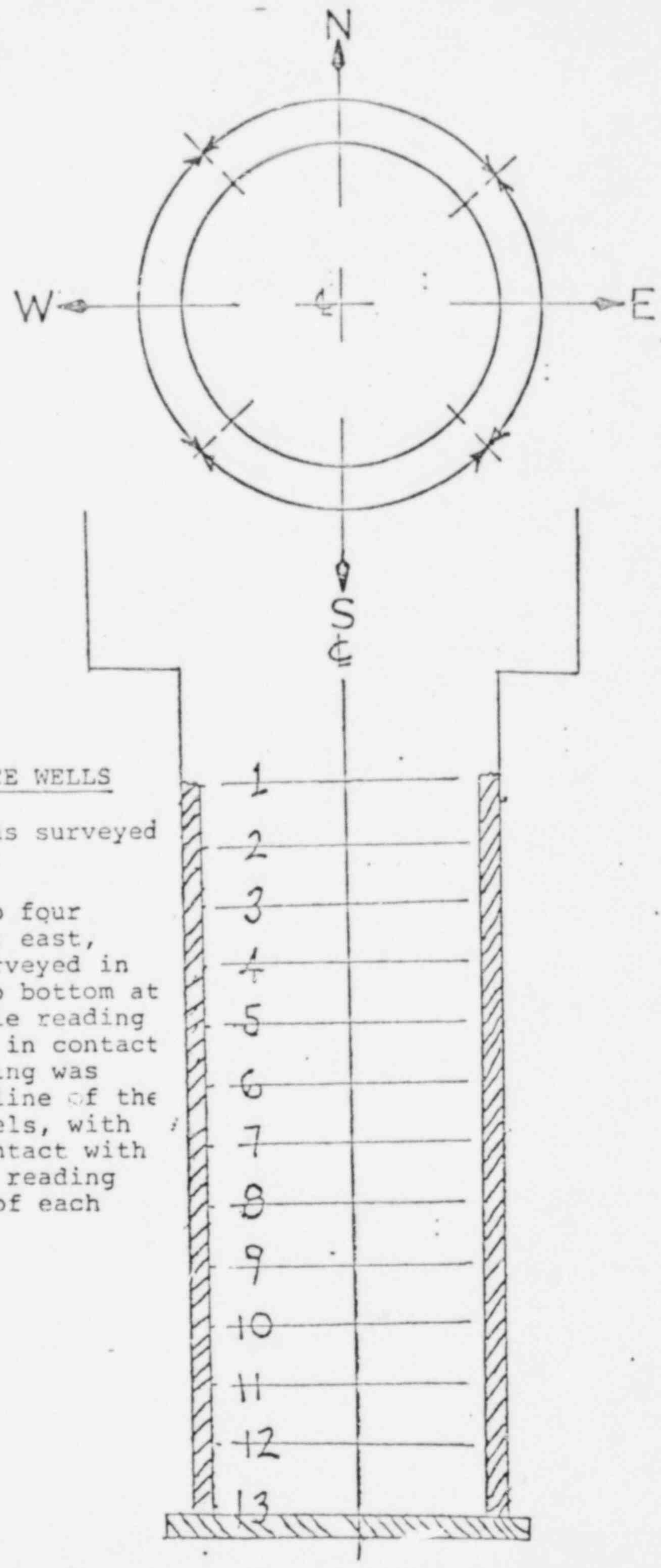
SOURCE WELLS
TOP PORTION REMOVED



SURVEY PLAN FOR THE SOURCE WELLS

Each source well was surveyed using the following plan:

The well was divided into four quadrants, labeled north, east, south and west. Then surveyed in each quadrant from top to bottom at 13 different levels; while reading quadrants, the probe was in contact with side walls. A reading was also taken at the centerline of the well at 13 different levels, with #13 being directly in contact with the bottom. The highest reading obtained for each level of each quadrant was recorded.



FIXED CONTAMINATION SURVEY
OF SOURCE WELL #1

METER: E120
SERIAL #: 5540
PROBE: H.P. 190
CALIBRATION DATE: April 15, 1980

DATE 1-4-80

SOURCE CHECK: .005 uc Co^{60} SAT.

(All Reading In mr/hr Beta & Gamma)

	NORTH	SOUTH	WEST	EAST	CENTER LINE
1.	.20	.38	.30	.25	.24
2.	1.2	.50	[illegible]	.25	.30
3.	.50	.20	.10	.25	.15
4.	.15	.18	.20	.10	.10
5.	.12	.20	.18	.10	.12
6.	.15	.15	.20	.12	.15
7.	.15	.15	.20	.12	.16
8.	.18	.14	.18	.12	.20
9.	.20	.12	.25	.15	.20
10.	.30	.20	.40	.20	.35
11.	.50	.25	.50	.50	.50
12.	.8	1.0	1.5	1.5	.8
13.	5.0 *(5.0)	8.0 (6.0)	4.5 (4.0)	6.0 (4.2)	2.5 (2.5)

*Readings in () are with a 1604.4 mg/cm^2 aluminum shield over B- window

SURVEYED BY: Gregory A. Garlock

FIXED CONTAMINATION SURVEY
OF SOURCE WELL #2

METER: F120
SERIAL #: 5540
PROBE: H.P. 190
CALIBRATION DATE: April 15, 1980

DATE 1-4-80

SOURCE CHECK: .005 uc Co^{60} SAT.

(All Readings in mr/hr Beta and Gamma)

	NORTH	SOUTH	WEST	EAST	CENTER LINE
1.	.35	.25	.20	.40	.30
2.	.25	.25	.20	.25	.15
3.	.20	.10	.15	.10	.15
4.	.12	.10	.10	.15	.10
5.	.12	.10	.12	.15	.10
6.	.10	.10	.10	.12	.10
7.	.10	.10	.10	.12	.10
8.	.10	.12	.10	.12	.10
9.	.15	.10	.10	.10	.10
10.	.12	.12	.10	.12	.10
11.	.20	.18	.10	.10	.12
12.	.35	.20	.15	.15	.25
13.	1.2 *(.8)	.45 (.40)	.50 (.45)	.35 (.35)	.50 (.30)

*Readings in () are with a 1604.4 mg/cm^2 aluminum shield in place over B- window

SURVEYED BY: Gregory A. Garlock

FIXED CONTAMINATION SURVEY
OF SOURCE WELL #3

METER: E120
SERIAL #: 5540
PROBE: H.P. 190
CALIBRATION DATE: April 15, 1980

DATE 1-8-80

SOURCE CHECK: .005 uc Co^{60} SAT.

(All Readings in mr/hr Beta & Gamma)

	NORTH	SOUTH	WEST	EAST	CENTER LINE
1.	.1	.12	.1	.1	.1
2.	.12	.18	.12	.12	.1
3.	.1	.15	.2	.2	.15
4.	.1	.15	.16	.15	.12
5.	.14	.14	.12	.1	.1
6.	.12	.12	.15	.1	.15
7.	.15	.15	.12	.2	.15
8.	.15	.15	.15	.2	.18
9.	.15	.20	.15	.15	.2
10.	.18	.20	.15	.20	.18
11.	.2	.25	.18	.25	.18
12.	.18	.20	.20	.20	.18
13.	.2 *(.18)	.25 (.15)	.25 (.24)	.20 (.18)	.18 (.15)

*Readings in () are with 1604.4 mg/cm^2 aluminum shield over B- window

SURVEYED BY: Gregory A. Garlock

FIXED CONTAMINATION SURVEY
OF SOURCE WELL #4

METER: E120
SERIAL #: 5540
PROBE H.P. 190
CAL ..RATION DATE: April 15, 1980

DATE 1-8-80

SOUR'.E CHECK: .005 uc Co^{60} SAT.

(All Readings in mr/hr Beta and Gamma)

	NORTH	SOUTH	WEST	EAST	CENTER LINE
1.	.25	.35	.35	.35	.2
2.	.1	.15	.18	.15	.1
3.	.1	.18	.1	.1	.1
4.	.1	.12	.12	.12	.1
5.	.2	.12	.1	.12	.1
6.	.1	.1	.2	.12	.1
7.	.1	.1	.15	.12	.1
8.	.1	.1	.2	.1	.1
9.	.1	.1	.15	.12	.1
10.	.1	.1	.1	.15	.14
11.	.2	.2	.1	.2	.2
12.	.3	.5	.3	.35	.4
13.	.8 *(.3)	2.0 (1.0)	1.0 (1.0)	.5 (.45)	.8 (.45)

*Readings in () are with a 1604.4 mg/cm^2 aluminum shield over B- win'ow

SURVEYED BY: Gregory A. Garlock

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DATA - SOURCE WELL #1

	mR/hr CENTERLINE	r_2 IN METERS	DR_2*	DR_f**
1.	0.24	2.44	0.01	0.23
2.	0.30	2.24	0.01	0.29
3.	0.15	2.04	0.01	0.14
4.	0.10	1.84	0.02	0.08
5.	0.12	1.63	0.02	0.10
6.	0.15	1.43	0.03	0.12
7.	0.16	1.23	0.04	0.12
8.	0.20	1.03	0.05	0.15
9.	0.20	0.83	0.08	0.12
10.	0.35	0.63	0.14	0.09
11.	0.50	0.43	0.30	0.20
12.	0.80	0.25	0.90	-0.10****
13.	2.5	----***	2.5	0.00

Average dose rate (DR_f) from center line = 0.14

Bottom source activity = 0.043 millicuries
Line source activity = 0.019 millicuries
Total activity = 62 uCi

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* Dose rate from bottom source (mR/hr)
** Center line dose rate-dose rate from bottom source (mR/hr)
*** r_1 = 0.15 meters
**** Average assumes all negative values equal to 0.00

DATA - SOURCE WELL #2

	mR/hr CENTERLINE	r_2 IN METERS	DR_2*	DR_f**
1.	0.30	2.44	0.00	0.30
2.	0.15	2.24	0.00	0.15
3.	0.15	2.04	0.00	0.15
4.	0.10	1.84	0.00	0.10
5.	0.10	1.63	0.00	0.10
6.	0.10	1.43	0.01	0.09
7.	0.10	1.23	0.01	0.09
8.	0.10	1.03	0.01	0.09
9.	0.10	0.83	0.02	0.08
10.	0.10	0.63	0.03	0.07
11.	0.12	0.43	0.16	-0.04
12.	0.25	0.25	0.18	0.07
13.	0.50	----***	0.50	0.00

Average dose rate (DR_f) from center line = 0.11

Bottom source activity = 0.009 millicuries
Line source activity = 0.015 millicuries
Total activity = 24 uCi

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* Dose rate from bottom source (mR/hr)
** Center line dose rate-dose rate from bottom source (mR/hr)
*** r_1 = 0.15 meters
**** Average assumes all negative values equal to 0.00

DATA - SOURCE WELL #3

	mR/hr CENTER LINE	r_2 IN METERS	DR_2*	DR_f**
1.	0.10	2.44	0.00	0.10
2.	0.10	2.24	0.00	0.10
3.	0.15	2.04	0.00	0.15
4.	0.12	1.84	0.00	0.12
5.	0.10	1.63	0.00	0.10
6.	0.15	1.43	0.00	0.15
7.	0.15	1.23	0.00	0.15
8.	0.18	1.03	0.00	0.18
9.	0.20	0.83	0.01	0.19
10.	0.18	0.63	0.01	0.17
11.	0.18	0.43	0.02	0.16
12.	0.18	0.25	0.06	0.12
13.	0.18	----***	0.18	0.00

Average dose rate (DR_f) from center line = 0.14

Bottom source activity = 0.003 millicuries
Line source activity = 0.020 millicuries
Total activity = 23 uCi

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* Dose rate from bottom source (mR/hr)
** Center line dose rate-dose rate from bottom source (mR/hr)
*** r_1 = 0.15 meters

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DATA - SOURCE WELL #4

	mR/hr CENTER LINE	r2 IN METERS	DR2*	DRf**
1.	0.20	2.44	0.00	0.20
2.	0.10	2.24	0.00	0.10
3.	0.10	2.04	0.00	0.10
4.	0.10	1.84	0.01	0.09
5.	0.10	1.63	0.01	0.09
6.	0.10	1.43	0.01	0.09
7.	0.10	1.23	0.01	0.09
8.	0.10	1.03	0.02	0.08
9.	0.10	0.83	0.03	0.07
10.	0.14	0.63	0.05	0.09
11.	0.20	0.43	0.10	0.10
12.	0.40	0.25	0.29	0.11
13.	0.80	----***	0.80	0.00

Average dose rate (DRf) from center line = 0.10

Bottom source activity = 0.014 millicuries
Line source activity = 0.014 millicuries
Total activity = 28 uCi

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* Dose rate from bottom source (mR/hr)
** Center line dose rate-dose rate from bottom source (mR/hr)
*** r_1 = 0.15 meters

TOTAL MILLICURIES Co^{60} IN SOURCE WELLS

Well #1		62 μCi
Well #2		24 μCi
Well #3		23 μCi
Well #4		28 μCi
	TOTAL in wells	137 μCi

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