DEPARTMENT OF THE ARMY
WALTER REED ARMY MEDICAL CENTER
WALTER REED HEALTH CARE SYSTEM
WASHINGTON, DC 20307-5001

REPLY TO
ATTENTION OF

MCHL-HP (385-11p) 20 October 1999

MEMORANDUM FOR Commander, Walter Reed Army Medical Center, ATTN: Environmental Division, Washington, DC 20307

SUBJECT: Final Survey of the Underground Storage Tanks, Building 516, Forest Glen Annex

1. REFERENCES. See Appendix A for a list of references.

2. PURPOSE:

a. Three 5000 gallon underground liquid waste tanks were used as holdup tanks for the Diamond Ordanance Research Facility (DORF), building 516, Forest Glen Annex to sample the liquid effluent prior to discharging the water to the sanitary sewer. The DORF reactor was decommissioned in 1980 and building 516 was used by the WRAMC Health Physics Office as a low level radioactive waste storage facility. The two furthest tanks from building 516 were closed off in 1980 and the closest tank was opened as a flow through sewer tank for building 516. In 1998, the WRAMC Environmental Office reviewed all USTs on the installation for removal or replacement and identified all three USTs for building 516 to be removed.

b. The Army Reactor Office (ARO) has issued a permit to the Army Research Laboratory (ARL) to ensure the activated building materials in the exposure room are properly decontaminated in the event building 516 is ever released for unrestricted use. As a condition of the permit, any plans to modify the facility require the notification and approval of both ARO and ARL (reference 1.a.). Both ARO and ARL were notified of the intentions of the WRAMC Environmental Office to remove the waste tanks.

c. This final survey of the three USTs was conducted to ensure that the tanks did not have any radiological contamination above Army and federal release levels for unrestricted use.

d. In addition to the use of the USTs during the operation of DORF in the 1970's, a small amount of liquid radioactive waste was released from a radioactive disposal sink in building 516 from 1981 until 2 March 1998. The radionuclides released from building 516 by the Health Physics Office mostly comprised hydrogen-3, carbon-14, phosphorous-32, sulfer-35, chromium-51 and iodine-125.

3. GENERAL:

a. Planning Phase. This survey is designed and developed using the Data Quality Objectives (DQO) Process.

(1) Problem. This survey will determine the presence and extent of any radiological health hazards in and surrounding the three underground storage tanks prior to releasing the tanks for unrestricted use.

(a) The WRAMC Health Physics Office with the assistance of the Army Research Laboratory and Army Reactor Office is responsible for the final survey of these tanks. WRAMC Health Physics Office staff along with Mr. Mike Borisky from the Army Research Laboratory will plan, conduct and analyze the survey results. The approval authority for this final survey plan is the WRAMC RPO, COL William B. Johnson.

(b) The resources used in this final survey will include portable survey meters and laboratory facilities located at the WRAMC Health Physics Office, building 41, WRAMC.

(2) Decision Statement. To determine if all the survey units satisfy the Army and NRC release criteria for unrestricted use.

(3) Inputs to the Decision. A historical site assessment indicated that radionuclides were released to the sanitary sewer from building 516. Based on the radionuclides released to the sewer, time the tanks were shut off until the survey was performed, the primary radionuclides of interest were H-3, C-14 based on the long half-lives of these radioisotopes and any long-lived fission or activation products (such as Co-60 and Cs-137) which may remain from the operation of the DORF reactor. Representative background measurements were obtained to compare to the measured readings.

(4) Boundaries of the Study. The boundaries of the study are the three USTs and the soil surrounding the tanks. See a copy of the site plan in Appendix C.

(5) Decision Rule. If the mean concentration in the survey unit is less than the investigation level, then the survey

unit will be in compliance with the release criteria. If the difference between the mean concentration in the survey unit and the mean concentration in the reference area is less than the investigation level, then the survey unit is in compliance with the release criteria. If the average level of residual radioactivity within the survey unit exceeds the regulatory limit, or if small areas within the survey unit with elevated residual activity exceed the regulatory limit then the survey unit will require further remediation before unrestricted release.

(6) Decision Errors. The lower bound for the sample distribution is background determined from soil samples near the USTs and the upper bound on the sample distribution is two times the $DCGL_W$.

(7) Survey Design. The design goal will be to minimize the number of false negative measurements, or to release a survey unit containing residual radioactivity above three times the DCGL (Type I error). The design goal will also attempt to minimize the number of false positive measurements (Type II error) which will add cost and time to the final survey effort. The null hypothesis for this survey is that the survey unit exceeds the release criteria. The design goal for the relative shift (Δ/σ) value will be to achieve a relative shift of two for a Class 2 survey unit. The values for a Type I decision error (α) and a Type II decision error (β) are equal to 0.05.

b. Implementation Phase. The data collected will be reviewed daily to ensure that the daily quality objectives are met and that the data is consistent over the course of the survey. Both random and systematic sampling designs will be incorporated into this survey based on survey unit classification. The schedule for surveying this location is approximately one week beginning 27 September 1999. The final survey effort for this location will not consider using passive controls for releasing a survey unit.

c. Assessment Phase. The assessment phase includes verification and validation of the survey data and an assessment of the quality of the data to ensure the data meet the objectives of the survey.

(1) Data Verification. The performance of tasks by personnel will be conducted according to the SOP, and will be

assessed using inspections, and surveillance. The performance of the equipment will be monitored daily using control charts.

(2) Data Validation. Data qualifier codes used in this survey report are:

(a) < MDC. The concentration of the radionuclide of interest was below the minimum detectable concentration (MDC) which is defined in this survey as 3 + 4.65 times the square root of the mean background counts.

(b) J. The associated value was modified, adjusted or an estimated quantity. This qualifier may be used to identify results based on surrogate measurements or gross activity measurements. The implication is that the estimate may be imprecise or inaccurate, and may be inappropriate for statistical evaluations. The potential uncertainty associated with this qualifier will be included with the results.

(c) R. The associated value was determined to be an outlier and is excluded in statistical evaluations.

(d) F. In a Class 2 survey unit, the value exceeds the predetermined investigation level and is flagged for further study as shown in the following table:

Survey Unit Classification	Flag Direct Measurement or Sample Result	Flag Scanning Measurement
Class 2	> $DCGL_W$	> $DCGL_W$ or > MDC

(3) Preliminary Data Review.

(a) The survey data from the field and laboratory measurements will be converted to DCGL units. Basic statistical quantities that will be calculated for each data set are the mean, standard deviation, and median values. A quantile plot and background measurements will be prepared for each class 2 survey unit, and any unit that fails the sign test for direct or sample results.

(b) The one sample statistical test (Sign test) will be used since the contaminants, tritium and carbon-14 are either not present in the background or could be considered insignificant and radionuclide specific measurements will be made. If any measurement in the survey unit exceeds the $DCGL_W$, the Sign test will be used to determine if the survey unit meets release criteria. Since all survey units are designated as Class 2 or Class 3 areas, no area of elevated activity is expected.

(c) The final status survey parameters for the survey units are shown in the following table:

Survey Unit	Type	DQO		Relative Shift	$DCGL_W$				Test
		α	β	Δ/σ	H-3	C-14	Co-60	Cs-137	
Prior Rad use removable	Class 2	0.05	0.05	2	1000 dpm per 100 cm^2	1000 dpm per 100 cm^2	1000 dpm per 100 cm^2	1000 dpm per 100 cm^2	Sign
Prior Rad use meter	Class 2	0.05	0.05	2	5000 dpm per 100 cm^2	5000 dpm per 100 cm^2	5000 dpm per 100 cm^2	5000 dpm per 100 cm^2	Sign

(d) The sample size based on the DQO and relative shift in the above table is 15 measurements per tank using Table A.2a, Sample Sizes for the Sign Test, NUREG-1505. The critical value to pass the sign test is 11 positive measurements per tank based on Table A.3, NUREG-1505. For these survey units, the survey locations are based on a rectangular grid with 5 feet spacing between measurements on the bottom and sides of the tank.

(e) A symmetrical rectangular grid pattern beginning from a randomly selected starting point will be superimposed on the rectangular reference grid on the inside of the tank.

Area Classification	Structures	
	Surface Scans	Surface Activity Measurements
Class 2	10 to 100% (10 to 50% of upper walls and ceilings) Systematic and Judgmental	Number of data points from statistical tests

(f) The level of scanning effort will be proportional to the potential for finding areas of elevated activity in the survey unit. A larger portion of the survey unit will be scanned if units have residual activity close to the release criterion. Areas that have the highest potential for contamination such as inlets, and drains will be performed in all tanks. Scanning techniques are not tied to the distance or area between measurement locations, but are rather dependent on the professional judgment of the surveyor.

(g) The soil surrounding the underground tanks is considered non-impacted based on the soil samples collected and analyzed by the Oak Ridge Institute for Science and Education (ORISE) and the visible condition and integrity of the three tanks. If after removal of the tanks and closer inspection it is determined that the tank integrity could have been compromised, then the area surrounding the tanks will have to be reclassified and a new survey plan for soil sampling will have to be developed.

d. A list of definitions and abbreviations is included in Appendix B.

e. Site diagrams, and survey measurements are provided in Appendix C.

f. A list of survey instruments and laboratory counters, calibration records, the minimum detectable activity for each instrument and the quality control charts used for this survey are provided in Appendix D.

4. HISTORICAL REVIEW.

a. A review of the historical records was conducted by CPT Morton. The tanks were used as hold-up tanks from the DORF reactor until it was decommissioned in 1980. A radioactive disposal sink was used for low level radioactive waste from the WRAMC Health Physics Office until 2 March 1998.

b. Based on the radionuclides released to the sewer, time the tanks were shut off until the survey was performed, the primary radionuclides of interest were H-3, C-14 and any fission or activation products (such as Co-60 and Cs-137) which may remain from the operation of the DORF reactor.

c. The ORISE alpha and gamma spectroscopy analysis of the sludge and water samples inside and surrounding the three tanks found that the samples did not exceed background levels for reactor fission or activation products.

d. After the results of the ORISE analysis came back clean, the tanks were filled with soapy water, the water circulated inside the tanks and then drained to the sewer prior to removal of the tanks from the ground.

5. RADIATION SURVEY INSTRUMENTATION.

a. Based on the results of the historical review, it was determined that these tanks would be surveyed for potential beta and gamma emitting radionuclides. The ORISE analysis found no alpha contamination above background levels inside the tanks or in the surrounding soil.

b. All portable survey instruments were checked for proper operation prior to use each day. Operational checks for field instrumentation as outlined in NUREG/CR-5849 were used as the standard for this final survey process. A series of 10 repetitive measurements of background and the check sources in 1 minute scaler mode are performed, the mean and standard deviation is determined, and an acceptable response range is +/- 2σ.

c. Portable meters and laboratory counters were function checked and tested against NIST traceable check sources each day prior to use. The following table lists the check source used during this final survey:

Manufacturer	Isotope	Activity	Date	Serial Number
IPL	Am-241	3.13E5 dpm	29 Sep 99	E-563

d. Blank smear samples were run through both the automated swipe counters. Check sources were run through the automated swipe counters, using Cs-137 check sources for the auto-gamma and H-3 and C-14 daily calibration standards and quench standards for the liquid scintillation counter (LSC).

6. RADIATION SURVEY TECHNIQUES.

a. The survey grid system used inside the tanks was 15 locations in each tank separated by 5 feet lengthwise and up 3 feet from the bottom of the tank. The 5 measurements were made along the right side, then the bottom of the tank (measurements 6-10), and left side (measurements 11-15) starting from the inlet end and proceeding to the exhaust end of the tanks.

b. Measurements for fixed and removable contamination were made on the exterior surface of tanks on the ends, near inlet and outlet pipes, and on the tank cradles.

c. Background measurements were taken outside, away from any buildings, at about 2.5 feet off the ground.

d. Meter measurements included 2-minute counts using a scaler mode at all locations inside the tanks. Swipe measurements for removable contamination were taken at all locations inside the tanks covering approximately 100 cm^2.

e. Judgmental samples were taken over at least 50% of the surface area of the tanks at about 1-cm from the surface.

f. If an elevated meter reading was found that was at least 2 times background, the area was immediately decontaminated and resurveyed.

g. The results of the meter surveys, background measurements and check source measurements were recorded on the survey forms, signed and dated by the surveyor.

h. The LSC samples were counted for 2 minutes each. All results were recorded in 3 channels based on contiguous energy regions; H-3 region 0-15 keV, C-14 region 15-150 keV, and a higher energy beta region > 150 keV. The LSC automatically calculates the dpm for H-3 and C-14 based on the daily calibration sources run through each of the LSCs. Each line item in the LSC printout includes the survey location, the dpm for H-3 channel, the dpm for the C-14 channel, and the cpm for the highest energy channel and a color quench indicator. The dpm calculations for C-14 and H-3 are automatically color quenched corrected. The dpm calculation for all other beta emitters will then be determined based on the efficiency of the particular radionuclide as determined by the beta curve.

i. The auto-gamma samples were counted for 2 minutes each in the Cobra autogamma. If a sample indicates gamma contamination, the isotope will be determined using the Packard gamma spectroscopy software and the sample rerun through the isotope specific protocol to determine the activity of the sample.

j. As a minimum, the mean, standard deviation, median, minimum, and maximum measurement for each room excluding the background and check source measurements are shown in Appendix C.

7. SURVEY RESULTS.

a. The condition of the three tanks was excellent before and after removal from the ground. All tank surfaces and pipes appeared to be intact and in excellent condition. The soil surrounding the tanks should remain classified as non-impacted.

b. Beta-Gamma Meter Results. A fixed meter reading was obtained using a Ludlum Data Logger with a G-M probe in the digital scaler mode set at 2-minutes per sample. Meter readings were made in each grid square at a distance of about 1-cm from the surface. All results by survey location are included in Appendix C. All of the field survey results were below the release criteria.

c. LSC Results. Wipe samples were collected for each grid location by swiping approximately 100-cm^2. Blank samples were used to screen for cross contamination, and tritium, and carbon-14 spikes were used as quality control measures. All results by survey location are included in Appendix C. The quality control documentation is included in Appendix D. All of the laboratory results were below the release criteria.

d. Auto-Gamma Results. Wipe samples were collected for each grid location by swiping approximately 100-cm^2. Blank samples were used to screen for cross contamination and cesium-137 was used for quality control measures. All results by survey location are included in Appendix C. The quality control documentation is included in Appendix D. All of the laboratory results were below the release criteria.

8. CONCLUSION. A review of all the survey results indicate that there are no radiological health hazards remaining in the three underground storage tanks or in the surrounding soil that would preclude the removal of the underground storage tanks from government control.

9. RECOMMENDATION. Recommend that the underground storage tanks be released to the contractor, Waste-Tron of Maryland, Inc. to remove the tanks from the WRAMC installation.

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APPENDIX A
REFERENCES

1. AR 11-9, 29 June 1999, The Army Radiation Safety Program.

2. NUREG-1500, Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment, August 1994.

3. NUREG-1501, Background as a Residual Radioactivity Criterion for Decommissioning, Draft Report for Comment, August 1994.

4. NUREG-1505, A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys.

5. NUREG-1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, December 1997.

6. NUREG-1575, Multiagency Radiation Survey and Site Investigation Manual (MARSSIM), December 1997.

7. NUREG/CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination, Draft Report for Comment, June 1992.

8. Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

9. U.S. Army Research Laboratory, AMSRL-CS-AL-RK, 22 October 1997, subject: Building 516 Notification Requirements.

10. Comprehensive Work Plan, Contract No. DACW31-95-D-0069, Walter Reed Army Medical Center Annex, Forest Glen, Maryland, UST Removals, Building 516, Prepared for: U.S. Army Corps of Engineers, Baltimore District, Prepared by: Waste-Tron of Maryland, Inc., 3922 M. Vero Road, Baltimore, Maryland 21227.

11. Proposal from Oak Ridge Institute for Science and Education for Walter Reed Army Medical Center, Environmental Division, Radiological Environmental Sample Collection and Analysis, 16 December 1998.

12. Unclassified report, from Oak Ridge Institute for Science and Education to the Chief, Environmental Division, Walter Reed Army Medical Center, 6 April 1999, subject: Report of Data for

Analysis of Samples Collected from Walter Reed Army Medical Center Annex, February 24-25, 1999, Forest Glen, Maryland (MIPR9DRAU0942).

13. Unclassified report, from Oak Ridge Institute for Science and Education to the Chief, Environmental Division, Walter Reed Army Medical Center, 23 April 1999, subject: Revision I - Report of Data for Analysis of Samples Collected from Walter Reed Army Medical Center Annex, February 24-25, 1999, Forest Glen, Maryland (MIPR9DRAU0942).

14. Memorandum, Walter Reed Army Medical Center, MCHL-HP, 30 September 1999, subject: Release of Storage Tanks from Building 513 Area.

APPENDIX B
ABBREVIATIONS AND DEFINITIONS

SECTION I

ALARA
as low as reasonably achievable

ALI
annual limit of intake

AR
Army Regulation

Bkd
background

Cal
calibration

CEDE
committed effective dose equivalent

CFR
Code of Federal Regulations

CG
Commanding General

cm
centimeter

cm^2
square centimeter

CPM
counts per minute

DA
Department of the Army

$DCGL_{EMC}$
Derived Concentration Guideline Level - Elevated Measurement Comparison

$DCGL_W$
Derived Concentration Guideline Level - Wide Area

dpm
disintegrations per minute

eff
efficiency

eV
electron volt

FY
fiscal year

Gy
gray

h
hour

IAW
in accordance with

m
meter

μCi
microcurie

μm
micrometer

μR/hr
microroentgen per hour

mCi
millicurie

mg
milligram

mm
millimeter

mrad
millirad

mSv
millisievert

MDA
minimum detectable activity

NIST
National Institute of Standards and Technology

NRC
U.S. Nuclear Regulatory Commission

NUREG
Nuclear Regulatory Guide

QA
quality assurance

RAM
radioactive material

RCC
radiation control committee

RPO
radiation protection officer

sn
serial number

SOP
standing operating procedure

Sv
sievert

TEDE
total effective dose equivalent

USACHPPM
U.S. Army Center for Health Promotion and Preventive Medicine

Section II Terms

ALARA
Acronym for "as low as is reasonably achievable" means making every reasonable effort to maintain exposures to radiation as far below applicable dose limits as is practical consistent with the purpose for which the activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations and in relation to utilization of nuclear energy and licensed materials in the public interest.

Alpha (α)
The specified maximum probability of a Type I error. In other words, the maximum probability of rejecting the null hypothesis when it is true. Alpha is also referred to as the size of the test. Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis.

Alpha particle
A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus that has a mass number of 4 and an electrostatic charge of +2.

Annual limit of intake (ALI)
The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year that would result in a committed effective dose equivalent of 5rems (0.05Sv) or a committed dose equivalent of 50rems (0.5Sv) to any organ or tissue.

Army regulation
A directive that sets forth missions, responsibilities, and policies, and establishes procedures to ensure uniform compliance with those policies.

Background Radiation
Radiation from cosmic sources, naturally occurring radioactive material, radon, and global fallout as it exists in the environment from the testing of nuclear explosive devices or from nuclear accidents. Background radiation does not include radiation from source, byproduct, or special nuclear materials regulated by the Federal or State agency.

Becquerel (Bq)
The SI unit of radioactivity equivalent to one nuclear transformation per second.

Beta (β)
The probability of a Type II error, the probability of accepting the null hypothesis when it is false. The complement of beta ($1-\beta$) is referred to as the power of the test.

Beta particle
An electron emitted from the nucleus during radioactive transformation.

Byproduct material
Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

Chain of Custody
An unbroken trail of accountability that ensures the physical security of samples, data and records.

Class 1 Area
A type of final status survey that applies to areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support reclassification as Class 2 or Class 3.

Class 2 Area
A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Class 3 Area
A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Committed dose equivalent
The dose equivalent to organs or tissue of reference that will be received from an intake of radioactive material by an individual during the 50 year period following the intake.

Committed effective dose equivalent
The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

Commodity, radioactive
See Radioactive commodity

Curie
A unit of radioactivity equal to 37 billion becquerels.

Data Quality Assessment (DQA)
The scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended use.

Data Quality Objectives (DQO)
Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision error that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

$DCGL_W$
Derived Concentration Guideline Level. Derived assuming the residual activity is uniformly distributed over a wide area, i.e., the entire survey unit.

$DCGL_{EMC}$
Derived Concentration Guideline Level - Elevated Measurement Comparison. Derived assuming the residual activity is concentrated in a small percentage of a survey unit. The $DCGL_{EMC}$ can never be less than the $DCGL_W$, but may be significantly greater.

Decommission
To remove (as a facility) safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the Nuclear Regulatory

Commission license, Army reactor permit, or Army radiation authorization.

Decontamination
The removal of radiological contaminants from, or their neutralization on a person, object or area to within levels established by governing regulatory agencies.

Deep-dose equivalent
Applies to external whole-body exposure and is the dose equivalent at a tissue depth of 1 centimeter (1000 mg/cm2).

Delta (D)
The width of the gray region.

Dose equivalent
The product of absorbed dose in tissue, quality factor and all other necessary modifying factors at the location of interest in tissue. The units of dose equivalent are the rem and sievert (Sv).

Effective dose equivalent
The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated.

Electron volt (eV)
A unit of energy equal to 1.6×10^{-19} joule.

Eye dose equivalent
Applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Final Status Survey
Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities (if any) in preparation for release.

Giga- (G)
An SI unit prefix indicating a factor of one billion (10^9).

Gamma radiation
Penetrating high-energy, short wavelength electromagnetic radiation emitted during radioactive transformation. Gamma rays are very penetrating and require dense materials for shielding.

Gray (Gy)
The SI unit of absorbed dose. One gray is equal to an absorbed dose 1 joule/kilogram (100 rads).

Gray region
A range of values of the parameter of interest for a survey unit where the consequences of making a decision error are relatively minor. The upper bound of the gray region in MARSSIM is set equal to the $DCGL_W$, and the lower bound of the gray region is a site-specific variable.

Impacted area
Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.

Indistinguishable from background
The detectable concentration distribution of a radionuclide is not statistically different from the background concentration distribution of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

Installation
A grouping of facilities located in the same vicinity, which support particular functions. Installations may be elements of a base. Land and improvements permanently affixed thereto which are under the control of the Department of the Army and used by Army organizations. Where installations are located contiguously, the combined property is designated as one installation and the separate functions are designated as activities of that installation. In addition to those used primarily by troops, the term "installation" applies to real properties such as depots, arsenals, ammunition plants (both contractor and Government operated), hospitals, terminals, and other special mission installations.

Investigation level
A derived media-specific, radionuclide specific concentration or activity level of radioactivity that: 1) is based on the release criterion; 2) triggers a response, such as further investigation or cleanup, if exceeded.

Ionizing radiation
Charged subatomic particles and ionized atoms with kinetic energies greater than 12.4 eV, electromagnetic radiation with

photon energies greater than 12.4 eV, and all free neutrons and other uncharged subatomic particles (except neutrinos and antineutrinos because they produce negligible ionization).

Kilo- (k)
An SI unit prefix indicating a factor of 1000.

Lower limit of detection (L_D)
The smallest amount of radiation or radioactivity that statistically yields a net result above the background. The critical detection level, L_C, is the lower bound of the 95% detection interval defined for L_D and is the level at which there is a 5% chance of calling a background value "greater than background." This value should be used when actually counting samples or making direct radiation measurements. Any response above this level should be considered as above background. This will ensure 95% detection capability for L_D. A 95% confidence interval should be calculated for all responses greater than L_C.

Micro- (m)
An SI unit prefix indicating a factor of one one-millionth (10^{-6}).

Milli- (m)
An SI unit prefix indicating a factor of one one-thousandth (0.001).

Minimum Detectable Concentration (MDC)
The minimum detectable concentration is the a priori activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument, this value should be used. The MDC is the detection limit, L_D, multiplied by an appropriate conversion factor to give units of activity.

Non-impacted area
Areas where there is no reasonable possibility (extremely low probability) of residual contamination. Non-impacted areas are typically located off-site and may be used as background reference areas.

Nonparametric test
A test based on relatively few assumptions about the exact form of the underlying probability distributions of the measurements. As a consequence, nonparametric tests are generally valid for a

fairly broad class of distributions. The Wilcoxon Rank Sum test and the Sign test are examples of nonparametric tests.

Outlier
Measurements that are unusually large or small relative to the rest and therefore are suspect of misrepresenting the population from which they were collected.

Qualified expert
A person who by virtue of training and experience can provide competent authoritative guidance about certain aspects of radiation protection. Being a qualified expert in one aspect of radiation protection does not necessarily imply that a person is a qualified expert in another aspect. Forward requests for determination of whether a certain individual is a qualified expert through command channels to the MACOM RPSO as necessary. Forward these requests to HQDA (DACS-SF), Washington, DC 20310-0200, for further evaluation as necessary.

Quality factor
The modifying factor [listed in tables 1004(b).1 and 1004(b).2 of 10 CFR20.1004] that is used to derive dose equivalent from absorbed dose.

Rad
A unit of absorbed dose. One rad is equal to an absorbed dose of 0.01 joule/kilogram (0.01 gray).

Radiation
For the purposes of this regulation, unless otherwise specified, radiation includes both ionizing and non-ionizing radiation.

Radiation area
An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005rem (0.05mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Radiation protection
For the purposes of this regulation, a scientific discipline whose objective is the protection of people and the environment from unnecessary exposure to radiation. Radiation protection is concerned with understanding, evaluating, and controlling the risks from radiation exposure relative to the benefits derived. Also called "health physics" and "radiation safety."

Radiation Control Committee
An advisory committee for the commander to assess the adequacy of the command's radiation protection program.

Radiation Protection Officer
The person that the commander designates, in writing, as the executive agent for the command's radiation protection program. Also called "radiation safety officer" or "health physics officer."

Radiation protection program
A program to implement the objective of radiation protection.

a. The Army's radiation protection program includes all aspects of measurement and evaluation of radiation and radioactive material as they pertain to protection of personnel and the environment, and of the Army's radiation dosimetry, radiation bioassay, radioactive waste disposal, radiation protection training, and radiation instrument TMDE and calibration programs.

b. A command's radiation protection program includes all aspects of measurement and evaluation of radiation and radioactive material within the command as they pertain to protection of personnel and the environment.

Radioactive commodity
An item of Government property made up in whole or in part of radioactive material. A national stock number (NSN) or part number is assigned to commodities containing radioactive material greater than 0.01 microcurie.

Radioactive waste
Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act, as amended, or is of sufficient quantity to require an Army radiation authorization, and is of negligible economic value considering the cost of recovery.

Radioactive waste, low-level
Material the NRC classifies as low-level radioactive waste (see 10 CFR 62.2); waste not classified as high-level radioactive waste (spent nuclear fuel), as transuranic waste, or as uranium or thorium tailings and waste; material acceptable for burial in a land disposal facility (10CFR 61).

Relative shift (Δ/σ)
The standard deviation of the measurements, is the relative shift expressed in multiples of the standard deviations.

Rem
A unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sievert).

Shallow dose equivalent
Applies to the external exposure of the skin or an extremity and is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area 1 square centimeter.

Sievert (Sv)
The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

Sign test
A nonparametric statistical test used to demonstrate compliance with the release criterion when the radionuclide of interest is not present in background and the distribution of data is not symmetric.

Standing Operating Procedure (SOP)
A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is officially approved as the method for performing certain routine or repetitive tasks.

Survey
A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.

Total effective dose equivalent
The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted release
Release of a site from regulatory control without requirements for future radiological restrictions.

Weighting factor
For an organ or tissue, the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly.

Wilcoxon Sum Rank test
A nonparametric statistical test used to demonstrate compliance with the release criterion when the radionuclide of interest is present in background and the distribution of data is not symmetric.

APPENDIX C

BUILDING DIAGRAMS, SURVEY MEASUREMENTS, RESURVEY MEASUREMENTS

Historical Review of Affected Areas					
Area	Auth.	Final	Isotopes	mCi	Comments
Tank 1	DORF	1980	Co-60	unk	Fission or activation products
	DORF	1980	Cs-137	unk	Fission or activation products
There should be no short lived radionuclides from the reactor operation as this tank was closed off in 1980. Alpha contamination was not found on the ORISE survey. In July 98 an exposure rate survey was performed using a Bicron Micro-Analyst in the tank and manhole and all measurements were at background levels.					

Historical Review of Affected Areas					
Area	Auth.	Final	Isotopes	mCi	Comments
Tank 2	DORF	1980	Co-60	unk	Fission or activation products
	DORF	1980	Cs-137	unk	Fission or activation products
There should be no short lived radionuclides from the reactor operation as this tank was closed off in 1980. Alpha contamination was not found on the ORISE survey. In July 98 an exposure rate survey was performed using a Bicron Micro-Analyst in the tank and manhole and all measurements were at background levels.					

Historical Review of Affected Areas					
Area	Auth.	Final	Isotopes	mCi	Comments
Tank 3	DORF	1980	Co-60	unk	Fission or activation products
	DORF	1980	Cs-137	unk	Fission or activation products
	221	3/98	H-3	unk	Liquid waste disposal
	221	3/98	C-14	unk	Liquid waste disposal
There should be no short lived radionuclides from the reactor operation as this tank was closed off in 1980. There should be no short lived radionuclides from Health Physics Operations as the tank was shut off 3/98. Alpha contamination was not found on the ORISE survey. In July 98 an exposure rate survey was performed using a Bicron Micro-Analyst in the tank and manhole and all measurements were at background levels.					

Area	Survey Unit	Sign Test				Notes
		Lab NaI	Lab LSC	GM	GM	
Tank 1	Class II	Pass	Pass	Pass	Pass	Tank condition excellent
Tank 2	Class II	Pass	Pass	Pass	Pass	Tank condition excellent
Tank 3	Class II	Pass	Pass	Pass	Pass	Tank condition excellent

APPENDIX D

SURVEY METERS, LABORATORY COUNTERS, QUALITY CONTROL DATA

1. The portable meters used in this survey include:

Manufacturer	Model	Serial Number	Probe	Serial Number	Calibrated	Calibration Due
Eberline	ESP-1	579	HP-210AL	707039	3 Dec 98	3 Dec 99
Ludlum	L-3	11982	HP-210		13 Apr 99	13 Apr 00
Ludlum	L-3	18189	44-9	18189-1	30 Jun 99	24 Jun 00
Ludlum	L-3	11937	44-9	11937-1	6 Oct 98	1 Oct 99
Ludlum	L-3	11911	44-9	11911-1	7 Oct 98	2 Oct 99
Bicron	Micro Analyst	C119C	NA	NA	17 Sep 99	15 Mar 00

2. The laboratory counters used in this survey include:

Manufacturer	Model	Serial Number	Calibrated	Calibration Due
Packard	2500TR	408523	Sep 99	Mar 00
Packard	5530	400577	Mar 99	Sep 99

MCHL-HP

16 February 1999

MEMORANDUM FOR Record

SUBJECT: DORF Underground Waste Storage Tanks

1. The Oak Ridge National Laboratory will be taking underground tank sediment and soil samples from 23-25 February 1999 near building 516, Forest Glen Section for alpha, beta or gamma radiological contamination.

2. The underground flow through/hold-up tanks are scheduled to be removed and a single flow through line will be connected to the sanitary sewer drains from buildings 513 and 516, Forest Glen Section.

3. If the radiological contamination survey for alpha, beta, and gamma contamination results from Oak Ridge National Laboratory are found to be releasable, the tanks will be removed by a contractor. If the results are positive, the tanks will be decontaminated prior to removal from the site. The Army Reactor Office will have to be included in the contamination results and decontamination plan as these tanks are also elements of the Army Reactor Office permit for the DORF facility.

4. The two tanks furthest from building 516 have been sealed since the DORF reactor was decommissioned in the 1970's. The closest tank has been used as a flow through tank since the DORF decommissioning. No radioactive waste from building 516 has been discharged through this tank since 2 March 1998. The primary radionuclides discharged through this tank were H-3 (12.3 y), S-35 (87.4 d), P-32 (14.3 d) and Cr-51 (27.7 d). Of these, tritium is expected to be the primary radionuclide remaining in this tank since the other shorter lived radionuclides should have mostly decayed away.

ARTHUR R. MORTON
CPT, MS
Chief, Health Physics Operations

MCHL-HP

2 September 1998

MEMORANDUM FOR Bay Area Office, USACE, ATTN: Walter Merski

SUBJECT: Radiological Analysis of Forest Glen Building 516 Hold-up Tanks

1. A radiological survey of the hold-up tanks from building 516, Forest Glen Section indicated that the hold-up tank nearest building 516 has 30 pCi/gm of alpha activity (enclosure). This amount of an unknown alpha contaminant is sufficiently above background levels that an identification of the isotope(s) is required before the tanks can be removed from the ground.

2. We recommend that none of the tanks be removed until the sample has been independently analyzed by the radiological laboratory of the Center for Health Promotion and Preventive Medicine (CHPPM) in Aberdeen Proving Ground, MD. We estimate that isotopic analysis of the sediment sample from the hold-up tank should take about 2 weeks.

3. Points of contact for more information regarding this memorandum are either Mr. David Burton, CPT Arthur Morton, or COL William Johnson at (202) 356-0058.

FOR

WILLIAM B. JOHNSON
COL, MS
Radiation Protection Officer, WRAMC

Encl
as

DEPARTMENT OF THE ARMY
WALTER REED ARMY MEDICAL CENTER
WASHINGTON, DC 20307-5001

REPLY TO
ATTENTION OF:

MCHL-HP

30 September 1990

MEMORANDUM FOR Chief, Environmental Office, ATTN: Mr. Brooks, Walter Reed Army Medical Center, Washington, DC

SUBJECT: Release of Storage Tanks from Building 513 Area

1. Three underground storage tanks located on the WRAMC Forest Glen Annex next to Building 513 have been removed from the ground by a contractor. Two of the tanks were in stand-by mode and one of the tanks was part of a direct line from Building 513 to the sewer. The tanks were part a possible hold up system to hold water contaminated with radioactive materials from the operation of a medical research reactor that was in Building 513. This facility was decommissioned about 20 years ago, and for the last 20 years the building has been used as low level radioactive waste consolidation facility for WRAMC. Liquid waste that meets NRC requirements have been discharged through the sewer line.

2. The tanks were sampled prior to removal and found to contain very low levels of radioactive material well within any NRC discharge limits. Radiation support and monitoring was provided during the removal of the tanks. The tanks were filled with soapy water, the water circulated and then the tanks were drained prior to removal. All monitoring and analysis of the tanks after removal indicate no removable levels of any radioactive materials present above the unrestricted release limit of 200 dpm. Scanning using calibrated survey meters found no levels of gamma or x-ray radiation above our release limit of 2X background.

3. Based on smears analyzed by NaI and liquid scintillation counting, and scanning of the tinside of the tanks using calibrated survey meters, no radiological contamination is present in any of the three tanks that would preclude the tanks removal from government control. Recommend that the tanks be released to the contractor to remove the tanks off site.

William B. Johnson
WILLIAM B. JOHNSON
COL, MS
Chief, Health Physics Office

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

April 23, 1999

Lt. Col. Martha Sanders
Walter Reed Army Medical Center
Environmental Division
6825 16th Street, NW
Washington, DC 20307-5001

SUBJECT: REVISION 1 - REPORT OF DATA FOR ANALYSIS OF SAMPLES COLLECTED FROM WALTER REED ARMY MEDICAL CENTER ANNEX, FEBRUARY 24-25, 1999, FOREST GLEN, MARYLAND (MIPR9DRAU0942)

Dear Lt. Col. Sanders:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) provided technical assistance to the Walter Reed Army Medical Center (WRAMC) in the form of sample collection and analysis support for the Building 516 Underground Storage Tank (UST) Project. The project is at the WRAMC Annex located in Forest Glen, Maryland (Figure 1). An ESSAP representative traveled to the site and on February 24, 1999, collected one sludge sample and three water samples from the USTs located near Building 516 (Figures 2 and 3). In addition, WRAMC personnel provided a drilling contractor who collected subsurface soil samples from nine boreholes, one of which represented a background location (Figure 3). Subsurface samples were collected at two-foot intervals beginning at 11 feet below grade—the depth that corresponded to the bottom tank level. Samples were maintained under ESSAP chain-of-custody and transported to ESSAP's laboratory in Oak Ridge, Tennessee for analysis.

Gamma spectroscopy analysis was performed on the nine soils that corresponded to the first sample depth of 11 feet—the remaining soil samples were archived for possible analysis, pending the initial results. The three water samples and one sludge sample were also analyzed by gamma spectroscopy. The results were reviewed for uranium and any other identifiable photopeaks corresponding to fission or activation products. The gamma spectroscopy analyses on the soil and the sludge tank samples showed uranium concentrations in the 1 to 2 pCi/g range, which is the typical background concentration level for most soils. The activation and fission product review of the soil and sludge gamma spectroscopy data identified very low levels of Co-60 and Cs-137 in the sludge sample. All other sample results were less than the respective minimum detectable concentrations (MDCs) for each radionuclide. The gamma spectroscopy results are presented in Table 1. Analysis of uranium in water by gamma spectroscopy has a very high MDC (>40 pCi/L) and serves primarily as a screening method. The isotopic uranium and plutonium alpha spectroscopy results are presented in Table 2. When analyzed by alpha spectroscopy, one water sample had a result above MDC for isotopic uranium. The other water sample results were less than the MDCs for uranium by alpha spectroscopy, which ranged from 0.2 pCi/L to 0.4 pCi/L. The uranium isotopic results for the sludge sample indicated a low concentration of enriched uranium. The observed uranium concentrations may still be representative of background conditions.[1] All plutonium isotopic results were below MDC.

ESSAP's Quality Control (QC) procedures were followed for these analyses. The daily QC and detector background for the counting instrumentation used in the analyses were within acceptable limits. The QC files are available for your review upon request. Because the initial borehole depth interval samples did not identify radionuclides in excess of expected background levels, the remaining subsurface samples were not analyzed. Gross alpha measurements were not performed due to the limited utility of this type of analysis for soil and sludge samples. It was determined that the radionuclide-specific analyses performed would provide quantitative results for any of the suspect contaminants through either the isotopic alpha spectroscopy or measurement of alpha emitter progeny through gamma spectroscopy. It is ESSAP's opinion that the only alpha emitters that would not have been identified either directly or indirectly by these methods are accelerator-produced transuranics.

Please contact me at (423)576-5073 or Dale Condra at (423)241-3242 with any questions or comments.

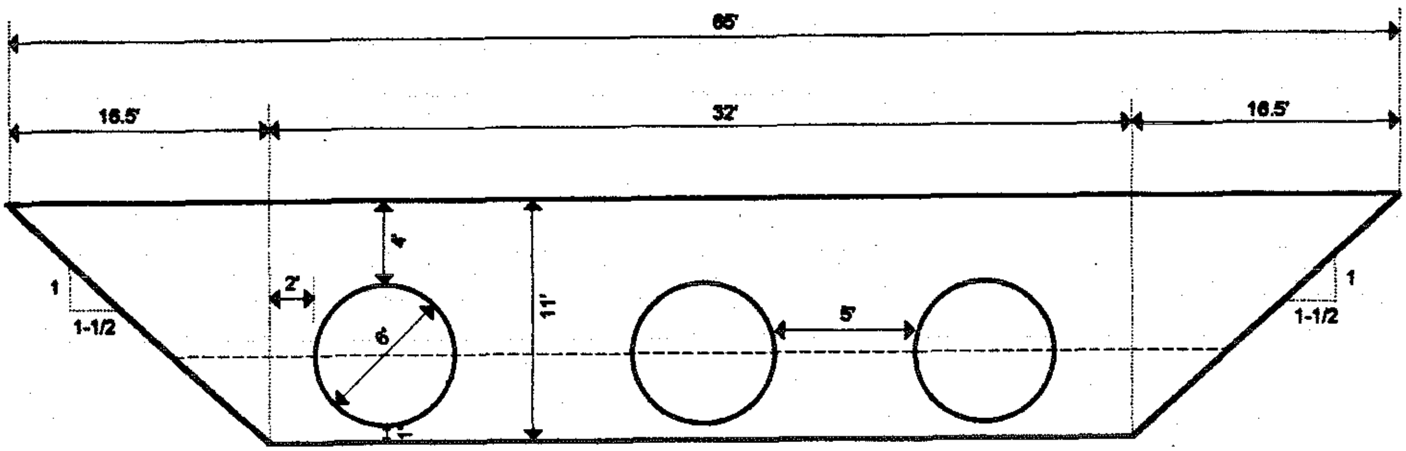
Sincerely,

Timothy J. Vitkus
Survey Projects Manager
Environmental Survey and
Site Assessment Program

TJV:RDC:cds

cc: W. Beck, ORISE/ESSAP
E. Abelquist, ORISE/ESSAP
D. Condra, ORISE/ESSAP
File/586

1 National Council on Radiation Protection and Measurement. Report No. 77, Exposures From the Uranium Series with Emphasis on Radon and Its Daughters, Chapters 2 and 6.



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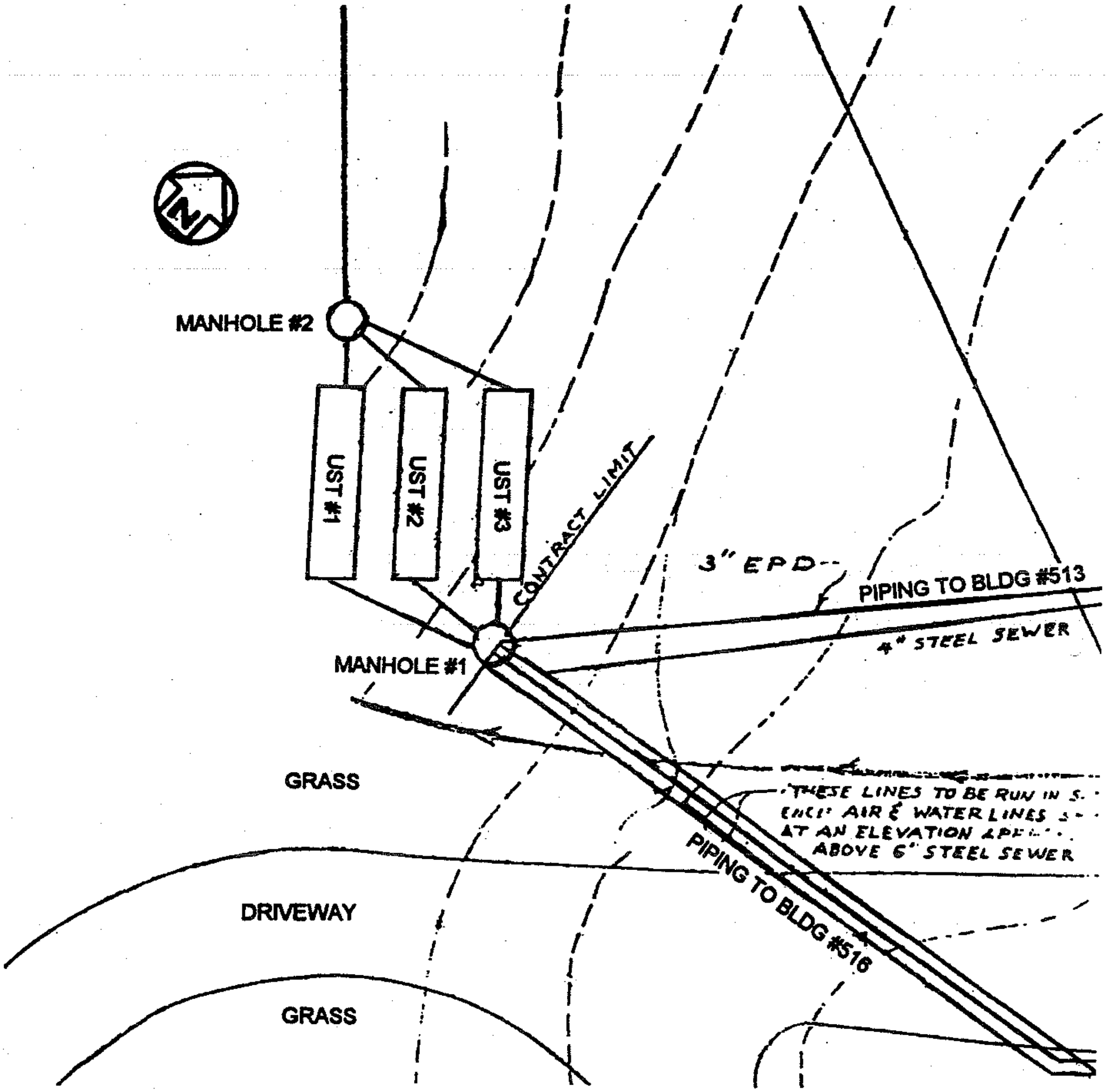
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UST #2
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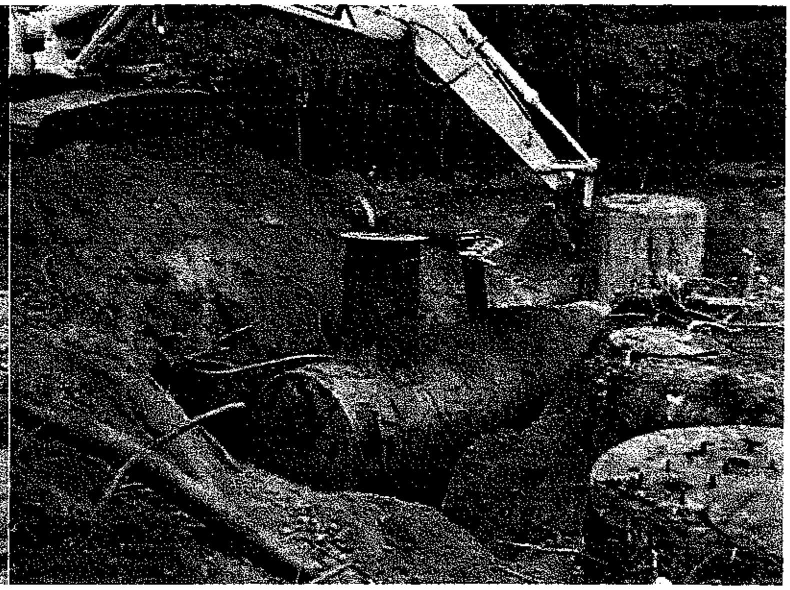
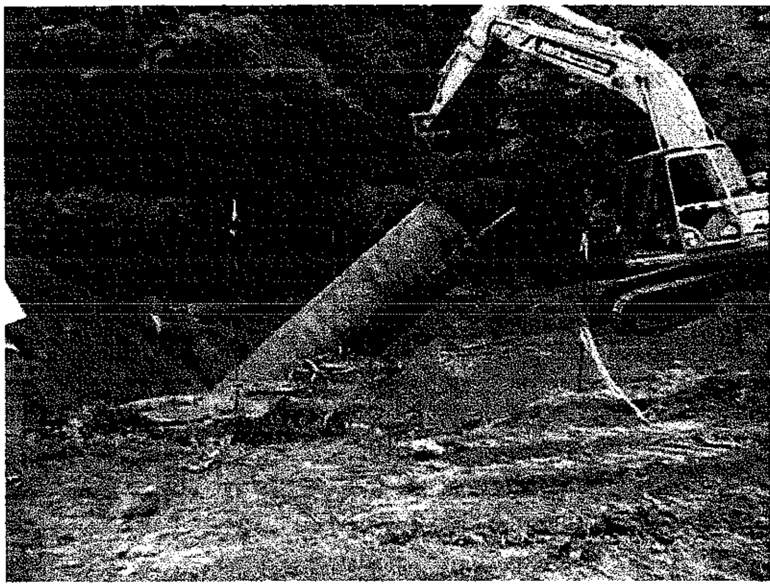
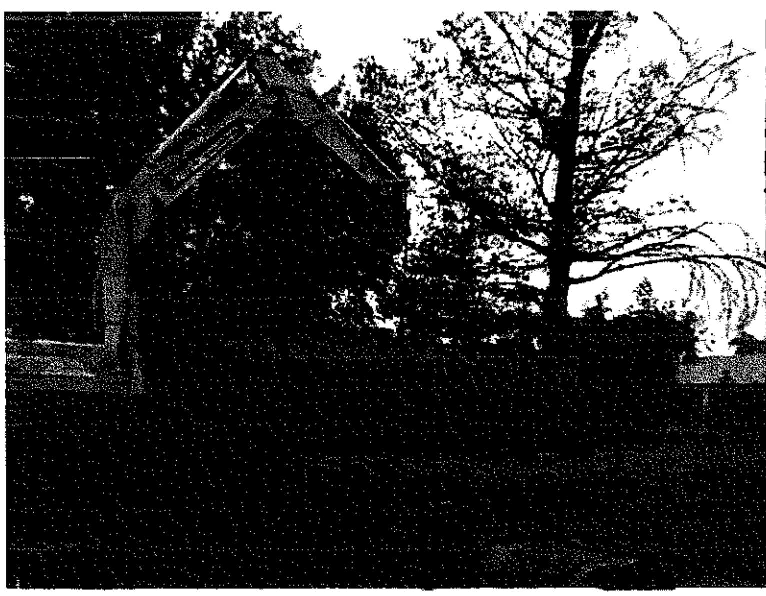
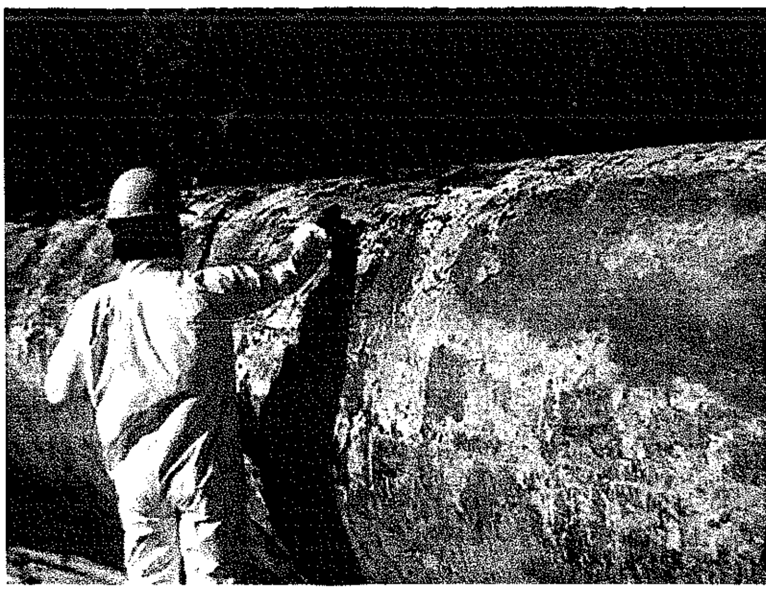
PIPING TO BLDG #513
4" STEEL SEWER
MANHOLE #1
GRASS
THESE LINES TO BE RUN IN
AIR & WATER LINES
AT AN ELEVATION
ABOVE 6" STEEL SEWER
PIPING TO BLDG #516
DRIVEWAY
GRASS

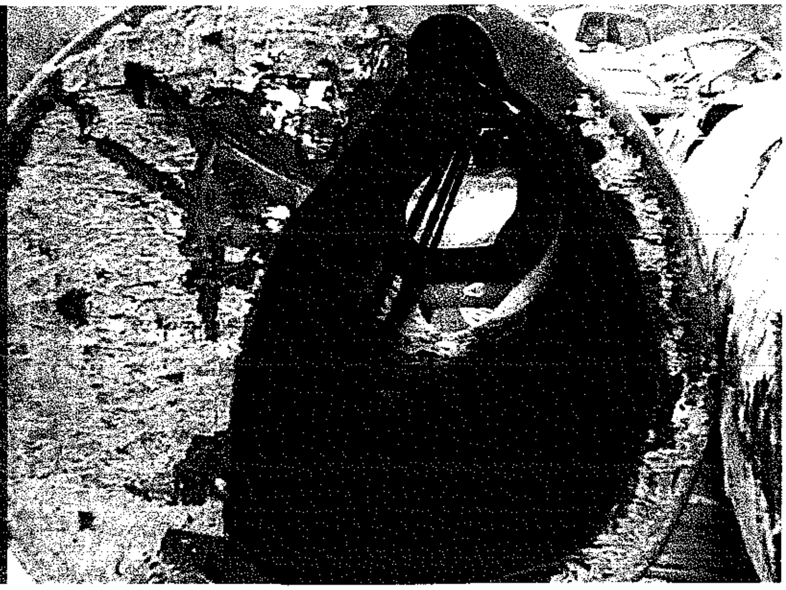




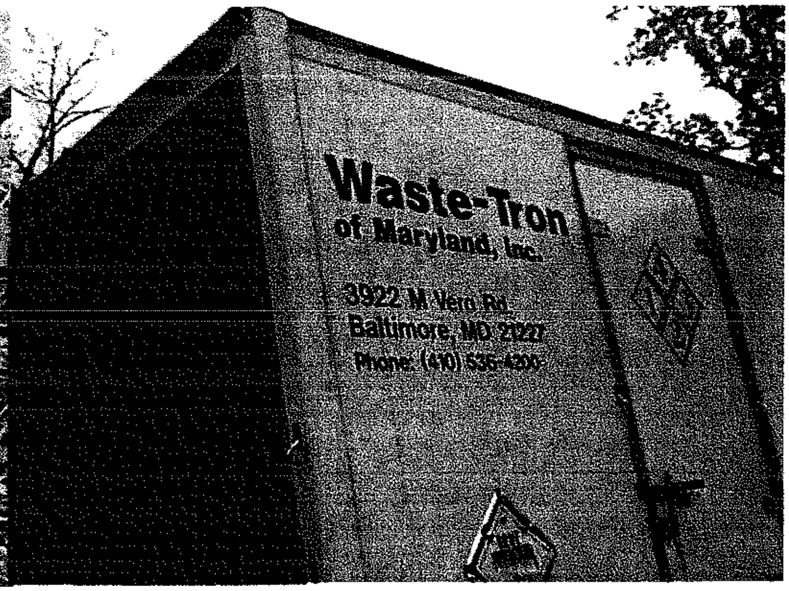







Waste-Tron
of Maryland, Inc.