MALLINCKRODT

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January 10, 2002

Attention: Document Control Desk
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

Ref: Docket No. 40-6563; License No. STB-401
Mallinckrodt, Inc., C-T Decommissioning Plan Revision

Attention: Document Control Desk

Mallinckrodt, Inc. submits 4 copies of a revised C-T Project Decommissioning Plan Phase I in its entirety herewith. The Phase I Plan was originally submitted to the NRC on November 11, 1997. This revision addresses comments to letters dated August 7, 2000, September 21, 2000, October 13, 2000, November 20 & 21, 2000, November 15, 2001, and meetings associated with these letters.

Responses to your written comments about Mallinckrodt's proposed plan to decomission its C-T process and support buildings are incorporated into the revised plan. A revision key submitted herewith correlates comments with the location in the Decommissioning Plan where it is addressed.

Mallinckrodt is submitting Appendix D pursuant to 10 CFR Part 2.790 under separate cover.

Changes to the Decommissioning Funding Plan is likewise being submitted under separate cover by Ms. Pat Duft.

Mallinckrodt wishes to decommission the C-T buildings as soon as reasonable. Please amend our license, STB-401, to authorize decommissioning in accordance with the proposed plan enclosed herewith and with Appendix D and the funding plan to be submitted separately. To enable timely approval of the plan, we are willing to provide any additional information that may be needed. Please contact me at (314) 654-1344 if you have any additional questions.

NMSSO1Public

Sincerely,

Mark Puett

Mark Puett
Manager of Health, Safety, and Environmental

1/4

3 copies sent to
P. Burkhalter

MALLINCKRODT

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SECTION 1

GENERAL INFORMATION

Mallinckrodt Inc.

Phase 1 Plan
For C-T Decommissioning

NRC Docket: 40-06563
NRC License : STB-401

January 9, 2002

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January 9, 2002

1. GENERAL INFORMATION

1.1 INTRODUCTION

Mallinckrodt Inc. (Mallinckrodt) has had a license, Number STB-401, docket number 40-06563 , since 1961, issued by the Atomic Energy Commission, and later the NRC, to extract columbium and tantalum from natural ores and tin slags. This license is currently a possession-only license. A license was required because the ores and the by-products of processing contained uranium and thorium isotopes. The Columbium-Tantalum (C-T) decommissioning project is designed to decontaminate and decommission the areas of Mallinckrodt's St. Louis Plant involved with the processing, storage, and handling of radioactive materials associated with the extraction of columbium and tantalum from ores and slag. The C-T production plant and associated support facilities are located within the boundaries of the Mallinckrodt site.

The ultimate goal of the C-T decommissioning project is to remediate the radiological constituents associated with C-T production to the extent required to terminate license STB-401. Remediation of radiological constituents in other areas of the St. Louis Plant is being performed by the U.S. Army Corps of Engineers (USACE) under the Formerly Utilized Sites Remedial Action Program (FUSRAP).

The C-T Project Decommissioning Plan will be submitted in two parts because the C-T decommissioning project will be conducted in two phases. Phase I will decommission the buildings and equipment to the extent that whatever remains on-site will be released for *unrestricted use* based on an industrial use scenario. Phase II will complete the decommissioning of the building slabs and foundations, paved surfaces. and all subsurface materials to the extent that they can be released for *restricted use.*

This document is the Phase I C-T Decommissioning Plan (hereafter, Phase I Plan), describing only the activities involving above-grade decommissioning of the buildings and equipment. The Phase II C-T Decommissioning Plan (hereafter, Phase II Plan) will cover the decontamination and decommissioning of the grade-level and below-grade facilities including the unreacted ore (URO) burial pits, pavement and building slabs, wastewater basins. and other subsurface materials. The Phase II Plan will be submitted later under separate cover.

The two-phase decommissioning plan provides Mallinckrodt the flexibility necessary to deal with the inherent complexities of the site and to take immediate steps to reduce the amount of residual radioactive material at the St. Louis Plant. The advantages of a two-phase decommissioning plan are as follows:

- A two-phase decommissioning plan follows a logical sequence. The removal of above-grade contaminated equipment and the decommissioning of the buildings in the C-T project site must be accomplished prior to addressing the subsurface material.

- There are limited staging areas available for use during decommissioning. The St. Louis Plant is an ongoing operational facility which manufacturers a variety of bulk pharmaceuticals and specialty chemicals. Manufacturing will continue during and after the decommissioning of the C-T project site. The decommissioning project must be carefully planned and staged to allow the ongoing operations to continue with minimal impact.

- The approval of the Phase I Plan allows physical remediation work to commence in those areas where on-site workers have the greatest chance of being exposed to residual radioactive material. Building surveys indicate that the majority of residual radioactive material is fixed and, although there are no immediate health and safety issues, the primary process buildings and equipment have not been in use for several years and are starting to physically deteriorate. Subsurface radioactive materials, by comparison, are not easily accessible to on-site workers due to the physical barriers presented by the paved surfaces and building slabs.

- The goal of the Phase I Plan is straightforward: decommission the facility for release for unrestricted industrial use. Approval of the Phase I Plan will allow Mallinckrodt to make progress toward license termination in a timely manner.

- Plan approval and implementation in phases will allow progress toward decommissioning, and allows decommissioning to proceed while NRC develops guidance for subsurface remediation.

Submittal of the Phase I Plan has been preceded by more than two years of planning and site characterization. These efforts significantly enhanced Mallinckrodt's knowledge regarding the current radiological status of the site. The recent characterization results have been combined with historical knowledge and previous characterization efforts to provide a more complete understanding of the radiological status of the C-T project area. The characterization results for the buildings and equipment are incorporated into the Phase I Plan. Characterization results for the unreacted ore (URO) burial pits, pavement and slabs, wastewater basins, and subsurface materials will be presented in the Phase II Plan.

1.2 LICENSE INFORMATION

The name of the STB-401 licensee is Mallinckrodt Inc, which has its principal offices at 675 McDonnell Blvd. St. Louis, MO 63042. The licensed facility is located at the St. Louis Plant, which is located at Mallinckrodt & Second Streets, P.O. Box 470158, St. Louis, MO 63147.

1.3 SITE DESCRIPTION

The St. Louis Plant has been in operation since 1867 and has produced a wide range of products including metallic oxides and salts, ammonia, organic chemicals, and various uranium compounds under contract to the Manhattan Engineering District and the Atomic

Energy Commission (MED-AEC). The plant currently produces a variety of products for the food, drug, cosmetic, pharmaceutical, and specialty chemical industries.

1.3.1 The St. Louis Plant

The St. Louis Plant is a 43 acre site located adjacent to the west bank of the Mississippi River in an area zoned and developed for industrial use (Figure 1-1). The plant is bounded by: Angelrodt Street on the south, Salisbury Street and the McKinley Bridge on the north, Broadway Street on the west, and Wharf Street on the east, except for the small Plant 7E area just east of the railroad tracks.

The St. Louis Plant currently contains more than 50 buildings in an area of approximately twelve city blocks. The St. Louis Plant has traditionally been subdivided into areas, called Plants, based on similar operations being performed. These Plants have been named historically in one of two ways: either using a letter or a number from 1 to 10 (with or without a letter), such as Plant 5 or Plant 7E. Additionally, areas of particular operations could be described by a process-related name, e.g. C-T Plant. Currently the St. Louis site is divided into numbered plant areas. This Phase I Plan will use either descriptive names or numeric names for these Plant areas. Individual buildings within each Plant are numbered, lettered, or both. A plot of the current arrangement of Plants within the St. Louis Plant is shown in Figure 1-2.

In addition to production facilities, the St. Louis Plant includes support facilities such as maintenance shops, research and quality control laboratories, warehouses, steam boilers, inactive wastewater neutralization basins, and a permitted facility for drum storage of hazardous waste.

1.3.2 The C-T Process and Support Buildings

The former C-T Process and Support Buildings within the St. Louis Plant, shown in Figure 1-3, encompass 21 buildings on approximately 4.2 acres, primarily within Plant 5 but also within portions of Plants 1, 3, 6, 7N, 7W, and 8. A more detailed description of the processing history of the various buildings is given in section 1.4 of this plan.

1.3.3 Physiography

The St. Louis Plant site is located in the Oak-Hickory-Bluestem Parkland section of the Prairie Parkland Province (Bailey 1980) and within the Florissant Basin (Lark 1992). The area adjacent to the St. Louis Plant is completely developed, with no pre-settlement vegetation existing. The ground upon which the St. Louis Plant is situated was built up using cinders, sand, dirt, construction debris, and gravel. Only hardy vegetation such as annual bromegrass and mustard survive under these soil conditions.

Numerous buildings and facilities cover a large portion of the St. Louis Plant and the majority of the area is paved with asphalt or concrete. Mallinckrodt restricts access to the site 24 hours a day to employees, contractor construction workers, and authorized visitors.

Land use within a 1.6-km (1-mi) radius of the St. Louis Plant reflects a mixture of commercial, industrial, and residential uses. Commercial or industrial properties in the vicinity of the St. Louis Plant include the McKinley Iron Company, Thomas and Proetz Lumber Company, Gunther Salt, and Cotto Waxo. Three other nearby properties are owned by the Chicago, Burlington, and Quincy Railroad, the Norfolk and Western Railroad, and the St. Louis Terminal Railroad Association, all of which have rail lines that transect the St. Louis Plant from north to south.

The property located between the St. Louis Plant and the Mississippi River is owned by the city of St. Louis. The land is undeveloped and unfenced. The St. Louis Plant, its vicinity properties, and most properties east of Broadway Street and south of Merchants Bridge are zoned "K" (unrestricted district) by the City of St. Louis. This industrial zone allows all uses except residential, provided that no other city codes are violated. Some of the uses within this zone allowed by the City of St. Louis Zoning Code, Section 26.60, under conditional use permits, are acid manufacture, petroleum refining, and stockyards. It is anticipated that this area will remain in industrial use.

The area where the St. Louis Plant is located is within Census Tract 1267. The residential population within Census Tract 1267 was 2,867 in 1990, and the total residential population within 1.6 km (1 mile) of the St. Louis Plant was 10,054, approximately 2.5 percent of the population of the City of St. Louis. The number of occupied dwellings within this 1.6 km radius was 4,710 for an average occupancy of 2.1 people per dwelling. The closest residential dwelling is located on North Broadway Street, 61 m (200 ft.) southwest of the southwestern corner of the St. Louis Plant (City of St. Louis Community Development Agency 1992). Most of the population in this area is located west of I-70.

The major surface water bodies in the area are the Mississippi, Missouri, and Meramec Rivers, which supply 97 percent of the 4.5 billion liters (1.2 billion gallons) per year of drinking and industrial water for the St. Louis area (BNI 1989). The area where the St. Louis Plant is located is at River Mile 182.5, on the western bank of the Mississippi River (Figure 1-1), 20 km (12.7 miles) downstream from the confluence of the Mississippi (River Mile 195.2) and Missouri (River Mile 0) Rivers. Storm runoff from the St. Louis Plant flows via a combined sewer system to the Metropolitan Sewer District (MSD). All City of St. Louis municipal water intakes are located upstream from the underground drainage system that drains the St. Louis Plant.

The Mississippi River at the St. Louis gauging station has a drainage area of approximately 1.8×10^6 km^2 (700,000 sq. miles). The average flow for a 114-year period is 5×10^6 m^3/s [177,000 cubic feet per second (cfs)]. The minimum flow recorded in this period is 5×10^5 m^3/s (18,000 cfs), and the maximum measure flow is 3×10^7 m^3/s (1,019,000 cfs). Although flooding has occurred every month of the year, higher flows are frequently associated with snow melt and heavy rains in spring. Lowest flows typically occur during December or January. A levee constructed in 1964 on city property east of the plant protects the plant from Mississippi River floodwaters. Flooding information for the Mississippi River is shown in Table 1-1.

Table 1-1 Flood Frequency Distribution for the Mississippi River at St. Louis, MO (1934-1979)		
Recurrence Interval (years)	Discharge Level (cubic feet per second)	Exceedence Probability (%)
1.01	146,000	0.99
1.05	223,000	0.96
1.11	273,000	0.90
1.25	341,000	0.80
2.00	490,000	0.50
5.00	651,000	0.20
10.0	735,000	0.10
25.0	820,000	0.04
50.0	872,000	0.02
100	915,000	0.01
200	952,000	0.01

1.3.4 Climatology and Meteorology

The climate of the St. Louis area is characterized as warm and moist in the summer and cold and dry in the winter. The region is dominated by warm, moist maritime tropical air masses, which flow northward from the Gulf of Mexico region, and by cooler, drier polar air masses, which drift down from the Canadian Provinces. The annual average of monthly high and low temperatures are 31°C and -5°C (88°F and 23°F), respectively. The area averages 91 cm (36 inches) per year in total precipitation (i.e., rainfall plus water content of melted snowfall). Average annual snowfall is approximately 66 cm (26 inches).

Tornadoes are the most common form of severe weather occurring in the region. From 1916 through 1985, 52 recorded tornadoes occurred in the St. Louis metropolitan area. In 1990, Missouri had 31 storms in 14 days, most of them in May and June. Based on the record between 1953 and 1990, Missouri is ranked seventh nationally in the occurrence of tornadoes and averages 11 tornado and 27 storm days per year (NOAA 1990).

1.3.5 Geology and Hydrology

The St. Louis Plant is underlain by two unconsolidated soil units and one bedrock unit. Figure 1-4 is a typical cross-section through the site. The upper unconsolidated unit is mostly fill material and varies between 12 and 30 feet in thickness. The lower unconsolidated unit varies from 0 to 60 feet in thickness and consists of relatively impermeable alluvial silt and clay above relatively permeable sandy alluvial sediments. The deepest unit is limestone bedrock.

The subsurface hydrologic conditions in the Plant 5 area of the St. Louis Plant are known from the installation of over sixty exploratory borings in Plant 5 during previous investigations. Selected borings, monitoring wells, and groundwater level contours in Plant 5 are shown on Figure 1-5. A typical subsurface profile of Plant 5, developed from borings is shown in Figure 1-6 where four stratigraphic units exist.

The topmost unit is 7-18 feet thick and consists of brick, clay, coal slag, cinder, concrete, construction rubble, glass, and sand fill materials. A perched groundwater unit occurs within the fill in Plant 5 at depths ranging from approximately three to nine feet below ground surface. Groundwater elevation measurements performed between 1982 and 1989 indicate that the perched groundwater flows generally to the northeast with a horizontal hydraulic gradient of approximately 0.006 ft/ft.

A relatively impermeable fine-grained alluvial unit, 20-30 feet thick, is found below the fill unit. The fine-grained alluvial unit consists of interbedded silty clay, clayey silt, and sandy silt. Representative hydraulic and geotechnical properties of this unit were evaluated by Department of Energy (DOE) under FUSRAP. An *in-situ*, changing head test performed in this unit in Plant 7 yielded a horizontal hydraulic conductivity of 9.9×10^{-6} cm/s. DOE also collected fourteen undisturbed samples of this unit from various boreholes across the St. Louis Plant and tested them for laboratory permeability, cation exchange, and geotechnical parameters. The vertical hydraulic conductivity ranged from 4×10^{-4} to 1×10^{-6} cm/s with a geometric mean of 1×10^{-5} cm/s. Cation exchange capacities ranged from 70 to 200 meq/100 g, with an average value of 39 meq/100 g.

The sandy alluvial unit beneath Plant 5 ranged from zero to ten feet thick, and consists of fine-to-coarse sand. Groundwater in this unit may be confined or semi-confined by the overlying relatively impermeable fine-grained unit. The groundwater potentiometric surface occurs at depths of about 10 to 35 feet below ground surface. Groundwater in this unit flows eastward towards the Mississippi River with a horizontal hydraulic gradient ranging from 0.01 to 0.02 ft/ft. See Figure 1-7 for a typical groundwater contour map.

The limestone bedrock surface beneath Plant 5 occurs at depths ranging from approximately 30 to 55 feet and slopes gently towards the Mississippi River (Figure 1-5).

Groundwater in the sandy alluvial unit is locally saline and generally very hard, with high iron and manganese content. Groundwater found in the underlying bedrock is generally saline and non-potable. The groundwater found beneath the St. Louis Plant and surrounding industrial areas is not used as a source of drinking water. There are no known drinking water wells in the vicinity of the plant. The St. Louis Plant is within the City of St. Louis, which has an established public water supply system. This system treats and distributes water obtained from the Mississippi River north of the St. Louis Plant.

1.4 PLANT DESCRIPTION AND OPERATION

Various past production operations at the St. Louis Plant have involved radioactive materials:

- From 1942 to 1957, Mallinckrodt extracted uranium from ores and produced purified uranium and uranium compounds for national defense purposes, first for the MED, and later for the AEC.

- From 1956 to 1960, Mallinckrodt extracted columbium, tantalum, uranium, thorium, and rare earth elements from euxenite mineral ore and converted the ore into useful products for delivery to the AEC and the General Services Administration (GSA) as part of the Defense Materials Procurement Program. The euxenite operation was performed under AEC source material license No. R-226 which expired in 1960. It is estimated that a total of 95 Curies (Ci) of natural uranium (U-238, U-234, and U-235) and 10 Ci of natural thorium (Th-232, Th-228) were extracted from the ore during this time period.

- From 1956 to 1977, Mallinckrodt subdivided small quantities of uranyl and thorium salts for resale under AEC/NRC license SUC-872. A report of Mallinckrodt's final radioactivity survey for this license was submitted to NRC on December 13, 1979.

- From 1961 to 1985, Mallinckrodt extracted columbium and tantalum from ores and tin slags containing low levels of natural uranium and thorium, under AEC/NRC rare earth extraction license No. STB-401. A two-month trial production run was performed in early 1987, but C-T extraction has not been performed since that time. A total of approximately 6 Ci of natural uranium and 19 Ci of natural thorium isotopes were contained in the ores and tin slags processed during the period of columbium and tantalum extraction.

1.4.1 MED-AEC Operations

In April 1942, Mallinckrodt, then called Mallinckrodt Chemical Works (MCW), was contracted to extract uranium from ore concentrates for eventual use in the first self-sustaining nuclear chain reaction in the graphite reactor being built at the University of Chicago. The initial contract was signed on July 20, 1942. Within 50 days of accepting the assignment from the War Department, MCW began producing highly refined uranium dioxide (UO_2) for the CP-1 pile reactor at the rate of 1 ton per day in Plant 2, supported by research activities in Plant 1. The UO_2 was also shipped to another MED site for reduction to metallic fuel for the reactor. The intermediary products, uranyl nitrate and uranium trioxide, were produced both as intermediaries to the production of uranium dioxide and as final products. A process to convert UO_2 to uranium tetrafluoride was begun as a batch process in 1942. A process to convert uranium tetrafluoride to uranium metal started in 1943. This activity was performed in process buildings located on the east side of Broadway Street, immediately west of Plant 5. At that time, this area was designated as Plant 4. This designation is no longer used for this area. The company was the sole supplier of uranium compounds for the Manhattan project well into 1943, and provided high purity uranium products for the duration of the war.

In 1945, the Destrehan Plant (Plants 6, 6E, and 7 north and south of Destrehan Street) was built to process pitchblende ore and to increase the capacity of the refinery. Plant 6 production began in 1946. In 1950 and 1951, the MED-AEC facilities in Plants 1 and 2 were partially decommissioned and finally decommissioned in the early 1960s. In 1958, the Destrehan plant was put on standby, and uranium processing was transferred to the MCW Weldon Spring Plant. In 1960 and 1961, the MED-AEC facilities in the former Plant 4 area (part of the area now known as Plant 10) and the Destrehan Plant were decommissioned.

Figure 1-8 illustrates the areas at the St. Louis Plant site that were used for MED-AEC production. The St. Louis Plant processed approximately 50,000 tons of uranium products during the 1942-1958 MED-AEC operations. Based upon the estimated 50,000 tons of uranium products produced from the ore concentrates and pitchblende ore, it is estimated that the minimum radioactivity throughput was approximately 30,000 Ci of uranium isotopes and 10 Ci of thorium isotopes.

DOE, under FUSRAP, had responsibility for remediating radioactive and chemical contamination in the areas of the St. Louis Plant that formerly housed MED-AEC operations. However, the U.S. Army Corps of Engineers (USACE) now has responsibility for these activities because in October, 1997, Congress transferred responsibility for FUSRAP implementation from DOE to USACE. FUSRAP was created to identify and control or remediate sites where residual radioactivity remains from activities conducted under contract to MED and AEC during the early years of the nation's atomic energy program. Some facilities that produced radioactive materials for commercial sale are also included under FUSRAP at the direction of Congress. The USACE is responsible for the cleanup of both radioactive and hazardous chemical contamination at the St. Louis Plant with oversight by the U. S. Environmental Protection Agency (EPA). These responsibilities are outlined in a Federal Facilities Agreement (FFA) negotiated by EPA Region VII and DOE in June of 1990 (Docket No. VII-90-F-0005). The FFA has been amended to transfer these responsibilities to USACE. The FFA further defines the conditions dictated by EPA to manage remediation at St. Louis. The document creates broad obligations for clean up of all residual waste from uranium processing, including such waste that might have mixed or commingled with other hazardous material substance at the site.

Buildings 50, 51, 51A, 52, 52A, 100, 116, 117, 219, 700, 704, 705, 706, 707,and 708, previously located as illustrated in Figure 1-9 were demolished by the DOE under FUSRAP. Before Building 250 was constructed, C-T laboratories were located in Building 25. It was also used as a laboratory to support MED-AEC operations. Some Plant 6 and 7 buildings and adjacent open areas were used to support C-T manufacturing following their decontamination and release to Mallinckrodt by the AEC in the early

1960s. The buildings in Plants 6 and 7 that supported C-T are summarized in Table 1-2. Buildings and soil in these areas contain substantial volumes of residues from uranium refining. All Plant 6 and 7 buildings previously used for uranium processing, including those that subsequently supported C-T manufacturing, were demolished by DOE. MED-AEC soil contamination in Plants 6 and 7 is currently being addressed under FUSRAP.

1.4.2 Euxenite Operations

From approximately 1956 to 1960, MCW extracted columbium, tantalum, uranium, thorium, and rare earth elements from euxenite mineral ore for national defense purposes. The operation was performed in connection with the Defense Materials Procurement Agency and AEC. MCW was a subcontractor to Porter Brothers Corporation and performed the euxenite processing under an AEC source material license: R-226. The license expired March 1, 1960. Former euxenite process and support areas are shown in Figure 1-10. (Please note that some of these buildings no longer exist.)

Columbium (now known as niobium) and tantalum are naturally occurring metallic elements with various uses. Columbium is used as an alloying agent in carbon and alloy steels and in nonferrous metals to improve material strength, and is also used in an alloy form for high temperature structural applications. Tantalum and its alloys are used in electronic components, chemical process equipment, and high temperature aircraft and missile parts.

1.4.3 C-T Production

In 1961, after the end of the euxenite operation, MCW began production of columbium and tantalum compounds from natural and synthetic ores and tin slags at the St. Louis Plant under an AEC rare earth extraction license, number STB-401 issued August 23, 1961. From 1961 to approximately 1974, Mallinckrodt purchased feed materials from Malaysia, Thailand, and other countries. From approximately 1975 to 1985, feed materials consisted of a blend of upgraded synthetic tin slag concentrates and natural columbite mineral ores and were processed under a long-term contract with National Research Corporation, Inc. In February 1986, Mallinckrodt informed the NRC that National Research Corporation, Inc. did not renew its contract and that the C-T Process and Support Areas would be placed on standby. Following a one-year shutdown, a two-month pilot production run was performed in early 1987 to explore new business opportunities. The pilot run processed approximately 20,000 pounds of tin slag from Thailand. The C-T Process and Support Areas returned to standby mode following the trial run and no C-T operations have occurred since that time. On July 12, 1993, NRC amended the license to a possession-only license for D&D and license termination.

1.4.4 Buildings Supporting C-T Production

C-T production and support buildings are listed in Table 1-2 and displayed in Figure 1-3. Although C-T production occurred in Plant 5, support activities were conducted in portions of Plants 1, 3, 6, 7, and 8. Process building 238 in Plant 5 was constructed for use by the euxenite operations, while other process buildings in Plant 5 were constructed specifically for the C-T operation. Selected buildings and areas in Plants 6 and 7 were used to receive and store feed materials and drummed URO waste. Some URO was buried in the western portion of Plant 6 in 1972 and 1973 in conformance with 10 CFR 20.304 (Figure 1-11).

Mallinckrodt began construction of Plant 5 in 1947 with the construction of Building 200 and 201 along Angelrodt Street at the southern end of the block. These buildings processed several types of non-radioactive materials. Building 200 is still in operation today processing organic materials. New sewers were installed as Plant 5 was being developed. Wastewater was conveyed in underground sewers to the northwest corner of Plant 7. From Plant 7, an underground sewer carried the Plant 5 effluent east and connected to the sewer and outfall system constructed to support the MED-AEC Destrehan Street Facility. In the early 1970s, a pair of wastewater neutralization basins were constructed in the northwest corner of Plant 7. These basins were used until 1993.

TABLE 1-2 C-T PROCESS AND SUPPORT BUILDINGS	
Building No. and Location	C-T Process and Support Areas
Plant 1 Area	
Building 25*	Laboratory
Plant 3 Area	
Building 62	Change Rooms (Lockers)
Plant 5 Area	
Building 213	Change and Break Rooms
Building 214	Transformer/Switchgear Room
Building 235	Feed Material/Storage (East Half)
Building 236	Feed Material Storage
Building 238	C-T Ore Grinding/Dissolving/T Processing
Building 246A	Offices
Building 246B	Solvent Extraction Process
Building 247A	C-T Solvent Extraction/Product Storage
Building 247B	Columbium Filtration and Drying
Building 248	Columbium Filtration/Drying/Calcining
Building 250	Offices and Quality Control Labs
Plant 6 Area	
C-T Incinerator (Bldg. 101)	C-T Incinerator
Building 116 **	Receipt/Unloading of C-T Ore
Building 117 **	URO Drum Preparation and Staging
Plant 7 Area	
Building 700 **	Storage of Tin Slag Feed Material
Building 704 **	URO Drum Storage
Building 705 **	C-T Ore Storage
Building 706 **	C-T Ore Storage
Building 708 **	Storage of Tin Slag Feed Material
Plant 8 Area	
Building 90/91	Maintenance Areas

* MED-AEC contamination in this building will be addressed by FUSRAP in a future Record Of Decision. The Record Of Decision will determine whether remediation is appropriate pursuant to CERCLA.

** These buildings were demolished by the DOE under FUSRAP.

Specific buildings that supported C-T production are described below.

- Buildings 213 and 236 were constructed in 1953. Building 213 was originally used as a locker and break facility for Plant 5 operations, including C-T. It now houses plant utility operations, as well as the break room. Building 236 is currently used as a maintenance shop. At one time, C-T product was dried in tray dryers in Building 236.

- Building 238 was constructed in 1954 to house the euxenite process, a predecessor to the C-T operation, then was used for C-T operations.

- Building 235 was constructed in 1959. Building 235 was used as a returned-goods warehouse and at one time was used to store C-T feed materials and URO. All areas of Building 235 have been renovated for manufacturing and associated support activities.

- Buildings 246A and 246B were built in 1961 as Building 238 was being converted for C-T processing. C-T operations offices were located in Building 246A. The original C-T extraction operations were performed in Building 246B.

- Building 250 was constructed in 1967 to support C-T and other manufacturing operations. The C-T quality control and research laboratories were located in Building 250, as were manufacturing and laboratory facilities for other Mallinckrodt products. Prior to Building 250 construction, C-T laboratories were located in Building 25 (in Plant 1). MED-AEC contamination in this building will be addressed by FUSRAP in a future Record Of Decision (ROD). The ROD will determine whether remediation is appropriate pursuant to CERCLA.

- Buildings 247A, 247B, and 248 were constructed in 1967 to house expanded C-T extraction and finishing operations.

All Plant 5 streets are paved with asphalt or concrete. Paved streets were installed to serve manufacturing and warehouse buildings as they were constructed.

1.4.5 C-T Process Description

A generalized C-T process flow diagram is shown in Figure 1-12. The feed materials included ore, slag, sodium hydroxide, hydrofluoric acid, sulfuric acid, aqueous ammonia, methyl isobutylketone, hydrochloric acid, and potassium chloride. Products from this process included tantalum oxide, potassium fluotantalate, and columbium oxide. Columbium and tantalum oxides and salts were produced in a batch process that included five major steps:

Step 1: Feed materials were received by truck in burlap bags and drums. Usually, the bags were placed in drums or boxes for storage. The drums or boxes were stored in Plant 6 and 7 prior to forklift transport to the ore staging area in Plant 5, where ore batches were selected.

The ore (feed material) was arranged into feed batches in the ore staging area east of Building 245. Ore was also staged on the other paved streets in Plant 5. The feed material was ground into fine grained slurry in the ball mill room (Building 238 annex) using a wet milling process. The slurry was then pumped into boil-down tanks where excess water was evaporated.

Due to the value of columbium and tantalum, the burlap ore bags were incinerated, and the ash was recycled back to the process to recover columbium-tantalum. The incinerator was originally located west of Building 248. In 1980, the incinerator was installed in its present location west of Building 101 in Plant 6.

Step 2: The ore slurry was pumped into large rubber-lined acid-dissolving tanks in building 238. Hydrochloric, sulfuric, and hydrofluoric acids were used during the tin slag processing. Hydrofluoric and sulfuric acids alone were used in dissolving/leaching columbite and tantalite ores and synthetically upgraded tin slags.

Step 3: The acid C-T mother liquor was decanted from the unreacted ore by mixing and settling. A flocculating agent was utilized to enhance separation. The decanted liquor was filtered and pumped to Building 247 for Step 4 processing. Initially, the URO acid slurry was filtered on a plate and frame press, washed with water and the cake discharged to the plant sewer system. Between 1975 and 1980, the URO press cake was drummed for future use or disposal. Beginning in 1980, the stored URO was reprocessed by slurrying in Step 4 raffinate in order to form a homogeneous mixture. This mother liquid was then decanted. The URO slurry was diluted with water, neutralized with caustic or ammonia, dewatered in a filter press, dried in a pancake dryer and drummed for disposal. All of the URO processing was performed in Building 238.

Step 4: The acid mother liquor was subjected to a two-series extraction/purification process. In the first series, the C-T mother liquor was extracted using methyl isobutylketone (MIBK) and sulfuric acid. This generated a C-T-MIBK stream (organic end) and a raffinate (aqueous end) consisting of hydrofluoric and sulfuric acids, salts, and residual URO material. In the second series, the C-T-MIBK stream was contacted with water in a second extractor to separate the columbium from the MIBK phase. This yielded a tantalum-MIBK stream (organic end) and a fluocolumbic acid stream (aqueous phase). MIBK was removed from the tantalum-MIBK stream by steam stripping, yielding a fluotantalic acid stream. The first series raffinate stream was used to wash columbium and tantalum acid liquors from the URO, reused as feed liquors for the solvent extraction step, or neutralized with ammonia and discharged to the sewer. These process steps were performed in Buildings 246B and 247B. Solvent extraction was not utilized until approximately 1964. Prior to this time, the columbium and tantalum were separated from the mother liquor by precipitation.

Step 5: The primary C-T process products were columbium oxide and potassium fluotantalate salt. Approximately five percent of the tantalum product was produced as tantalum oxide. Columbium and tantalum oxides were precipitated from their respective product streams (fluocolumbic acid, fluotantalic acid) by addition of ammonia. Finishing steps included filtration, drying, and calcining. Columbium oxide precipitation and finishing were performed in Building 248. The potassium fluotantalate salt was precipitated from the fluotantalic acid stream by addition of potassium chloride, separated in a centrifuge, and dried in tray dryers. These steps were conducted in Building 238.

1.4.6 C-T Operations Environmental Controls and Waste Management

Air emissions from C-T processing in Building 238 were controlled using a dust collector in the ball mill area, two acid fume scrubbers and an ammonia scrubber. Certain decanted liquors, raffinate from the solvent extraction step, and C-T filtrate from the final process steps were discharged to the plant sewer in accordance with NRC license conditions and St. Louis Metropolitan Sewer District (MSD) permit.

Prior to 1975, most of the URO was discharged to the sewers in accordance with License No. STB-401 and other regulatory requirements, except for some drums of URO that contained higher than normal levels of tantalum. These drums were held on-site for reprocessing but were not reused due to the high cost of recovery. As a result, approximately 300 cubic yards of drummed URO were buried on-site (Figure 1-11) in 1972 and 1973 in conformance with 10 CFR 20.304. Starting in 1975, all URO solids were drummed and stored on site. Processing of the stored URO started in 1980 using the new URO neutralization, filtration and drying system. All URO processed through this system was drummed for transfer to a licensed uranium mill or a licensed low level radioactive waste disposal facility.

1.4.7 Historical Occurrences

Documentation does not describe any accidental releases of radioactive material from the time period in which the C-T process site was operational. Therefore, interviews were conducted to obtain historical information from past and present employees involved in C-T operations. The following events were described in these interviews.

- Raffinate Tanks - During the operational period of the C-T process site, raffinate tanks located north of Buildings 246 and 247 overflowed on more than one occasion. In the event of an overflow of the main tanks, raffinate was diverted to a backup tank. However, in some instances, the backup tank did not contain all materials.

- Steam Jet Emissions - The entrained liquid from a high pressure vacuum steam jet on the southwest roof of Building 238 occasionally sprayed into the air potentially contaminating roofs of surrounding buildings.

1.5 APPROACH TO C-T SITE DECOMMISSIONING

1.5.1 Site-Specific Considerations and Objectives

Based on the information presented in the prior sections, a site-specific characterization approach was proposed. The proposal was based on facts related to the St. Louis site that are important considerations for the C-T site decontamination and decommissioning pursuant to license No. STB-401:

- The areal extent and scale of MED-AEC operations as shown by historical records, maps, and photographs, as well as the radioactivity throughput, indicate that virtually all of the radiological contamination outside the well defined Plant 5 C-T process and support areas is derived from MED-AEC operations and is unrelated to the NRC licensed operations.

- The areal extent of the former MED-AEC process and support areas surrounding Plant 5 (see Figure 1-8), and routes of contamination dispersal (e.g. loss during materials transport, atmospheric deposition, and flooding) suggest that MED-AEC contamination may have migrated into Plant 5.

- The DOE originally began investigating and remediating residual contamination from the MED-AEC operations under FUSRAP and in accordance with the terms of a FFA. The USACE proposed a remedial action plan for the site and in coordination with the EPA and the Missouri Department of Natural Resources (MDNR). With public notice and comment, the USACE selected remediation activities, a Record of Decision (ROD), and began remediation of MED-AEC residues.

The presence of MED-AEC contamination of the St. Louis plant, and the overlap of the Plant 6 and 7 MED-AEC process areas and C-T support areas indicate that the plans for the C-T site characterization and decommissioning must seek to limit the potential conflict, duplication, and inconsistency between Mallinckrodt's responsibilities under NRC license No. STB-401 and those of the USACE under the FFA and FUSRAP. Therefore the objectives considered in developing the Phase I Plan are as follows:

- Develop decontamination and decommissioning goals and approaches that are protective of human health and the environment and consistent with applicable NRC, EPA, and state regulations.

- Develop practical, cost-effective decommissioning approaches that limit potential interference and duplication of effort with remediation activities pursuant to the FFA and FUSRAP.
- Limit major inconsistencies with the remedial goals and approaches established by USACE, and MDNR for remedial work under the FFA and FUSRAP.

1.5.2 Proposed Approach and Rationale

To achieve the objectives listed above, Mallinckrodt proposes an approach to C-T decommissioning pursuant to NRC License No. STB-401 that addresses the unique mix of regulatory and technical issues at this facility. The approach is designed to protect human health and the environment consistent with NRC goals and accommodate FUSRAP activities.

The proposed scope of the decommissioning program involves all C-T process and support areas in Plant 5 (except as described in the following paragraph) and certain C-T support areas in Plants 3, 6, 7, and 8. Although the presence of MED-AEC contamination cannot be precluded, the contamination in these areas appears to be primarily related to C-T operations.

DOE has identified radiological contamination in Plant 10 (the former MED-AEC Plant 4 area) and in areas along Second Street between Angelrodt and Salisbury Streets. Surficial and subsurface contamination at the northwest corner of building 250 has been documented by DOE. Mallinckrodt has also identified radiological contaminants along the west side of building 250. The area was used by Mallinckrodt as an employee parking lot prior to building 250 construction. Mallinckrodt believes contamination of these areas including the soils beneath Buildings 250 and 240 and other non-C-T Plant 5 buildings is the result of MED-AEC activity (MED activities in Plant 4 and materials transport along streets and tracks west of Plant 5). Areas under Buildings 240 and 250 may be addressed by a future ROD under FUSRAP if remediation of MED-AEC contamination is appropriate pursuant to CERCLA.

An indeterminate amount of contamination of MED-AEC origin may exist in certain C-T support areas in Plants 1, 6, and 7. Such contamination does not involve buildings with the exception of Building 25, in Plant 1, and thus is beyond the scope of the Mallinckrodt PhaseI Plan.

Mallinckrodt will continue to work with the appropriate government agency that is responsible for FUSRAP to assure that all residual contamination associated with building 25 will be addressed by the appropriate party prior to license termination.

1.6 CHARACTERIZATION STATUS

The characterization status of the C-T project is based on historical characterization programs and the data resulting from the Columbium-Tantalum Characterization Plan submitted to the NRC in January 1994. The following discussions provide information about each of the characterization efforts performed to date, as well as the resulting evaluation and current radiological status, and the planned disposition of each of the C-T process and support area buildings, and associated equipment.

1.6.1 Radiological Characterization Programs

In addition to the DOE site-wide investigations referenced in paragraph 1.4.1 above, several site assessments specific to the C-T process have been conducted in Plant 5 and other support areas of the C-T project. The site assessments included hydrogeologic, radiological, and chemical investigations.
The site assessments were designed to quantify the physical and chemical characteristics of the C-T process and process support areas, and perform an initial assessment of the suspected areal and vertical extent of radioactive contamination. Affected and potentially affected building structures and equipment, as well as subsurface materials were characterized. The primary isotopes of concern in these characterization studies were U-238, U-234, Th-230, Ra-226, Th-232, Th-228, Ra-228, and the unregulated radionuclide K-40.

Measurement techniques for buildings and equipment included gamma scanning while walking over the areas and gamma and beta-gamma activity measurements on a gridded surface using hand-held, direct reading instruments. Discrete samples were also gathered and sent for gamma spectroscopy and alpha spectroscopy at the TMA/Eberline laboratory in Oak Ridge, Tennessee.

Summaries of the radiological investigation programs that involved equipment and building surfaces, the focus of each program, and the techniques used are discussed below. A summary evaluation of the C-T characterization program results and the current radiological status of each building is provided in Appendix A and discussed in paragraph 1.6.2 below.

FUSRAP

As discussed in paragraph 1.4.1, the DOE has performed extensive radiological investigations of the St. Louis Plant and has remediated some residual contamination from the MED-AEC operations under FUSRAP and in accordance with the terms of the FFA.

Since DOE performed investigations and demolition of buildings on site, USACE has submitted and received approval of a ROD which has allowed them to continue to investigate, prepare plans, and further remediate the subsurface of many areas within the St. Louis Plant, as well as Vicinity Properties.

Preliminary Radiological Investigation (PRI)

In 1992, TMA/Eberline removed loose contamination from equipment, interior walls, and floors of selected C-T process buildings in Plant 5. Following this removal activity, TMA/Eberline performed a Preliminary Radiological Investigation of loose and fixed contamination of selected C-T and Plant 5 buildings and roofs. This activity provides a significant portion of the surface data required for the characterization.

Scoping Surveys

In 1993, Rust Remedial Services, Inc.(Rust) performed a radiological scoping survey in selected C-T support areas; Buildings 90, 91, and 236 maintenance shops; Buildings 62 and 213 locker rooms; and Building 250 laboratories. Fixed and removable beta-gamma measurements were performed.

1.6.2 Columbium-Tantalum Plant Phase I Characterization

Based on the knowledge of site operations and results of previous radiological assessments, the significant radionuclides of concern were determined to be the radionuclides found in natural uranium and natural thorium. A characterization plan was submitted to NRC in January, 1994. Comments on the plan were received from NRC in June, 1994 and considered prior to implementation of the program. Characterization activities were completed in 1996. Characterization activities focused on the identified radionuclides of concern and the former C-T process and support areas in Plant 5. C-T support areas outside of Plant 5 were also characterized: employee change rooms in Building 62, Plant 3; maintenance areas in Buildings 90 and 91, Plant 8; C-T incinerator and adjacent Building 101 roof in Plant 6, and the wastewater basins in Plant 7.

The preliminary radiological investigation and scoping survey direct measurements were performed using instruments sensitive to gamma or beta/gamma activity. The characterization plan stated that direct measurements would measure alpha, beta, and/or beta/gamma activity. Beta radiation was selected as the basis for characterization activity and any subsequent direct measurements of fixed contamination. Removable contamination was measured using the typical alpha measurement of surface wipe samples. Beta activity was selected for the following reasons:

- Direct measurement of beta/gamma activity would not provide results representative of actual contamination due to contribution of "shine" from subsurface and other areas containing natural gamma emitters (e.g., brick and concrete).

- Beta activity measurements can achieve lower MDAs as beta background is approximately 1/3 that of background beta/gamma activity.

A series of guideline values were established for each radionuclide of concern and were based on the NRC's Branch Technical Position, Option 1. and Policy and Guidance Directive FC 83-23.

Surface contamination guideline values were established for each support and process building. Six surface samples were obtained from buildings 62, 90/91, 213, 238, 246, 247, and 248; and analyzed to define the presence and distribution of radionuclides. Samples of surface contamination on concrete and brick were collected and analyzed for relevant radionuclides to determine average release guidelines for these surface materials.

In order to determine criteria for the various areas, a scan was taken over an area to find locations with high readings. These locations were outlined and scabbled samples were taken from these locations. The samples were then analyzed for the seven isotopes of interest. A beta surface activity guideline was derived based upon the relative distribution of radionuclide activity in the samples and NRC's Acceptable Surface Contamination Guidelines for nuclide groups using equation A-2 from NUREG/CR 5849:

$$\text{Derived Guideline} = 1/(f_1/G_1 + f_2/G_2 + \dots f_n/G_n),$$

where: f_n = fraction of total sample activity contributed by each radionuclide "n", and
G_n = NRC free release surface guideline value for radionuclide "n".

For a more complete discussion of this derived beta surface activity derivation, see Appendices C and D.

The C-T process and support areas were initially separated into affected and unaffected areas based on historical knowledge and facility use. Areas with known contamination and areas for which the previous surveys identified activities in excess of 25% of the guideline values were also identified as affected areas. C-T areas for which there was a low likelihood of contamination based on historical knowledge or for which previous surveys identified activities less than 25% of the guideline values, were identified as unaffected areas. Areas surveyed as unaffected areas were resurveyed as affected areas if any activity exceeding 25% of the guideline value. During the Phase I characterization program a duplicate reading was obtained for every twentieth survey point during the fixed gamma/beta-gamma surveys.

A smear for the measurement of removable contamination was taken at every fifth survey point. A duplicate smear was taken for every tenth smear collected. Approximately 2,000 random smears (every fifth survey data point) were taken during the characterization program. Of these, about 200 had detectable measurements. Only five of these smears had readings greater than 20% of the characterization surface release criteria. Upon examination of the location of these five samples, it was determined that all were in relatively inaccessible areas such as inside of ductwork, behind access panels and p-traps of drain lines. In addition, a smear sample was taken from the area of the highest measurable surface contamination detected during the survey of asphalt surfaces. Evaluation of this smear sample indicated no removable contamination was present.

Due to the large number of smear samples taken and the small number of positive readings, and considering the location of those samples, the possibility of finding large amounts of removable contamination is very small. Further, although some additional characterization will be necessary for waste segregation, data of sufficient quantity and accuracy exists to safely initiate remediation and in-process sampling activities.

Building Interiors - A 6-foot grid system was installed on the floors and mezzanines of each affected building surveyed. The origin of the grid system was the southwest corner of the respective building or room. Direct radiological measurements for beta and/or beta-gamma activity were taken at each 6-foot grid intersection. Removable measurements were taken at every fifth survey point and at locations where direct measurement values exceeded the removable criteria. Table 1-3 identifies the building surfaces surveyed as part of this characterization program.

Piping, Vessels and other Equipment - Certain vessels and other equipment in the C-T process buildings were surveyed as part of the PRI site assessment (see Appendix A). No additional equipment was surveyed as part of the Phase I characterization. Table 1-3 identifies buildings in which equipment surveys were performed.

Building Exterior Walls - The exterior walls of Buildings 213, 238, 246A&B, 247A&B, and 248A&B were surveyed on a 6-foot grid for gamma/beta-gamma activity by taking direct measurements. Removable measurements were taken at every fifth survey point and at locations where direct measurement values exceeded the removable criteria. Buildings 235, 236, and 245 were surveyed on a 12-foot grid. See Table 1-3 for a list of building exterior walls surveyed as part of this characterization program.

TABLE 1-3
BUILDING SURFACE SURVEYS

BUILDING/ AREA	101	213	235	236	238	246A	246B	247A	247B	248A	248B
First Floor, Floors		X	X	X	X	X	X	X	X	X	X
First Floor, Walls		X	X	X	X	X	X	X	X	X	X
First Floor, Ceiling		X	X	X	X	X	X	X	X		X
Second. Flr., Floors					X	X		X	X	X	X
Second. Flr., Walls					X	X		X	X		X
Second. Flr., Ceiling					X	X		X			X
Equipment					X	X	X	X	X	X	X
Exterior Walls		X	X	X	X	X	X	X	X	X	X
Outside Fence Area	X										

Building Roofs - Based upon operating history, proximity to C-T operations, and data obtained during the PRI and scoping surveys, the roofs of Buildings 213, 222, 223, 235, 236, and 245 were surveyed using a gamma walkover scan. Core samples were taken on each roof at locations with elevated gamma activity, or at locations identified in the PRI or scoping surveys, for sample analysis and direct beta-gamma measurements.

For building roofs with no previous survey data (Buildings 250, 240, and 101), a six-foot grid system was installed. Direct measurements were taken for gamma/beta-gamma activity. Removable contamination measurements were taken at every fifth survey location and at locations where direct measurement values exceeded the removable criteria.

Roofs of Buildings 200E, 200W, and 204, which did not house any C-T processing operations, were surveyed as unaffected areas. A total of 20% of the surface area was surveyed with a gamma walkover scan, and direct measurement for gamma/beta-gamma activity.

Roof drains on C-T process buildings were surveyed at their determined end points. All roof penetrations and ventilation systems were surveyed at access/discharge points on the roof. Table 1-4 provides a complete list of building roof surveys conducted during the Phase I characterization.

In addition to the activities described in the characterization plan, Mallinckrodt performed additional measurements in selected internal and external areas of Buildings 101, 235, 250, and 245. In most instances, these measurements were performed to support building remodeling and renovation projects and represent final surveys for these areas. It should be noted that some of the building roofs have been replaced post CT operations, as identified in Appendix A. These measurements are described in additional detail in Section 1.6.4.

TABLE 1-4
BUILDING ROOF SURVEYS

BUILDING	RADIOLOGICAL SURVEY	CORE SAMPLES
101	gamma/beta-gamma	4
200E	gamma/beta-gamma	0
200W	gamma/beta-gamma	0
204	gamma/beta-gamma	4
213	Gamma	4
222	Gamma	4
223	Gamma	4
235	Gamma	4
236	Gamma	4
238	None	4
240	gamma/beta-gamma	4
245	Gamma	3
246A	None	2
246B	None	2
247A	None	2
247B	None	2
248	None	4
250	gamma/beta-gamma	4

1.6.3 Radiological Data Analysis

The radiological information that follows is a summary of all data collection efforts on buildings and structures conducted to-date at the C-T project site. Mallinckrodt has compiled the data from the characterization programs into a single database and the C-T Project buildings and equipment have been divided into 321 survey areas with each wall, roof, floor, and equipment item representing an individual survey area, as shown in Appendix A. Appendix A also provides the detailed radiological data collected to-date for each building and equipment survey area, and in addition to the survey area number, identifies the building, surface, survey results (mean and upper 95% confidence level of the mean of all the samples available for each survey area, and using the Students' t-test with appropriate degrees of freedom), surface release criteria value applied, survey evaluation summary and planned classification for final release survey. A summary evaluation of these results and the planned disposition of buildings and equipment follows.

Buildings

C-T process and support buildings have been extensively surveyed using direct reading instruments to determine the gamma and beta-gamma activity, and using smear samples for evaluation of removable contamination. These surveys have included interior and exterior walls, floors, ceilings, roofs, and equipment (i.e., associated pipes, ducts, fixtures, and other equipment). These surface areas have been identified and data collected as individual survey areas. Each wall, floor, ceiling, and roof is an individual survey area and the equipment is combined into logical survey groupings or areas. Results for each of the 321 survey areas are shown in Appendix A.

1.6.4 Current Radiological Status

Buildings

Buildings within the C-T process and support areas have been grouped according to their radiological status and intended disposition. Buildings 213, 214, 238, 246A&B, 247A&B, and 248 will be demolished. Contaminated equipment will be removed from the roof of Building 204. Contaminated roofing material will be removed from Buildings 222 and 223. Localized decontamination will be performed in Building 250 laboratory and office areas which supported C-T. The interiors of Buildings 62, 90, 91 and the exteriors of Building 101, CT incinerator facility, and other non C-T Plant 5 buildings are clean and will be surveyed for release. Specific areas of Building 250 were surveyed during a recent renovation while others will be locally decontaminated and surveyed for release. Interior and exterior surfaces of Building 245 were surveyed during a recent renovation. Building 250 and 245 surveys will be included in the Final Status Survey Reports.

Buildings116, 117, 219, 700, 704, 705, 706, 707, 708, and 100 were demolished by the DOE under FUSRAP, and thus, have been excluded from this Plan. Buildings that were demolished were taken down to grade, leaving the floor slabs in place until subsurface remediation can be performed. For example, areas under buildings 705 and 706 still have the floor slab in place and will be dealt with during subsurface remediation.

Each building associated with the C-T process or located within Plant 5, including material storage and other support areas in other Plants, is identified in Table 1-5 below. In addition to the list of structures, the table identifies the C-T operational usage, and the planned disposition of each structure. Whether to demolish or to decon, survey, release, and retain a building or part of it may also depend on a management decision about anticipated future use.

TABLE 1-5 DISPOSITION OF C-T PROCESS AND SUPPORT AREA BUILDINGS		
Bldg. and Location	C-T Operational Usage	Planned Disposition
Plant 1 Area		
Building 25	Laboratory	FUSRAP/CT Remediation
Plant 3 Area		
Building 62	Change (Locker) Rooms	Survey and Release
Plant 5 Area		
Building 200	Organic/Inorganic Manufacturing Process	Roof Sampling/Decontamination
Building 204	Inorganic Chemical Manufacturing	Roof Sampling/Decontamination
Building 213	Change and Break Rooms	Demolish
Building 214	Transformer/Switchgear Room	Demolish
Building 219	Warehouse/Shed	FUSRAP*
Building 222	Warehouse	Roof Sampling/Decontamination
Building 223	Warehouse	Roof Sampling/Decontamination
Building 235	Feed Material/URO Storage (East Half)	Surface Decon
Building 236	Maintenance Area, Product Drying	Surface Decon
Building 238	C-T Ore Grinding/Dissolving/T Processing	Demolish
Building 240	Offices	Survey and Release
Building 245	Not Used for C-T (Renovated)	Survey and Release
Building 246A	Offices	Demolish
Building 246B	Solvent Extraction Process	Demolish
Building 247A	C-T Solvent Extraction/Product Storage	Demolish
Building 247B	Columbium Filtration and Drying	Demolish
Building 248	Columbium Filtration/Drying/Calcining	Demolish
Building 250	Offices and Quality Control Labs	Local Decon - Survey and Release
Plant 6 Area		
Building 101 Roof	N/A	Roof Sampling/Decontamination
Bldg 101 Incin Pad	C-T Incinerator	Eqpmt. Removal - Local Decon
Building 116	Receipt/Unloading of C-T Ore	FUSRAP*
Building 117	URO Drum Preparation and Staging	FUSRAP*
Plant 7 Area		
Building 700	Storage of Tin Slag Feed Material	FUSRAP*
Building 704	URO Drum Storage	FUSRAP*
Building 705	C-T Ore Storage	FUSRAP*
Building 706	C-T Ore Storage	FUSRAP*
Building 708	Storage of Tin Slag Feed Material	FUSRAP*
Plant 8 Area		
Building 90/91	Maintenance Areas	Survey and Release

[a] Appendix A is an expanded list of buildings and equipment.

* Buildings were originally demolished by DOE under FUSRAP, but the building slabs were left for future remediation by Mallinckrodt or FUSRAP.

Equipment

Equipment within the C-T process and support area buildings has been surveyed using direct reading instruments to determine the gamma/beta-gamma activity, and using smear samples for evaluation of removable contamination. The disposition of equipment by building and disposition category is covered in the following paragraphs. Specific survey results for equipment within each building by floor/room location is provided in Appendix A.

Considered Potentially Contaminated: The C-T process equipment within Buildings 238, 246A, 246B, 247A, 247B, and 248, is considered potentially contaminated, even though more data are needed on some of the equipment to verify the contamination status and to support segregation and disposal. This equipment will be segregated by known characterization results and if practical, decontaminated and/or volume reduced.

Equipment on the roofs of Buildings 200E, 200W, 204, 213, 235, and 236 is also considered potentially contaminated because of their proximity to the processing buildings, however, further testing is required to support segregation and disposal, decontamination and/or volume reduction.

In addition, the equipment located on the Building 101 Incinerator Pad is considered contaminated and will be segregated by known characterization results and volume reduced if practical.

Considered Clean: Equipment within Buildings 90 and 91 is considered clean. This equipment will be surveyed and released.

1.6.5 Conclusion

The C-T project buildings and equipment have been subjected to comprehensive radiological characterization investigations. These programs have delineated the nature and extent of radiological contamination present and have confirmed the suspected radiological conditions, for both affected and unaffected areas, based on process history and site knowledge, using surface beta measurements. Concentrations of radionuclides that exceed acceptance criteria have been identified on building surfaces and equipment, and these locations accurately recorded for subsequent remediation.

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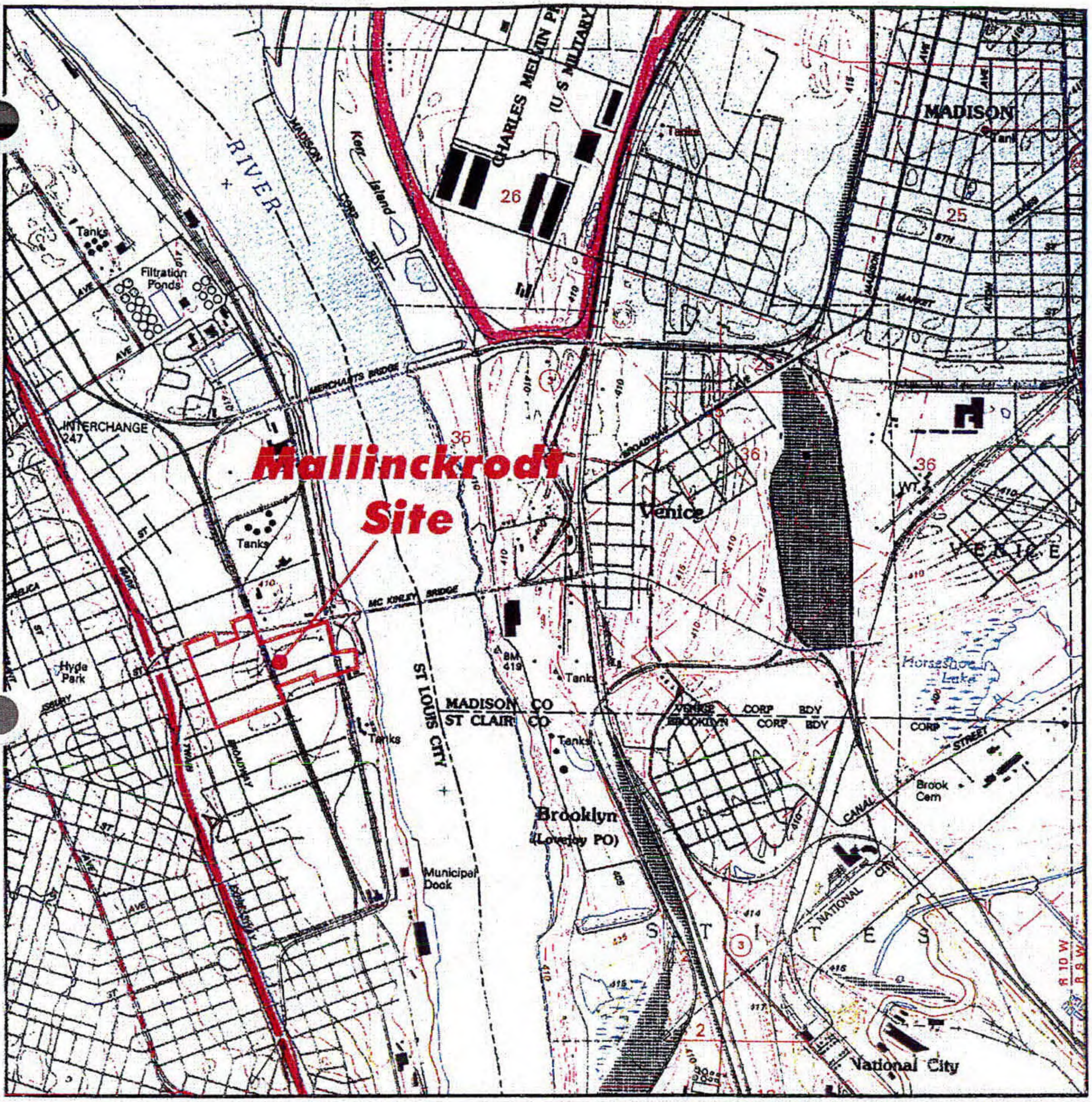

Note: Drawing taken from USGS Granite City, IL-MO quadrangle, dated 1993

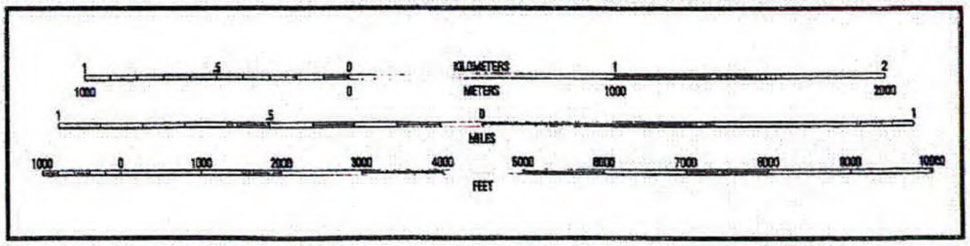

Figure 1-1
Site Location Map
Rev 0

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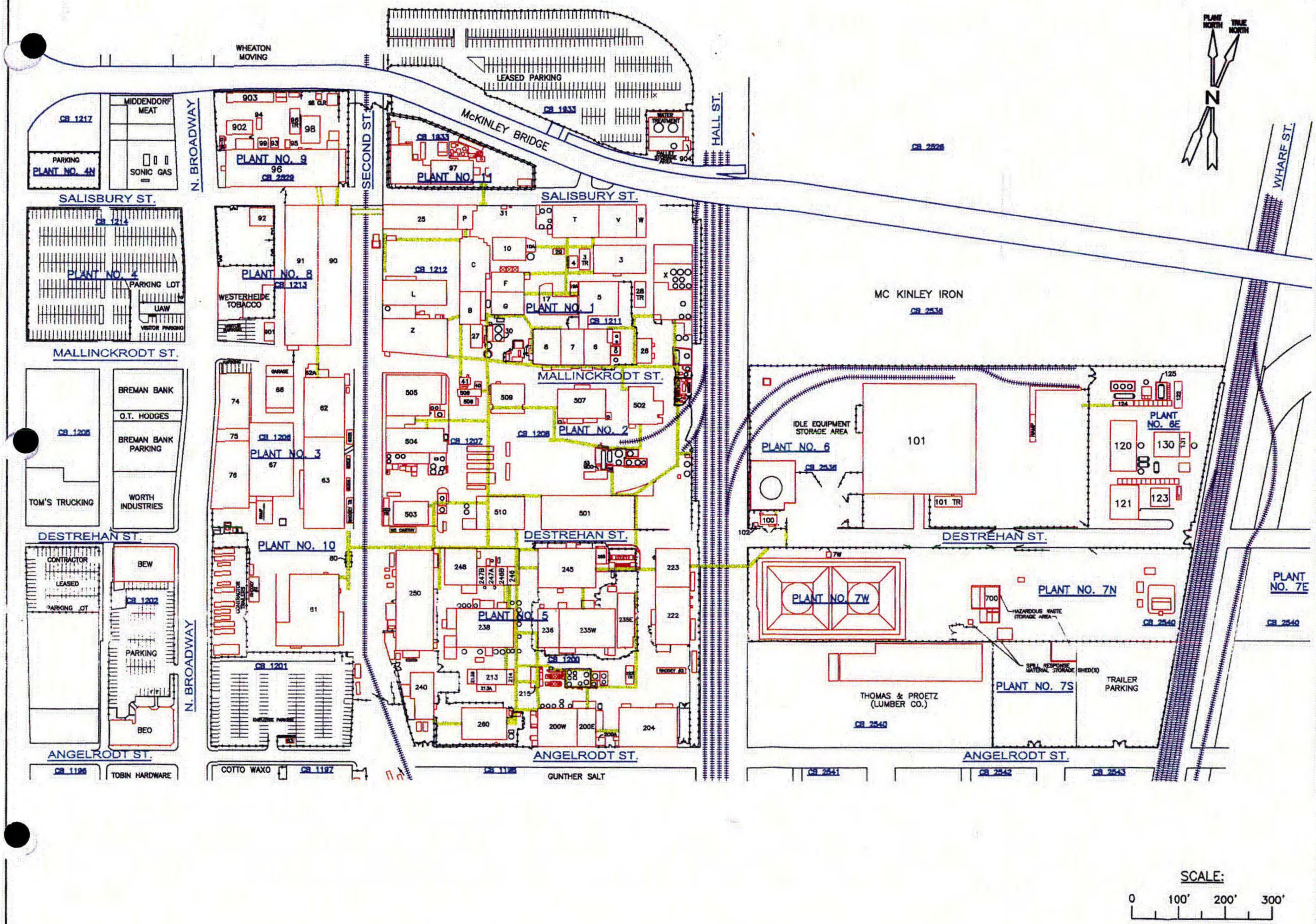

C02

NO.	DATE	ENGR.	DESCRIPTION
2	11/27/00		GENERAL REVISION
1	10/23/97		GENERAL REVISION

DRAWING REVISIONS

JOB NO. | PROJECT NO.

MALLINCKRODT

ST. LOUIS, MO.

ST. LOUIS PLANT
SITE MAP
FIGURE 1-2

SITE STL | PLANT ALL | BLDG. ALL | FLOOR N/A
SCALE 1"=100' | DATE 11/28/00
DR. BY J. MCMAHON | ENGR.
CHECKED
DRAWING NO. FIGURE 1-2 | REV. 2

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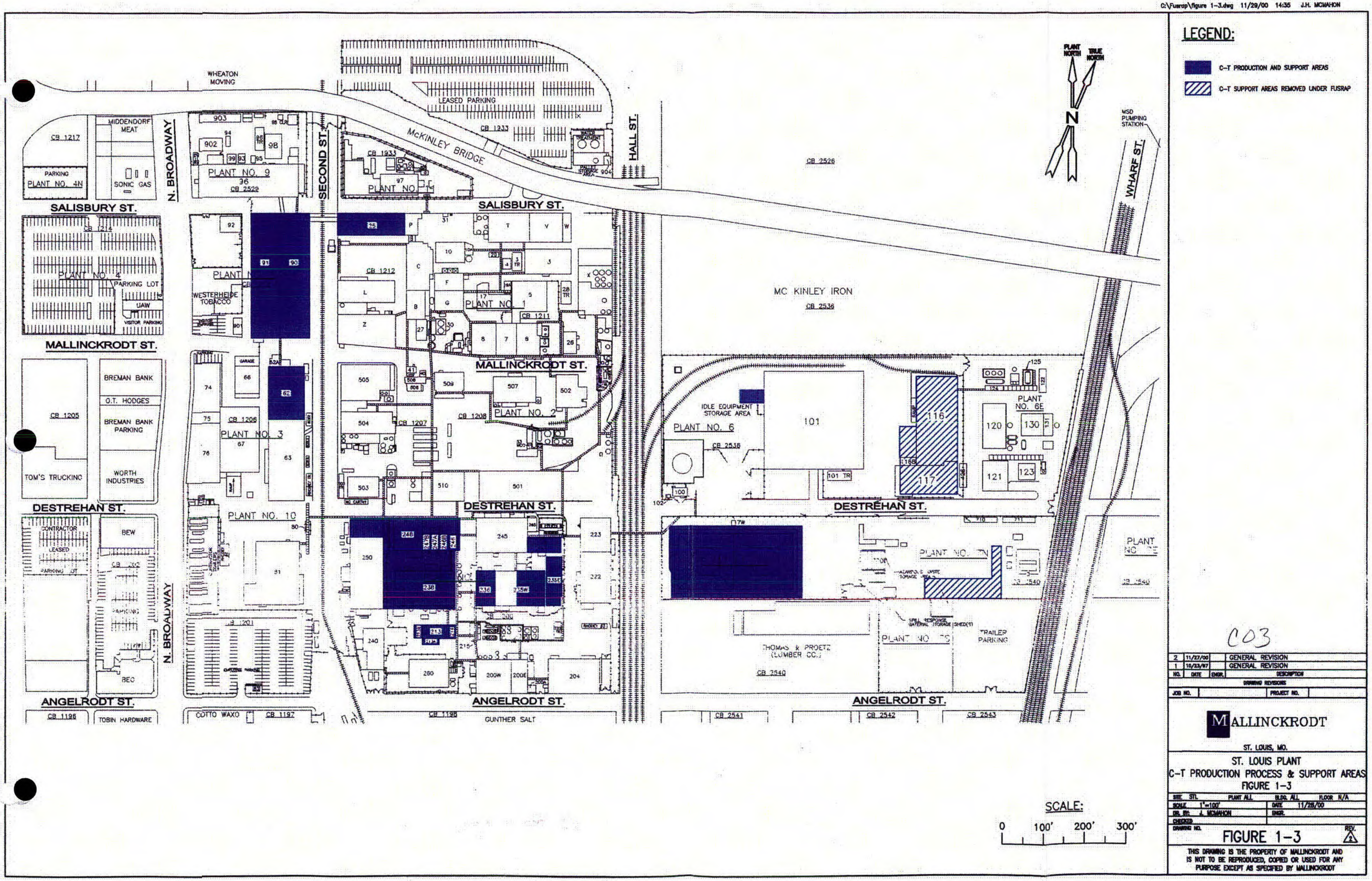
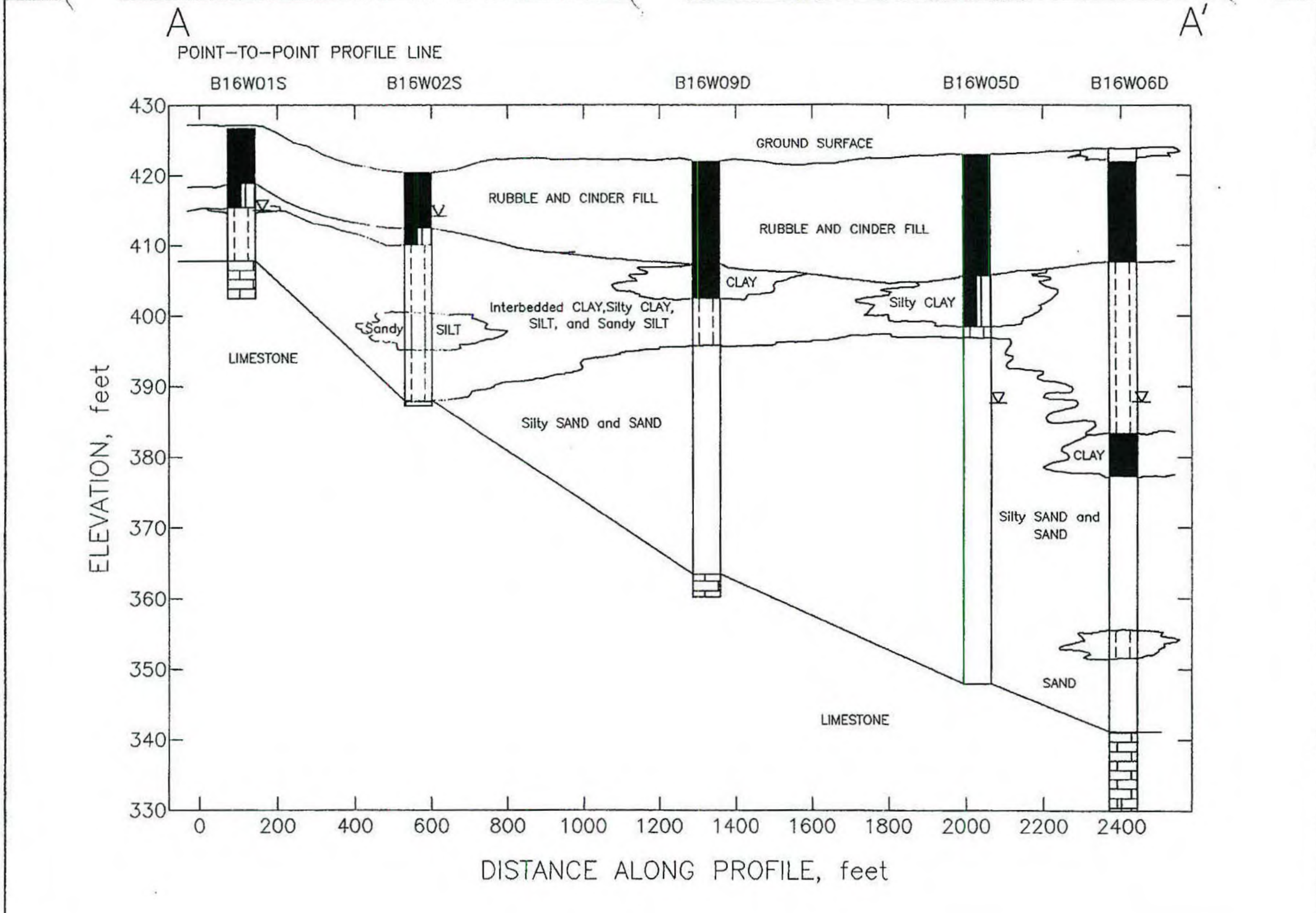
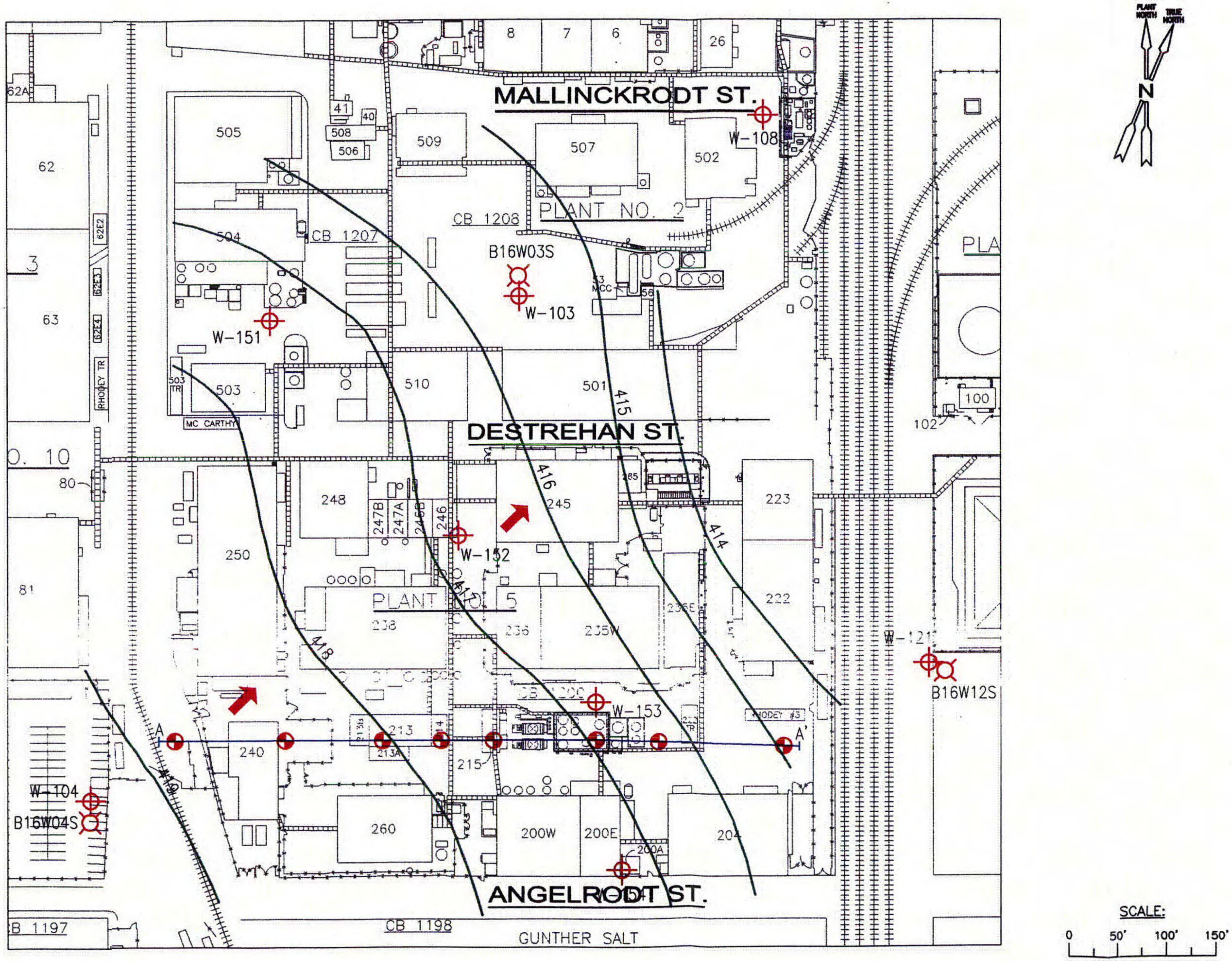




SOURCE:
Bechtel National, Inc. September 1990. Radiological, Chemical, and Hydrogeological Characterization Report for the St. Louis Downtown Site in St. Louis, MO. Formerly Utilized Sites Remediation Action Program (FUSRAP). Volumes I–III: Revision 1. DOE/OR/20722-258

FIGURE 1-4
HYDROGEOLOGICAL CROSS SECTION
REV. 1

fn = HYDRO_XN 10/16/97



NOTES:

1. FIELD INFORMATION COMPILED ON JUNE 12, 1989
2. THE SOURCE FOR THIS DRAWING IS: BECHTEL NATIONAL, INC. SEPTEMBER, 1990. RADIOLOGICAL, CHEMICAL, AND HYDROGEOLOGICAL CHARACTERIZATION REPORT FOR THE ST. LOUIS DOWNTOWN SITE IN ST. LOUIS, MO. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM (FUSRAP) VOLUMES 1-3; REVISION 1. DOE/OR/20722-258.

LEGEND:

FUSRAP/DOE MONITORING WELL (1988)

MALCOM PIRNIE MONITORING WELL (1989)

414 WATER LEVEL CONTOUR, PERCHED GROUNDWATER JUNE 12, 1989 (FEET, MSL)

GENERAL DIRECTION OF GROUNDWATER FLOW

WABASH DRILLING CO. (1947)

A A' LOCATION OF GEOLOGIC PROFILE

C04

NO.	DATE	ENGR.	DESCRIPTION
2	11/27/00		GENERAL REVISION
1	10/23/97		GENERAL REVISION

DRAWING REVISIONS

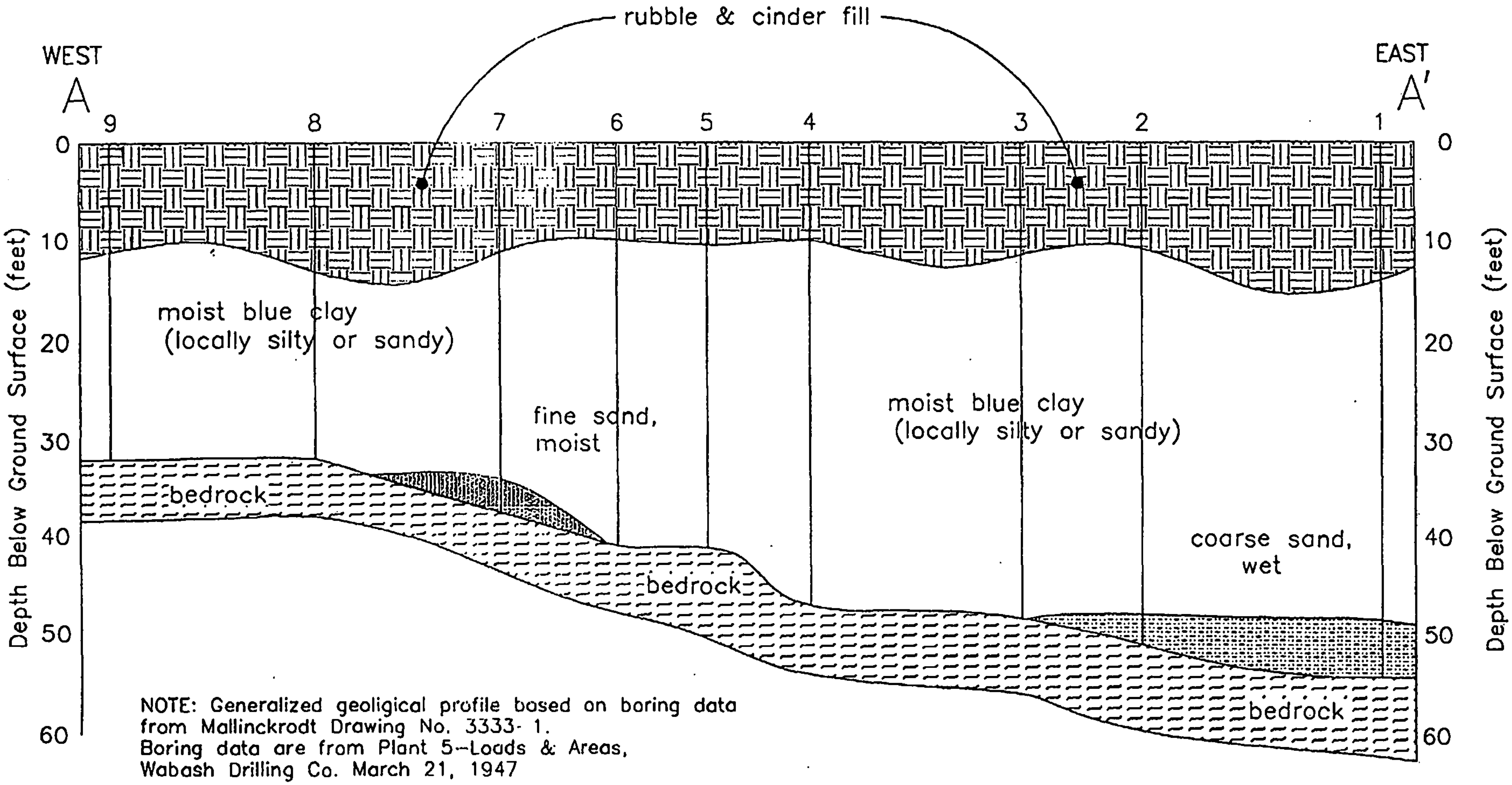
JOB NO. | PROJECT NO.

MALLINCKRODT

ST. LOUIS, MO.

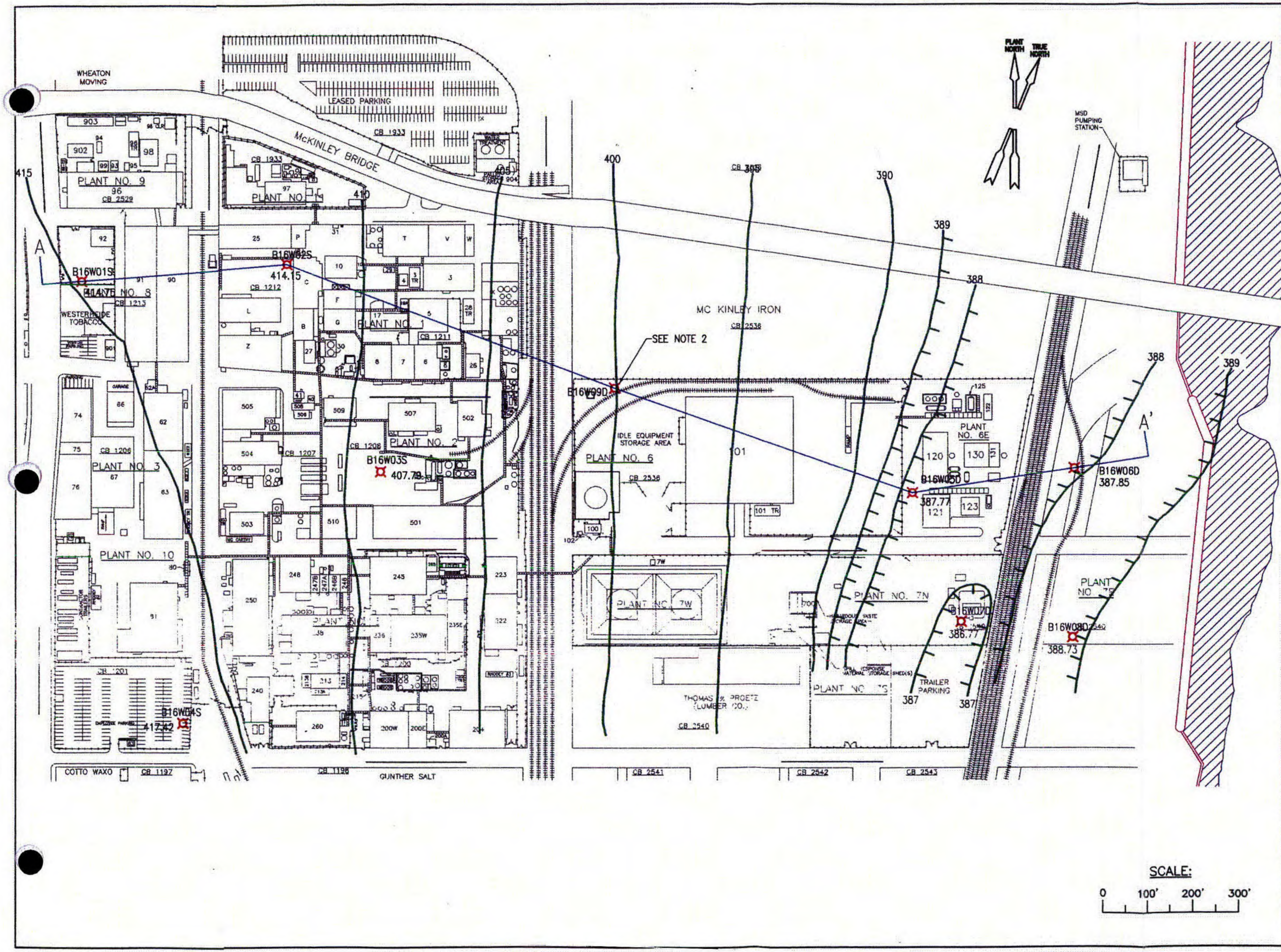
ST. LOUIS PLANT
MONITORING WELL LOCATIONS
FIGURE 1-5

SITE STL PLANT ALL BLDG. ALL FLOOR N/A
SCALE 1"=50' DATE 12/06/00
DR. BY: J. MCMAHON ENGR.
CHECKED
DRAWING NO. FIGURE 1-5 REV. 2



GENERALIZED GEOLOGICAL PROFILE
PLANT 5

FIGURE 1-6
GENERALIZED GEOLOGIC PROFILE
PLANT 5
REV. 1



NOTES:

1. FIELD INFORMATION COMPILED ON JUNE 9, 1989
2. WELL B16W09D WAS NOT COMPLETED UNTIL AFTER THE READINGS WERE TAKEN.
3. THE SOURCE FOR THIS DRAWING IS: BECHTEL NATIONAL, INC. SEPTEMBER, 1990. RADIOLOGICAL, CHEMICAL, AND HYDROGEOLOGICAL CHARACTERIZATION REPORT FOR THE ST. LOUIS DOWNTOWN SITE IN ST. LOUIS, MO. FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM (FUSRAP) VOLUMES 1-3; REVISION 1. DOE/OR/20722-258.

LEGEND:

MONITORING WELL

390 ELEVATION OF GROUNDWATER IN FEET ABOVE NATIONAL GEODETIC VERTICAL DATUM (NGVD). GRADE ELEVATION OF THE SITE RANGES FROM 419 TO 425 FEET ABOVE NGVD.

CONTOUR OF GROUNDWATER ELEVATION

C05

NO.	DATE	ENGR.	DESCRIPTION
2	12/06/00		GENERAL REVISION
1	10/23/97		GENERAL REVISION

DRAWING REVISIONS

JOB NO. PROJECT NO.

MALLINCKRODT

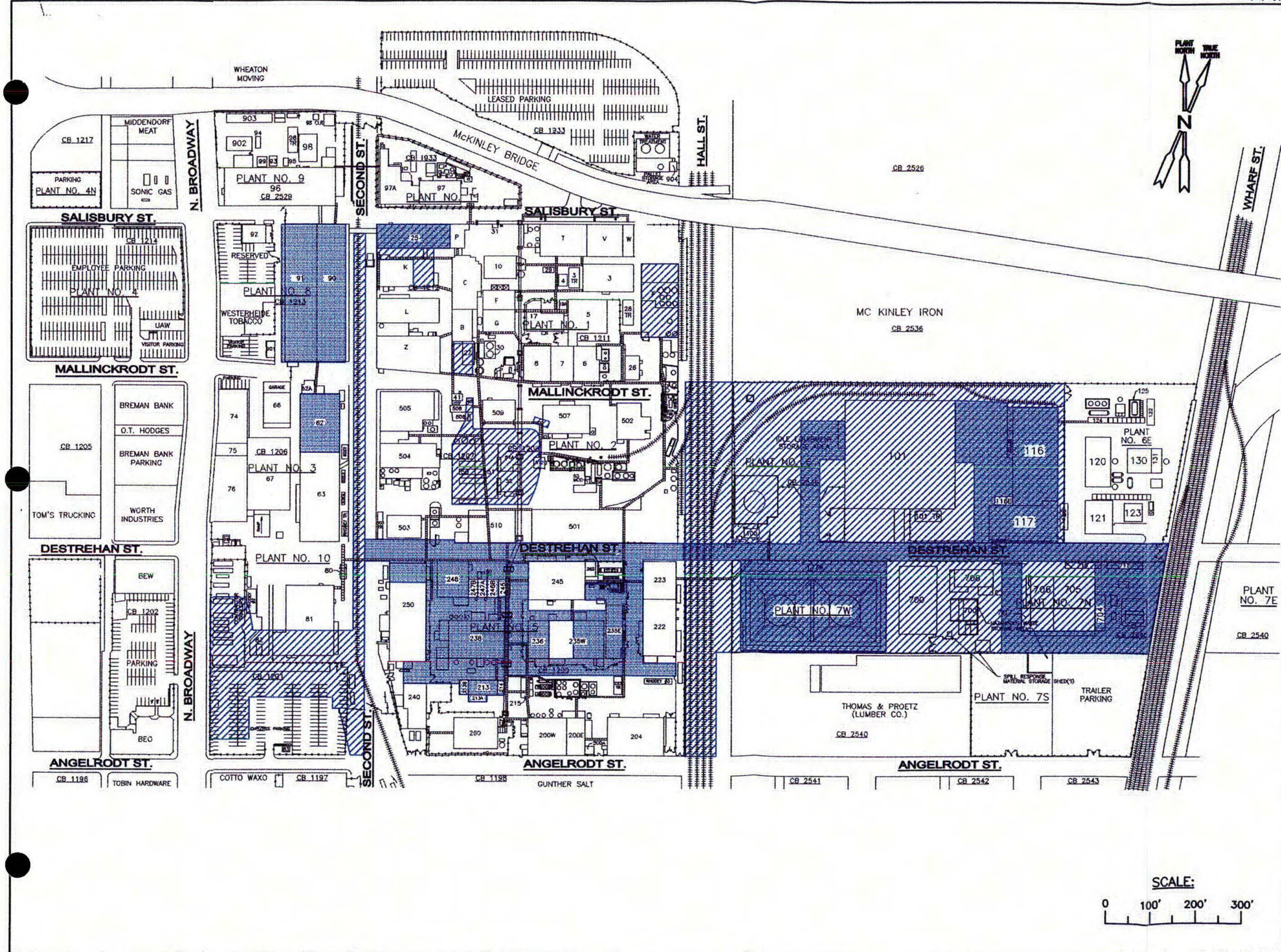
ST. LOUIS, MO.

ST. LOUIS PLANT
WATER LEVEL CONTOUR MAP-ALLUVIAL SAND UNIT
FIGURE 1-7

SITE STL PLANT ALL	BLDG. ALL FLOOR N/A
SCALE 1"=100'	DATE 12/06/00
DR. BY J. MCMAHON	ENGR.
CHECKED	

DRAWING NO. FIGURE 1-7 REV. 2

S:\CorpEng\DOCS\FUSRAP\figure 1-8 rev 4.dwg 06/04/01 09:53 J.H. MCMAHON



LEGEND:

THIS IS WHERE OPERATIONS OF EITHER MED-AEC OR C-T HAS OCCURED OVER TIME

C-T PRODUCTION AND SUPPORT AREAS

MED-AEC OPERATIONS
- PLANTS 1 & 2 (1942-1946)
- PLANT 4 (1942-1961)
- PLANT 6 (1946-1958)
- PLANTS 6E & 7 (1950-1958)

NOTES:

1. THIS DRAWING IS A GENERAL DRAWING SHOWING C-T AND MED-AEC OPERATIONS. ALTHOUGH MANY BUILDINGS AND STRUCTURES HAVE CHANGED OVER TIME, THIS DRAWING IS NOT INTENDED TO DEPICT ACTUAL DELINEATION.

C06

NO.	DATE	ENGR.	DESCRIPTION
4	06/04/01		REVISED CT AREAS
3	04/25/01		ADDED NOTES

DRAWING REVISIONS

JOB NO. | PROJECT NO.

MALLINCKRODT

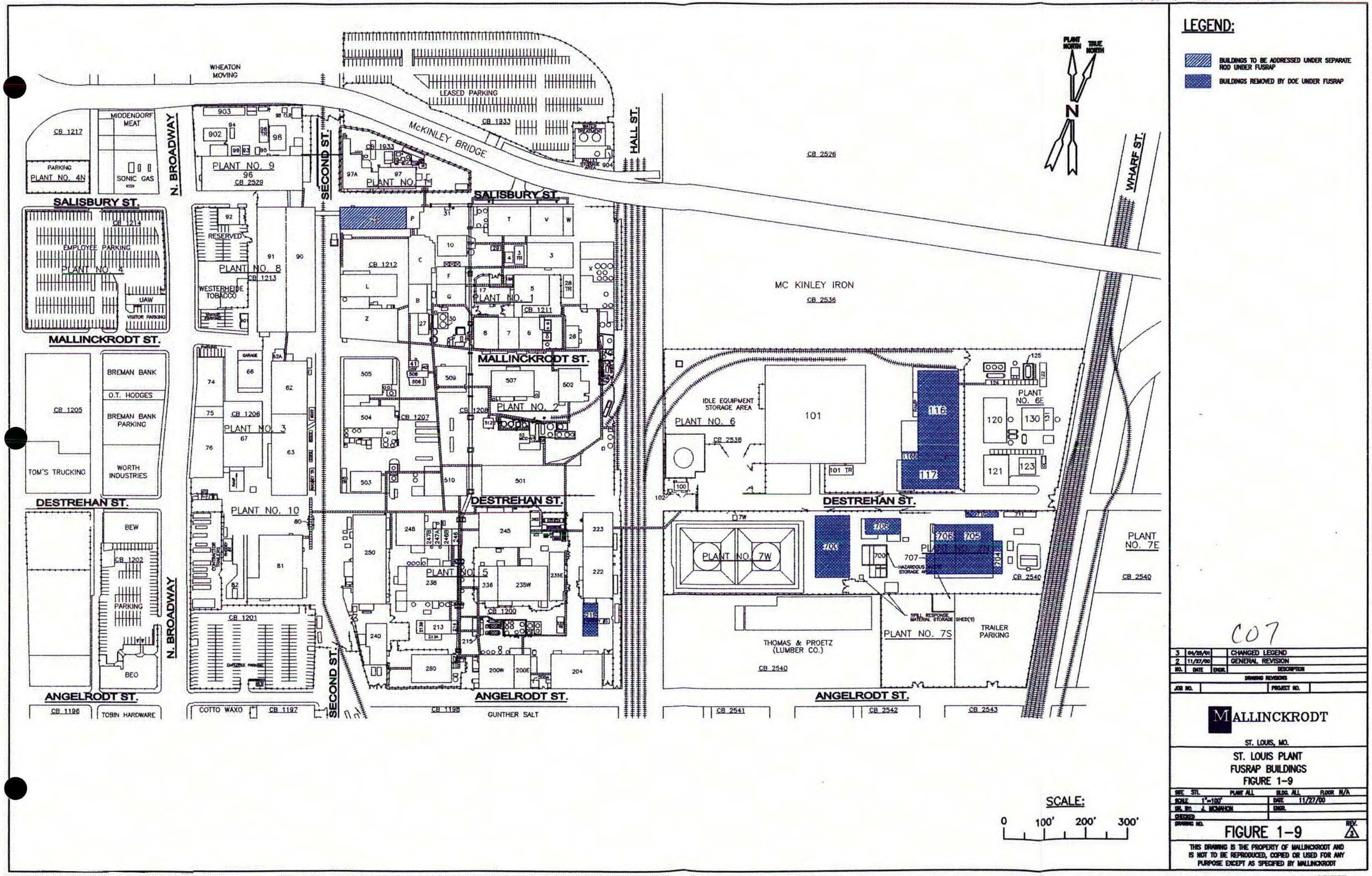
ST. LOUIS, MO.

ST. LOUIS PLANT
MED-AEC PRODUCTION & SUPPORT AREAS
FIGURE 1-8

SITE STL	PLANT ALL	BLDG. ALL	FLOOR N/A
SCALE 1"=100'		DATE 11/28/00	
DR. BY: J. MCMAHON		ENGR.	
CHECKED			

DRAWING NO. FIGURE 1-8 REV. 4

S:\CorpEng\DOCS\FUSRAP\figure 1-9 rev 3.dwg 06/05/01 11:06 J.H. MCMAHON



T_BLK25.DWG

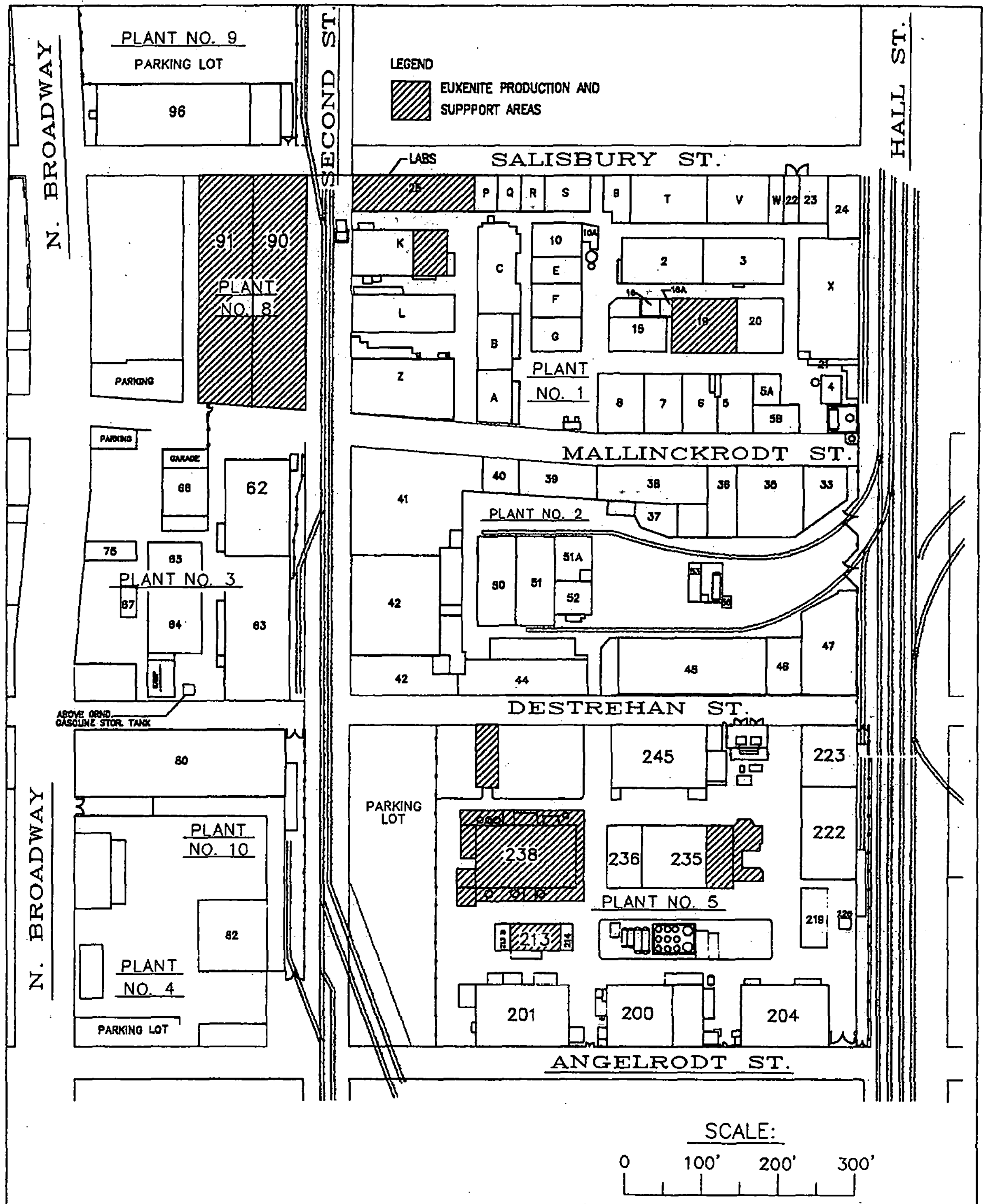
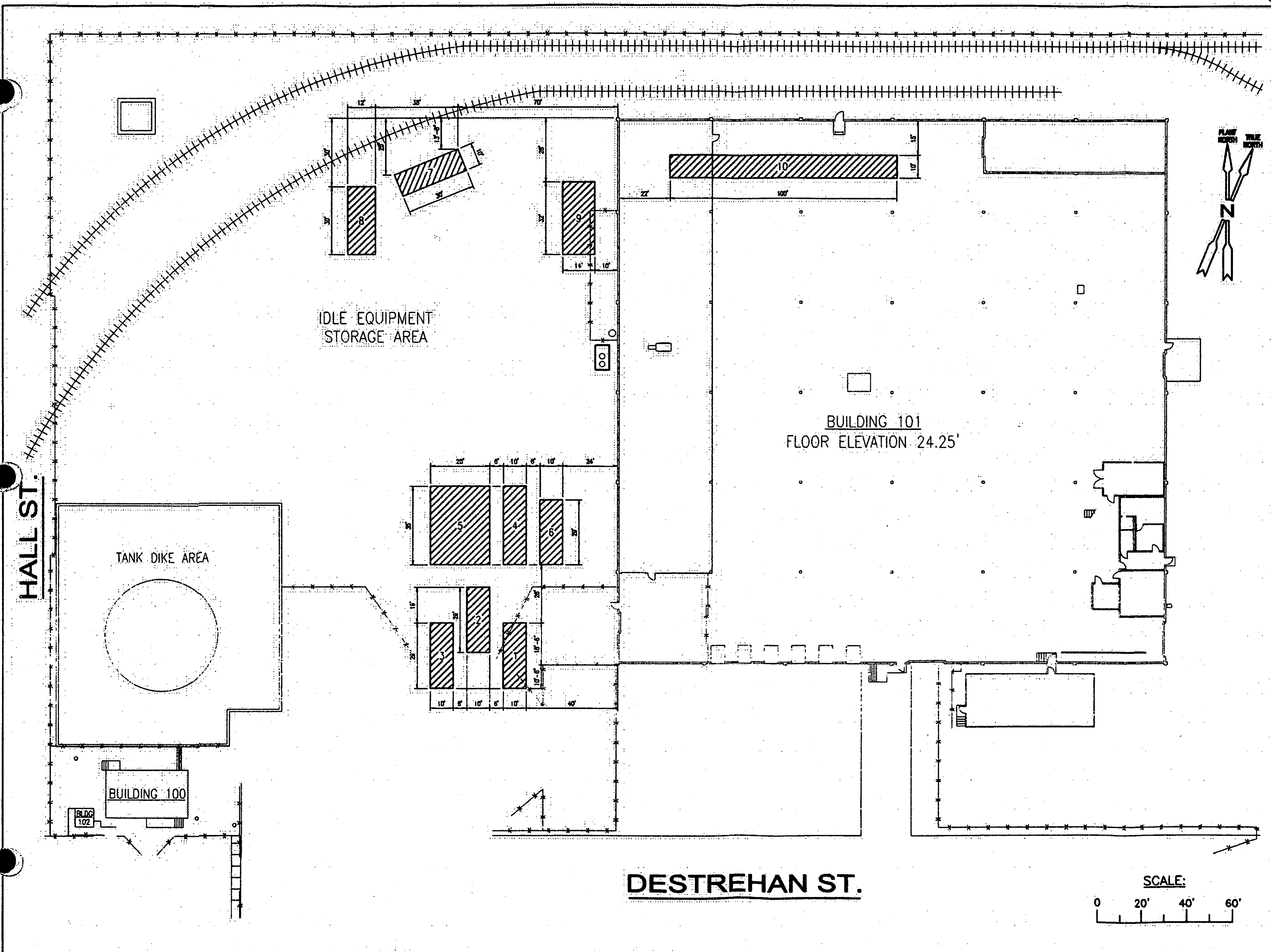


FIGURE 1-10
FORMER EUXENITE SUPPORT AREA
REV. 1

fn=euxenite 10/15/97

C:\Fuerop\figure 1-11.dwg 11/30/00 10:21 J.H. MCMAHON



LEGEND:

URO BURIAL FROM JULY 2, 1973 THRU JULY 17, 1973

BURIAL SITE NO.	BOTTOM ELEV.(MCW)	TOP ELEV.(MCW)	VOLUME CU. FT.
1	18.00'	20.00'	[illegible]
2	17.50'	18.00'	[illegible]
3	17.50'	18.00'	[illegible]
4	17.50'	18.50'	[illegible]
5	17.50'	18.50'	910
6	18.00'	20.00'	[illegible]
7	[illegible]	[illegible]	[illegible]
8	16.25'	18.25'	720
9	17.00'	18.00'	[illegible]
10	16.50'	18.50'	2000

C08

DWG. NO.	TITLE
SK-11706	URO BURIAL SITE
SK-11819	URO BURIAL DETAILS
4332-201-001	PLANT NO. 7 SOUTH PIT LOCATIONS
4332-202-001	URO BURIAL LAYOUT

REFERENCE DRAWINGS

NO.	DATE	ENGR.	DESCRIPTION
2	11/30/00		GENERAL REVISION
1	08/07/97		GENERAL REVISION

DRAWING REVISIONS

JOB NO. PROJECT NO.

MALLINCKRODT

ST. LOUIS, MO.

PLANT 6
URO BURIAL LAYOUT
FIGURE 1-11

SITE STL PLANT 6 BLDG. ALL FLOOR N/A
SCALE 1"=20' DATE 11/28/00
DR. BY J. MCMAHON ENGR.
CHECKED
DRAWING NO. FIGURE 1-11 REV. 2

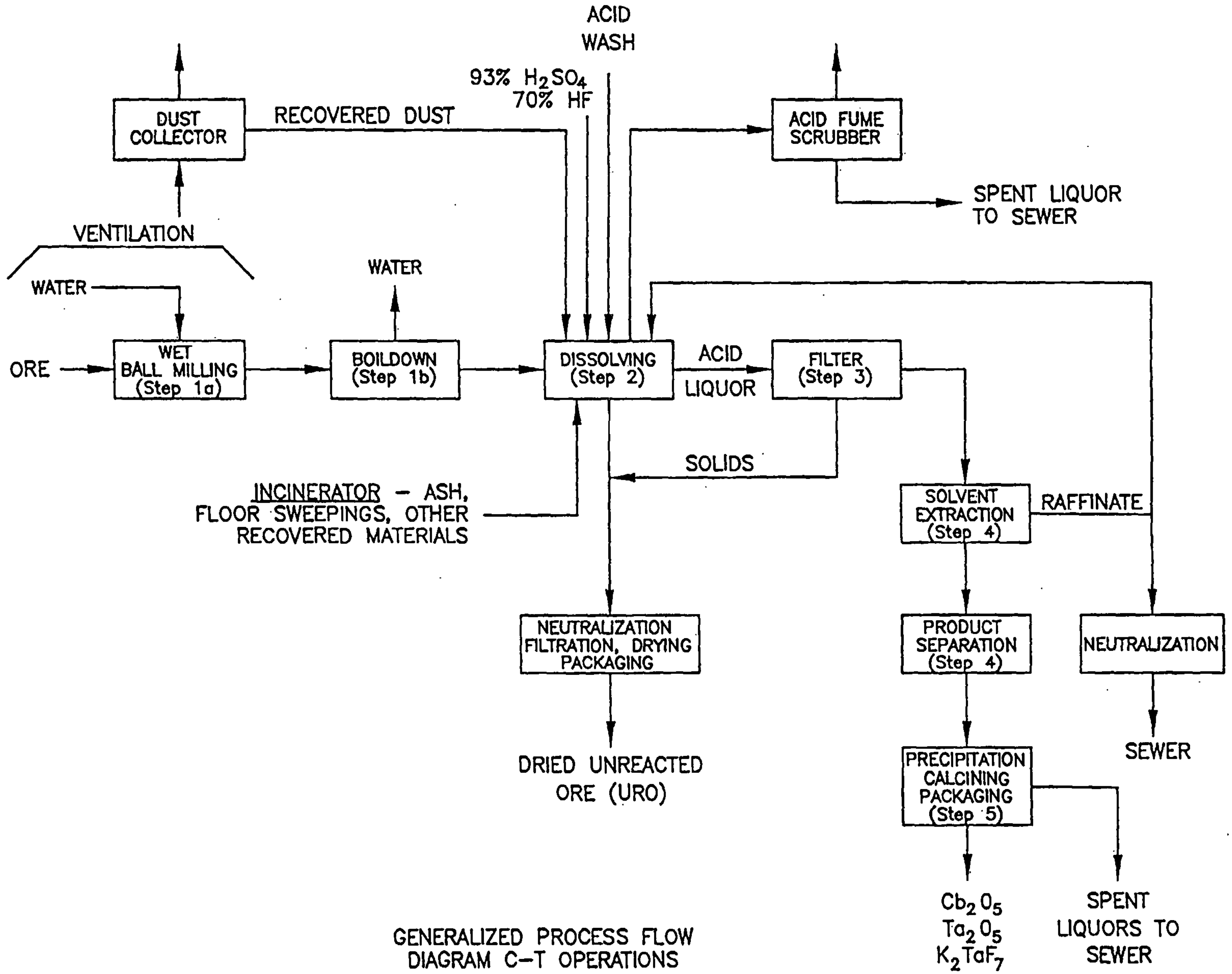


FIGURE 1–12
GENERALIZED PROCESS FLOW DIAGRAM
C–T OPERATION
REV. 1

fn = Gen_proc 8/6/97

SECTION 2

DECOMMISSIONING OBJECTIVES, ACTIVITIES, AND TASKS

Mallinckrodt Inc.

Phase 1 Plan
For C-T Decommissioning

NRC Docket: 40-06563
NRC License : STB-401

January 9, 2002

2. DECOMMISSIONING OBJECTIVES, ACTIVITIES AND TASKS

2.1 DECOMMISSIONING OBJECTIVE

The objective of the Phase I Plan is to remediate the C-T process equipment and buildings, and support buildings to obtain an unrestricted release or to dismantle them and dispose of the debris. Equipment will be released in accordance with NRC "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material". The remaining Plant 5 buildings will be released in accordance with this Plan.

2.2 DECOMMISSIONING CRITERIA

2.2.1 Introduction

Based on C-T process history and site characterization, the radiological constituents[1] addressed in this Phase I Plan are:

- U-238, U-235, and U-234, all from naturally occurring uranium (and their progeny Th-230, Ra-226, and other short-lived isotopes); and
- Th-232 from naturally occurring thorium, and its progeny (Ra-228, Th-228, and other short-lived isotopes).

The release limits proposed in this Phase I Plan are listed in Table 2-1 for removable equipment surfaces and in section 2.2.3 for building surfaces. These criteria apply to residual regulated radionuclides and excludes background radioactivity, for example, radioactivity from non-regulated radionuclides such as K^{40}.

2.2.2 Equipment[2]

Although Mallinckrodt prefers to dispose of contaminated equipment when it is cost-effective, equipment that is to be released without restriction on use will be subject to NRC "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," as specified in Materials License STB-401, condition 16. Table 2-1 lists equipment surface release limits for the uranium series and thorium series distributions representative of C-T. The composite maximum acceptable average areal density ($MAAAD_\alpha$) for equipment. 2400 dpmα/100 cm^2 is derived by the sum-of-fractions method as described in Appendix H. A composite MAAADα = 2400 αdpm/100 cm^2 applies to surfaces of all C-T affected equipment surveyed for unrestricted release.

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[1] When a radionuclide contributes < 10% of the total effective dose equivalent and is not in a predictable, fixed ratio to a key radionuclide, it does not have to be accounted for (ref. NUREG-1727, Appendix E, §9, p. E16).

[2] Examples of *equipment* are described in section 4.4.1.1.

Table 2-1
Equipment Surface Release Limits

Equipment Location	Average[a] (dpmα/100 cm^2)	Maximum (dpmα/100 cm^2)	Removable (dpmα/100 cm^2)
Any	2400	7200	500

[a] Basis is average of 69 derivations based on 69 C-T samples. U series -to- Th series ratio averaged 2 -to- 1 (ref. Appendix D).

Interpretation of measurements to assess compliance in comparable units is explained in Appendix H.

2.2.3 Buildings[3]

Buildings remaining after decommissioning are subject to a radiological dose standard of 25 mrem/yr as required by 10 CFR Part 20, Subpart E. A universally applicable, derived maximum acceptable average areal density in and on buildings and similar structures surveyed for release without restriction during C-T decommissioning is 13,000 dis/(min·100 cm^2). Derivation of this value and justification of its appropriateness are explained in Appendix C.

Interpretation of measurements to assess compliance in comparable units is explained in Appendix D if gross beta radiation is measured or in Appendix H if gross alpha radiation is measured.

The floor slab, subject to survey in accordance with Appendix A, of a building that was not a C-T process or support building[4] and where subsoil contamination is not expected[5] may be released without restriction on its disposition provided it subjected to a final radiation status survey and meets the composite surface release limit, 13,000 dis/(min·100 cm^2).

2.2.4 Building Disposition

In the event a building or other structure is to be demolished, before dismantlement, it will be decontaminated only to the extent necessary for health and safety control.
The waste material will be characterized prior to release to a carrier for transport and for receipt by the disposal site operator.

- If waste material, including building debris, contains more than an exempted quantity of source material as defined in 10 CFR 40.13 (a), it will be disposed at a regulated disposal facility authorized by radioactive materials license to receive it. Segregation from other material will be maintained.

[3] Examples of *building* components are described in section 4.4.1.2.

[4] Process and support buildings are named in Table 1-5. The floor slabs of Buildings 62 and 90/91 may be released.

[5] A reason not to expect subsoil contamination could be either history of use, *i.e.*, not used for processing nor storing radioactive material or it could be data from a radiation survey.adjacent the slab.

- If waste material, including debris, contains more than unrestricted release radioactivity concentration (ref. §2.2.3) and no more than an exempted quantity (*i.e.*,concentration) of source material as defined in 10 CFR 40.13 (a), it will be disposed by an NRC-authorized transfer to a disposal facility subject to approval of the cognizant state regulatory agency(ies) in which the disposal facility is located.

- Building surfaces and material which meet the requirements of FC 83-23 can be released in accordance with license conditions 16, or in accordance with the future NRC regulations on clearance, or under the provisions of 10 CFR 20.2002.

- In the event mixed waste is identified during remediation activities, the licensee will characterize such wastes, identify a disposal method, assess the effect on the schedule, assess related disposal costs, and modify handling procedures, as needed, and will notify the NRC.

2.3 C-T PROJECT DECOMMISSIONING ACTIVITIES

Most of the activities required to decommission the C-T project site will take place within Plant 5. However, certain structures and areas outside Plant 5 were also involved in C-T work and will also be remediated. Within Plant 5, the C-T Project remediation area boundaries have been defined as:

- everything south of the south edge of Destrehan Street,

- everything north of a line drawn along the south sides of Buildings 201, 200 and 204.

- everything west of a line drawn on the east side of Bldgs. 222 and 223, and

- everything east of a line drawn along the west sides of Buildings 240 and 250.

See Figure 2-1 for a map of the Plant 5 C-T Project remediation areas.

The following C-T support areas outside of Plant 5 will also be surveyed and, if necessary, remediated during Phase I:

- Building 62 in Plant 3,[6]

- Building 101 area in Plant 6 (specifically the C-T incinerator), and

[6] Building 62 floor pad or Building 90/91 crane pad may be released provided it is surveyed and meets final radiation status composite surface release limit for buildings specified in section 2.2.3. If any other building slab, not listed in Table 1-5, where contaminated subsoil is not expected, were surveyed and found compliant with building surface release criteria, it could be released.

- Buildings 90 and 91 crane pad in Plant 8.[6]

See Figure 2-2 for a map of the St. Louis Plant C-T support areas requiring surveying and possible remediation.

During the planning stages, alternative methods for decommissioning the C-T project site were evaluated. Some of the alternatives evaluated included various options for decontaminating buildings as well as equipment decontamination. Mallinckrodt, after a careful review of site and facility characterization data, research program results, and engineering cost analyses, has decided to: (a) demolish buildings 213, 214, 238, 246A&B, 247A&B, and 248; and (b) survey and decontaminate (if necessary) the remainder of the building structures and the equipment. If it were to be more cost-effective to dismantle and dispose than to decontaminate and perform a final survey, then Mallinckrodt may dismantle and dispose as per Section 2.2.4.

Decontamination and volume reduction methods were selected to minimize the volume of radioactive waste requiring disposal. This Phase I Plan is based on:

- a preference to dismantle and dispose when it is cost-effective;
- decontaminating process equipment when it is judged to be cost-effective compared to disposal;
- decontaminating or removing selected contaminated areas of concrete, block, and brick if needed to reduce the average mass concentration activity below the release limits; and
- dismantling buildings and equipment and close packing of debris to increase the bulk density, thereby lowering the shipping volume and transportation costs.

2.3.1 Technical Approach to Decommissioning

Mallinckrodt's generally preferred approach is to dismantle and dispose of radioactively contaminated buildings and equipment when it is cost-effective. Mallinckrodt and its contractor will decide whether decontamination, if necessary, and final survey of individual buildings and or equipment is preferred. The technical approach for decommissioning during Phase I is based on:

- removing all equipment and services from Buildings 213. 214, 238, 246A&B, 247A&B. and 248 in preparation for demolition;
- roof sampling and decontaminating roof and exterior surfaces of Buildings 101, 200, 204, 222, 223, 235, 236, 240, 245, and 250, if necessary to prepare for the final radiological survey for release for unrestricted use;

- locally decontaminating and surveying affected interior areas in Building 250 for release for unrestricted use;

- surveying for release for unrestricted use Building 62;

- perform surveying for release for unrestricted use on selected areas, *i.e.,* crane pad, and equipment in Buildings 90, 91;

- remove incinerator on pad near Building 101;

- demolishing the interior walls, elevated floors, mezzanines and the remaining shells (walls and roofs only) of Buildings 213, 214, 238, 246A&B, 247A&B, and 248.

- concrete slab debris from elevated floors, block, and brick in preparation for sampling and disposal;

- packaging and shipping for an NRC-authorized transfer to a licensed facility or disposal at an appropriate waste disposal facility; and,

- removing or fixing[7] any surface contamination remaining on the concrete floors after building demolition. Process building ground-floor slabs will be removed during Phase II. Non-process building ground floor slabs may be removed during Phase I. At least once every calendar quarter after fixative is applied, Mallinckrodt's Site Radiation Safety Officer, or designee, will inspect each *fixed* slab and will notify appropriate construction and or manager(s) to avoid action that would remove fixative from the protected floor slabs. Any area found without fixative to resist removal of contamination will have fixative re-applied.

2.3.2 Decommissioning Activities

The activities to be performed during Phase I decommissioning are grouped below in several categories based on similar work.

- **Utility relocation, termination, and temporary connections**

  The C-T Project is served by overhead gas, electric and cooling water, and underground city water and fire mains. Prior to the start of decommissioning, all services which feed through the C-T project site, will be relocated to minimize utility disruption for the rest of the site.
  As work commences in each building to be demolished, all services to that building will be terminated. Contractor feed points will be established to

[7] *Fixing* means putting a substance on the slab surface that adheres surficial radioactive contamination onto the slab to resist removal of the contamination by foot or rubber-tire-vehicle traffic.

allow the decommissioning contractor access to and control of temporary electricity, water, and other utilities as appropriate within the area. Utilities were already terminated in Building 238 prior to the application for a possession-only license.

A new construction power source will be installed to provide electrical power service to the main site during its decommissioning. This service will likely be a 480-volt, 600-amp service. The new construction power source will be available at two connection points, currently planned to be near building 213 and near building 247, although other locations may be selected during detailed planning. Construction power will be run from these points into each building via temporary lines and connected to power carts for contractor use.

Buildings where limited decontamination or removal activities are to take place (e.g., Building 250) have adequate power to support the decontamination activity, although it may be necessary to locally de-energize the area to be remediated and run temporary lines from distribution points elsewhere in the building.

- **Removal of C-T process equipment**

The removal of process equipment, whether located inside or exterior to the buildings, will be performed using standard equipment. C-T process equipment will either be transferred to another licensee, decontaminated and released for unrestricted use, disposed of as is, or reduced in size for disposal. The C-T incinerator located in Plant 6 will also be removed.

- **Interior demolition of the C-T Project process buildings**

During demolition of the internal walls and floors, the building may be modified to provide high efficiency or HEPA filtered containment as appropriate. Support systems and services such as ventilation, air monitoring, fire protection, and temporary or emergency power will be maintained, as practical, until the building demolition is complete.

- **Decontamination of C-T support facilities and other areas**

Contaminated support facilities and other areas will be removed for disposal. The only C-T process equipment outside of Plant 5 is the incinerator near Building 101 in Plant 6. The incinerator will be reduced in size to efficiently fit into standard shipping containers.

Localized contamination in Building 250 will be removed by scrubbing or abrasive cleaning, or removal of the contaminated item - e.g. lab drain piping. No other decontamination of C-T support buildings (buildings 90, 91, 62) is required. Contaminated roofing and/or roof equipment will be removed as required.

Potential radiological hazards due to waste generation during decontamination activities are expected to be minor. Liquid effluent will be minimized during decommissioning. Dry abrasive cleaning, when used, will result in airborne particulate. In such instances, containment zones may be established by erecting temporary walls of plastic, cloth, or other material around the remediation area to minimize the spread of contamination. If needed for control, air would be exhausted through roughing filters, prefilters, and high efficiency or HEPA filters, as appropriate, prior to discharge into the main building, and a negative pressure would be maintained in the enclosure relative to the rest of the building. The pressure differential would be verified through the use of a differential pressure gauge or smoke testing to determine the direction of airflow.

- **Asbestos removal for C-T Project process buildings**

All asbestos abatement work will be performed in accordance with the EPA and Occupational Safety and Health Administration (OSHA) regulations and guidelines. State of Missouri asbestos regulations, and City of St. Louis ordinances. The buildings within the C-T project site that will be demolished have limited amounts of asbestos containing material (ACM). Buildings 213, 214, 238, 246A&B, 247A&B, and 248 have asbestos-containing, built-up roofing.

- **Demolition of the C-T Project process buildings**

At the time of demolition, the buildings will consist of exterior walls, the grade-level concrete floor slab and the roof. The exterior walls are constructed of two or three course block and/or brick walls. approximately 12 inches thick. Structural steel columns support the roof, and formerly supported the interior upper floors. Demolition of the exterior walls and roof will be performed in sections. The order of demolition will be removal of the brick and block sections between the structural steel columns. followed by removing the roof and demolishing the structural steel. Finally, if the upper surface of the grade-level concrete floor slab is still contaminated, the surface will either be decontaminated or have a fixative applied to it. Removal of the floor slab is part of Phase II Plan.

Removal of the brick and block will be performed with appropriate dust control, such as a water mist or a high efficiency or HEPA filtered, as appropriate. temporary enclosure. Such methods provide adequate removal of particulates from air by capture in mist or by containment of potentially contaminated airborne particulate by establishing inward airflow and lowering the airborne particulate inside the enclosure to minimize worker exposure.

In the event a temporary enclosure is used, the preferred temporary enclosure will be a lean-to design and constructed in-place. The enclosure will consist of a rigid frame and a plastic sheet contamination barrier. The enclosure will be attached to the wall section to be removed with additional plastic sheeting and sealed at the ground with sandbags or equivalent. In this way, the remaining portion of the building will act as part of the enclosure.

After the brick and block have been removed from the enclosed section of the building, operations will be suspended and the enclosure moved to an adjacent building section. The openings between the enclosure and the building will again be sealed with plastic sheeting, and the demolition process repeated. Upon completing the progressive removal of the block and brick, the plastic sheeting enclosure frame will be disassembled. The materials will be packaged for proper disposal when no longer needed for building demolition.

The nonmetallic wall and roof debris will be removed using standard construction equipment and may be transported to an on-site area for further processing and disposition.

Demolition waste will be managed as described in Section 2.2.4.

The Phase 2 Plan activities will include removal of the grade-level concrete floor slabs under the demolished buildings, asphalt and concrete pavement, and subsurface material. These activities will be defined in detail in the Phase 2 Plan.

After Phase 2 and before the license is terminated, Mallinckrodt will perform a confirmatory radiation survey to assess whether buildings in Area 5 previously released by a final status survey might have been contaminated as a result of subsequent decommissioning activity. The confirmatory survey would emphasize floors near entrances since re-contamination would most likely be by tracking-in.

2.4 PROJECT ORGANIZATION AND CONTROL

This section describes the project organization that will become effective upon NRC approval of the Phase I Plan. As the project moves forward, changes to the project organization may be justified in response to the varying level of site activities. Effective with NRC approval of this plan, the licensee may make changes to the organizational structure provided: (1) the safety and quality functions maintain an independent reporting relationship from that of operations; and, (2) the individuals responsible for safety functions satisfy the educational and experience qualifications in Section 2.4.3. See Attachment 2 for administrative controls.

2.4.1 Project Organizational Structure

The C-T decommissioning organizational structure will consist of a management team from Mallinckrodt and the decommissioning contractor. The C-T project decommissioning organization is illustrated in Figure 2-3.

The Mallinckrodt Site Environmental Manager/C-T Project Manager will provide overall direction for the C-T project decommissioning. The Project Manager will be supported by managers responsible for contract administration, environmental affairs, quality assurance, project engineering, and legal.

While Mallinckrodt will be responsible for ensuring that NRC requirements are met, Mallinckrodt has contracted the services of a joint venture of Burns & McDonnell Engineering Company, Inc. and Nextep Environmental, Inc.

The contractor will implement the radiological, occupational, and environmental safety programs and the procedures to implement the program requirements. The contractor will also provide an independent quality assurance program, and provide and manage a trained, experienced labor force to perform the decommissioning activities.

The contractor's Project Manager will provide day-to-day direction for the C-T Project decommissioning, but will report directly to the Mallinckrodt Project Manager. The contractor's Project Manager will be supported by operations, environmental, safety, and health personnel who will provide technical advice, resources, and day-to-day management of the decommissioning workers.

The responsibilities of the primary managers are provided in section 2.4.2. Section 2.4.3 identifies the minimum qualifications for managers with safety-related responsibilities.

2.4.2 Managerial Responsibilities

Mallinckrodt Site Environmental Manager/C-T Project Manager is responsible for ensuring that the overall C-T decommissioning project, and the work being performed by all the contractors, is in accordance with applicable health, safety, quality, technical, and contractual requirements. The Mallinckrodt Project Manager is responsible for assuring that the requirements of the NRC are met. He also is responsible for coordinating activities between Plant operations and the decommissioning contractor. He shall use other Mallinckrodt staff as appropriate to perform this coordination. The Mallinckrodt Project Manager has full authority to halt any operation which he believes has the potential to threaten the health and safety of personnel, the public, or the environment, or is not meeting the requirements of the NRC. He is also responsible for ensuring that established environmental programs and contractor environmental programs are in compliance with applicable and relevant laws and regulations. The Site Environmental Manager/C-T Project Manager is the designated contact point with the NRC.

Mallinckrodt Site Radiation Safety Officer (SRSO) is responsible for ensuring that radiation programs are in compliance with applicable and relevant laws and regulations and for auditing the contractor's compliance with these programs. The SRSO advises the Mallinckrodt C-T Project Manager on matters pertaining to radiation safety. The SRSO reports to the Site Environmental Manager. The Mallinckrodt SRSO has the authority to halt any operation which he believes has the potential to threaten the health and safety of personnel, the public, or the environment.

Contractor's Project Manager is responsible for the execution of all of the decommissioning activities. He is the primary interface with the Mallinckrodt C-T Project Manager. The contractor's Project Manager is directly responsible for all field work being performed by the contractor. As such, he is responsible for field work being conducted in accordance with applicable health, safety, quality, and technical requirements, including Mallinckrodt procedures. The contractor's Project Manager has full authority to stop any activity when he believes these requirements are not being met.

Contractor's Environment, Safety and Health Representative is responsible for implementation of the environmental and safety programs. This function reports directly to the contractor's Project Manager and is functionally independent of Operations, thus assuring independence of action in matters pertaining to health and safety. The contractor's ES&H Representative has the authority to stop work on any decommissioning operation based on safety concerns.

Contractor Operations Manager reports directly to the contractor's Project Manager and receives program and task directives directly from the contractor's Project Manager. The contractor's Operations Manager is responsible for nuclear materials accounting, field engineering, waste tracking, daily work assignments for all field personnel and the physical execution of the decontamination and decommissioning activities for the C-T decommissioning project.

Contractor's Quality Assurance Representative is responsible for establishing and assuring implementation of the contractor quality assurance program. This function is independent of Operations and will report directly to the Mallinckrodt C-T Project Manager with copies of audits provided to the contractor's Project Manager. The details about how Quality Assurance will be incorporated into Phase I decommissioning are provided in Section 5.0.

2.4.3 Minimum Qualifications for Safety Related Positions

Mallinckrodt Site Environmental Manager/ C-T Project Manager must hold a baccalaureate degree in science or engineering and have a minimum of five years of project management experience.

Mallinckrodt Site Radiation Safety Officer must have completed a basic health physics course, must have a minimum of five years experience in radiation safety, and must be familiar with NRC radiation protection standards.

Contractor's Project Manager must hold (a) a baccalaureate degree in science or engineering and have a minimum of five years of experience in the nuclear industry, including five years of project management experience or (b) a baccalaureate degree in science or engineering and have a minimum of five years of construction experience with at least five years of experience in nuclear activities as well as five years of project management experience.

Contractor's ES&H Representative must hold a baccalaureate degree in science or engineering and have a minimum of five years experience in nuclear safety, health physics, industrial safety, or environmental safety, and five years of management experience.

Contractor's Quality Assurance Representative must hold (a) a baccalaureate degree with at least two years experience in quality assurance or quality control.

2.4.4 Work Controls

Decommissioning activities for the C-T Project will be performed in accordance with written instructions. There will be four general types of written instructions in use for the C-T Project: Plans, Procedures, Field Instructions, Safety Permits (Safety Work Permits, Hot Work Permits, etc.). These written instructions will be reviewed and approved by the contractor operations representative and the ES&H representative, as well as being reviewed and approved by the Mallinckrodt Project Manager or his designated representative where applicable, e.g. when health, safety, and quality of the decommissioning issues are addressed.

Plans are broad-based documents that provide management guidance for operations in the field. Plans include decommissioning contractor developed plans such as a Health and Safety Plan, Waste Management Plan. Final Status Survey Plan, Quality Assurance Plan, and the Industrial Safety Plan. All plans affecting the health, safety, and quality of the decommissioning will be reviewed by Mallinckrodt. Specific procedures, field instructions, and radiation work permits, as discussed below implement these programs and plans.

Procedures are essential, written instructions and specifications to provide the controls needed to ensure safety and other objectives of the procedure are achieved. A procedure is ordinarily appropriate for repetitive activities such as defining how to operate equipment, calibration methods, or other routine work activities.

Field Instructions are the primary written instructions for decontamination and decommissioning work for the C-T Project. They may be as short as a simple job order (e.g. run temporary electricity into Building XX), or as detailed as necessary to safely accomplish the work. The detailed field instructions provide specific instructions in a logical and sequenced manner for one-time or short duration activities requiring a disciplined approach to ensure that health and safety requirements are met.

Safety Work Permits (SWP) specify necessary industrial and radiation safety controls, including personnel monitoring, monitoring devices, protective clothing, respiratory protection equipment, special air sampling, and additional precautionary measures. SWP are issued for non-routine activities where there is a need to prescribe the conditions under which the work may be done in order to assure adequate protection of workers and the public from the potential hazards that may be encountered. SWP required for decommissioning activities are usually identified during the preparation and review of procedures and field instructions. SWP will be prepared in accordance with the contractors written procedure that will be reviewed by Mallinckrodt.

Daily Safety Permits check for hazardous conditions, allow use of spark-generating tools and equipment, ensure adequate ventilation, *etc.*

Mallinckrodt will implement an administrative controls plan that establishes guidelines for creation, use, and control of these administrative controls to ensure that C-T decommissioning is performed safely, and in conformance with governing regulations, the NRC license, and the NRC-approved decommissioning plan. It will also implement a plan to manage C-T decommissioning records.

2.4.5 Final Status Survey

Each final status survey (FSS) will be specified by documented design. Each FSS design and each FSS report is subject to Mallinckrodt's administrative control plan and are subject to review and approval as described therein.

2.5 SCHEDULE

A preliminary schedule has been developed for the Phase I decommissioning activities described in Section 2.3. This schedule is presented in Appendix F.

The key elements forming the bases for the schedule are:

- removing the equipment from the C-T project site buildings will take approximately 8 months;
- demolishing the buildings in Plant 5 will take approximately 12 months;
- relocating the utilities will take approximately 6 months and certain utility relocation must be completed prior to the start of demolition; and

- completing the final radiation surveys and NRC verification that the residual radioactivity limits have been met will occur concurrent with other activities and not impact the length of the Phase I schedule.

- In the event mixed waste is identified during remediation activities, the licensee will assess the effect on the schedule and will notify the NRC.

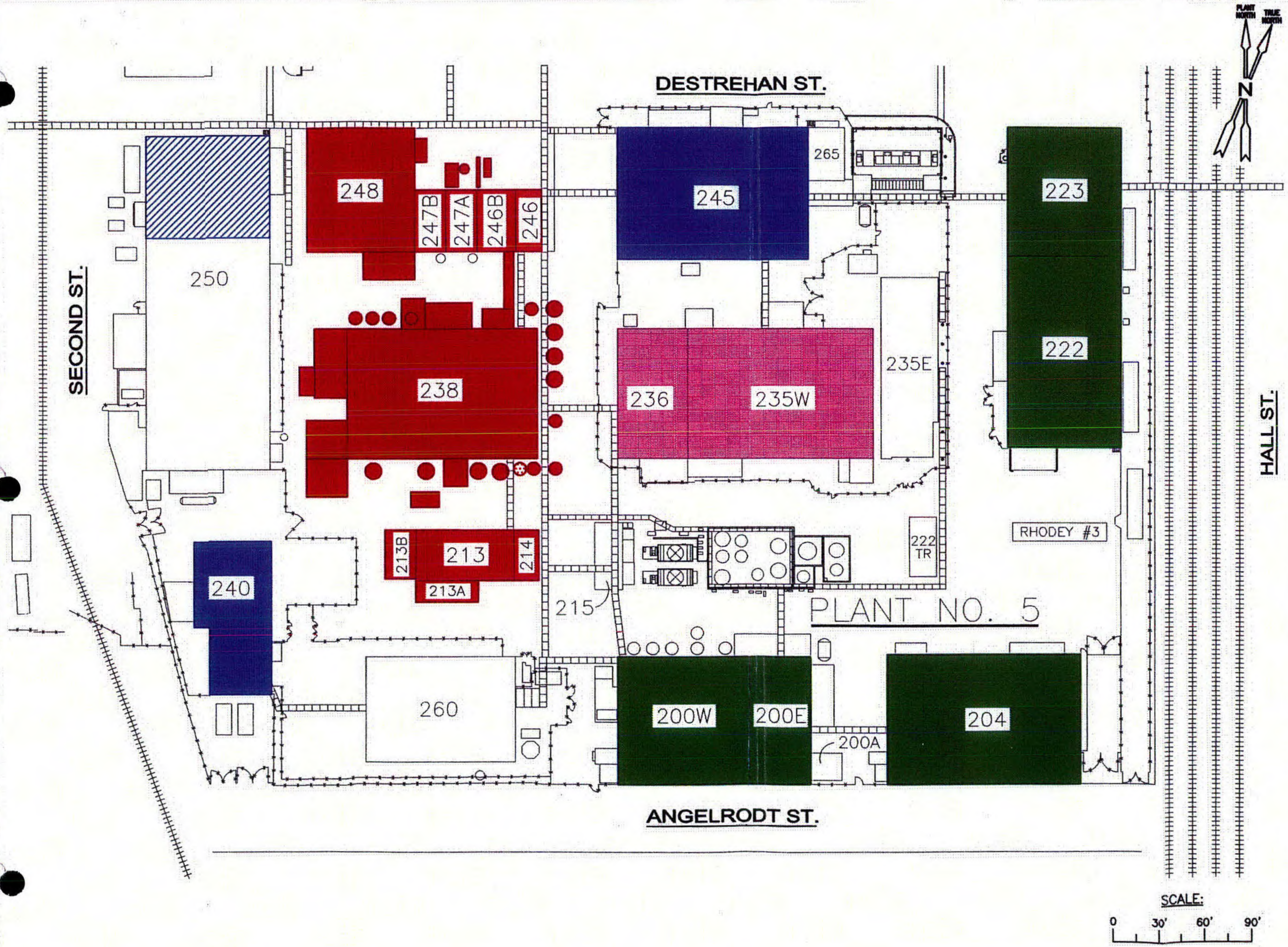
2.6 ADJUSTMENTS TO THE DECOMMISSIONING PROCESS

Decommissioning is intended to remove sources and structures, thereby diminishing the extent of controls needed to assure protection of health, safety, and the environment as it progresses. Mallinckrodt may make justified changes related to the decommissioning process without filing an application for an amendment to the license to change the decommissioning plan when the following conditions are satisfied:

- the change does not conflict with requirements specifically stated in license STB-401 or impair Mallinckrodt's ability to meet all applicable NRC regulations;
- there is no degradation in safety or environmental commitments addressed in the NRC-approved decommissioning plan for the activity being performed;
- the quality of the work, the remediation objectives, or health and safety will not be adversely affected significantly; and
- the change is consistent with the conclusions of actions analyzed in the Environmental Assessment;
- Result in there no longer being reasonable assurance that adequate funds will be available for decommissioning;
- Reduce the coverage requirements for scan measurements and/or sample density;
- Increase the derived concentration guideline levels and related minimum detectable concentrations (for both scan and fixed measurements methods);
- Increase the radioactivity level, relative to the applicable derived concentration guideline level, at which an investigation occurs;
- Change the statistical test applied to one other than the Sign test or Wilcoxon Rank Sum test, or those described in NUREG - 1505;
- Increase the Type I decision error;
- Decrease an area classification (i.e., impacted to non-impacted; Class 1 to Class 2; Class 2 to Class 3; or Class 1 to Class 3);

Persons having managerial responsibilities as identified in Section 2.4.2, including proponents of controlled documents, will be asked to report any change to the decommissioning process that would seem to violate either of conditions a through k. Determination of whether the conditions are met will be made by and each change shall require approval by Mallinckrodt's C-T Environmental Manager/Project Manager, and Site Radiation Safety Officer, the contractor's Project Manager, and its ES&H representative. The contractor's and Mallinckrodt's C-T Project Managers are responsible for ensuring that the project is in accordance with applicable health, safety, quality, and technical requirements. Mallinckrodt's C-T Project Manager shall be responsible for approval of operational and engineering changes. The contractor's ES&H representative and Mallinckrodt's Site Radiation Safety Officer are responsible for assuring that each change conforms to health and safety program requirements.

Mallinckrodt shall retain records including written safety and environmental evaluations of each authorized change that provide the basis for determining that conditions in this §2.6 have been met. The records of each evaluation shall be retained until license termination.



LEGEND:

- DEMOLISH
- SURFACE DECONTAMINATION & EQUIPMENT REMOVAL
- ROOF SAMPLING & DECONTAMINATION
- SURVEY AND RELEASE
- LOCAL DECON SURVEY & RELEASE

C09

NO.	DATE	ENGR.	DESCRIPTION
2	01/16/01		GENERAL REVISION
1	10/23/97		GENERAL REVISION

DRAWING REVISIONS

JOB NO. | PROJECT NO.

MALLINCKRODT

ST. LOUIS, MO.

ST. LOUIS PLANT
C-T PRODUCTION PROCESS & SUPPORT AREAS
FIGURE 2-1

SITE STL	PLANT ALL	BLDG. ALL	FLOOR N/A
SCALE 1"=30"		DATE 10/23/97	
DR. BY: J. MCMAHON		ENGR.	
CHECKED			

DRAWING NO. FIGURE 2-1 REV. 2

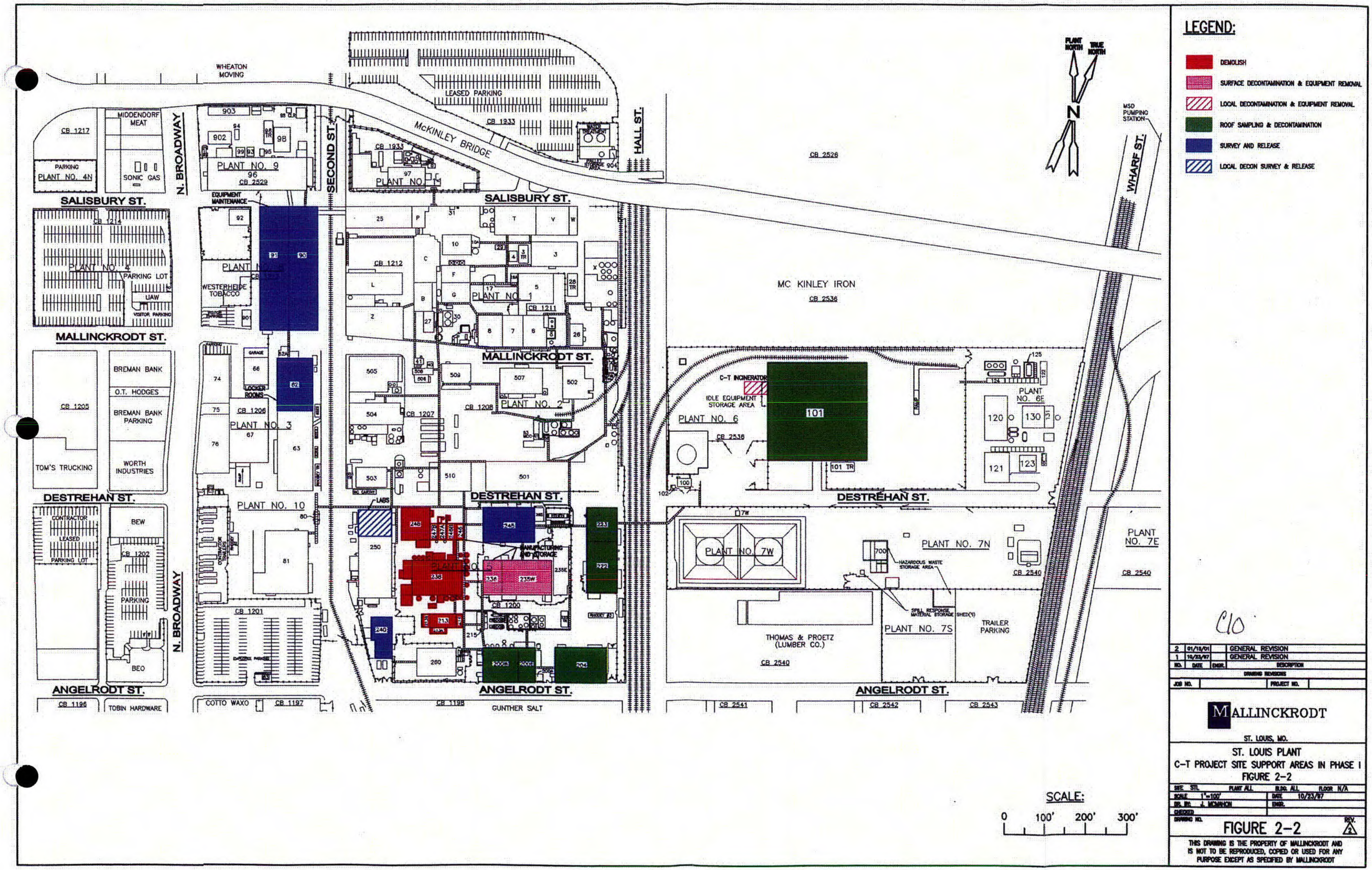

LEGEND:
DEMOLISH
SURFACE DECONTAMINATION & EQUIPMENT REMOVAL
LOCAL DECONTAMINATION & EQUIPMENT REMOVAL
ROOF SAMPLING & DECONTAMINATION
SURVEY AND RELEASE
LOCAL DECON SURVEY & RELEASE
PLANT NORTH
TRUE NORTH
N
MSD PUMPING STATION
WHEATON MOVING
LEASED PARKING
CB 1933
McKINLEY BRIDGE
HALL ST.
WHARF ST.
CB 2526
MIDDENDORF MEAT
CB 1217
PARKING PLANT NO. 4N
SONIC GAS
N. BROADWAY
PLANT NO. 9
CB 2529
SECOND ST.
PLANT NO. 14
SALISBURY ST.
EQUIPMENT MAINTENANCE
CB 1214
PLANT NO. 4
PARKING LOT
UAW
VISITOR PARKING
PLANT NO. 11
WESTERHEIDE TOBACCO
CB 1212
PLANT NO. 1
CB 1211
MC KINLEY IRON
CB 2536
MALLINCKRODT ST.
BREMAN BANK
O.T. HODGES
CB 1205
BREMAN BANK PARKING
TOM'S TRUCKING
WORTH INDUSTRIES
LOCKER ROOMS
CB 1206
PLANT NO. 3
CB 1207
CB 1208
PLANT NO. 2
C-T INCINERATOR
IDLE EQUIPMENT STORAGE AREA
PLANT NO. 6
PLANT NO. 6E
DESTREHAN ST.
CONTRACTOR LEASED PARKING LOT
BEW
PLANT NO. 10
LABS
MANUFACTURING AND STORAGE
PLANT NO. 5
CB 1202
PARKING
CB 1201
CB 1200
PLANT NO. 7W
PLANT NO. 7N
HAZARDOUS WASTE STORAGE AREA
CB 2540
PLANT NO. 7E
SPILL RESPONSE MATERIAL STORAGE SHED(S)
PLANT NO. 7S
TRAILER PARKING
THOMAS & PROETZ (LUMBER CO.)
BEO
ANGELRODT ST.
CB 1196
TOBIN HARDWARE
COTTO WAXO
CB 1197
CB 1198
GUNTHER SALT
CB 2541
CB 2542
CB 2543
SCALE:
0 100' 200' 300'
C10
2 01/15/01 GENERAL REVISION
1 10/23/97 GENERAL REVISION
NO. DATE ENGR. DESCRIPTION
DRAWING REVISIONS
JOB NO. PROJECT NO.
MALLINCKRODT
ST. LOUIS, MO.
ST. LOUIS PLANT
C-T PROJECT SITE SUPPORT AREAS IN PHASE I
FIGURE 2-2
SITE STL PLANT ALL BLDG. ALL FLOOR N/A
SCALE 1"=100' DATE 10/23/97
DR. BY J. MCMAHON ENGR.
CHECKED
DRAWING NO. FIGURE 2-2 REV. 2
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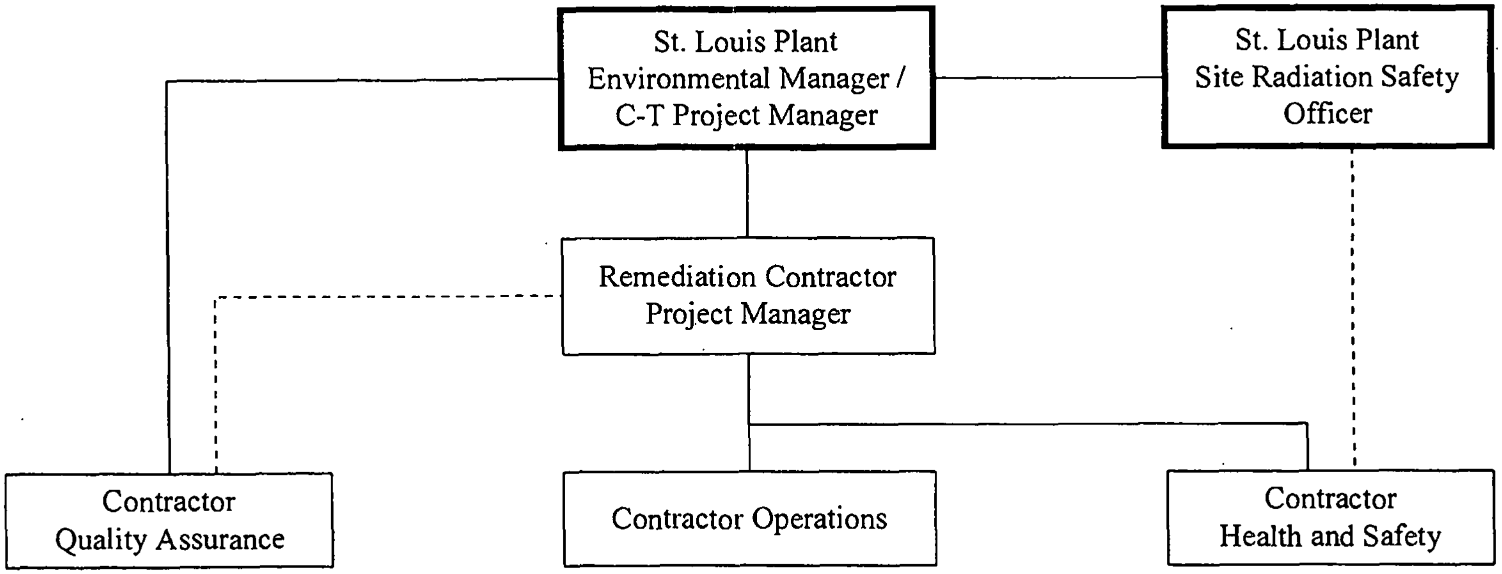
Figure 2-3
Mallinckrodt C-T Phase 1 Organization



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