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92-028

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Nancy Lubiewski
Environmental Quality Commission
65 St. Maurice
Florissant, MO 63031

Dear Ms. Lubiewski:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

The purpose of this letter is to transmit to you a copy of the Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site. This document identifies the tasks to be conducted by the Department of Energy (DOE) during the formal environmental review process to be applied to three groups of properties in the St. Louis area, collectively referred to as the St. Louis Site. The properties are the St. Louis Downtown Site, the St. Louis Airport Site, and the Latty Avenue Properties (including the Hazelwood Interim Storage Site).

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DOE is beginning the process necessary to finish cleanup of the St. Louis Site. Because of the complex nature of these cleanup actions and because two of the properties are on the National Priorities List, DOE will conduct a formal study process as required by the Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Additionally, DOE must meet the requirements of the National Environmental Policy Act (NEPA). The purpose of the combined study process is to select the best alternatives for controlling the contamination.

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This RI/FS-EIS process will culminate in a Proposed Plan that will present the preferred cleanup alternatives to the public and to state and federal officials for review and comment. Based on comments received on the RI/FS-EIS and Proposed Plan, DOE will issue a Record of Decision which will formally document the remedial action(s) selected to be implemented at the St. Louis Site.

To ensure that public comments are appropriately addressed during the RI/FS-EIS process, DOE is making the work plan available for your review and comment. In addition to the work plan, a community relations plan is available for your review in the Government Information Section of the St. Louis Public Library, 1301 Olive Street, St. Louis; the St. Louis County Library-Prairie Commons Branch, 915 Utz Lane, Hazelwood; and the DOE Public Information Office, 9200 Latty Avenue, Hazelwood. We welcome your comments on these plans.

Comments on any of these plans or on the public meeting should be forwarded by February 7, 1992 to:

Lester K. Price, Director
Former Sites Restoration Division
U.S. Department of Energy
Oak Ridge Field Office
P.O. Box 2001
Oak Ridge, TN 37831-8723.

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Kay Drey
Missouri Coalition for the
Environment
515 West Point Avenue
University City, MO 63130

Dear Ms. Drey:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-030 084626

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Daryl Roberts, Chief
Bureau of Envir. Epidemiology
Missouri Dept. of Health
P.O. Box 570, 1730 East Elm
Jefferson City, MO 65102

Dear Dr. Roberts:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-031084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Dean Jarboe
Futura Coatings
9200 Latty Avenue
Hazelwood, MO 63042

Dear Mr. Jarboe:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-032 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Roger Keller, Attorney
Mallinckrodt, Inc.
675 McDonnell Boulevard
P.O. Box 5840
St. Louis, MO 63134

Dear Mr. Keller:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Jack Frauenhoffer
Mallinckrodt, Inc.
Mallinckrodt and Second St.
P.O. Box 5439
St. Louis, MO 63147

Dear Mr. Frauenhoffer:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628
92-034

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Tracy Mehan III, Director
State of Missouri
Dept. of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Dear Mr. Mehan:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Former Sites Restoration Division

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Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Christopher E. Byrne
St. Louis County Dept. of Comm.
Health & Medical Care
111 S. Meramec Avenue
Clayton, MO 63105

Dear Mr. Byrne:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628

92-036

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Dr. Alpha F. Bryan, Director
St. Louis County Dept. of
Comm. Health & Medical Care
111 S. Meramec Avenue
Clayton, MO 63105

Dear Dr. Bryan:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Lester K. Price, Director
Former Sites Restoration Division
U.S. Department of Energy
Oak Ridge Field Office
P.O. Box 2001
Oak Ridge, TN 37831-8723.

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628

92-037

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. George R. Westfall
County Executive
County Government Center
7900 Forsyth Blvd.
Clayton, MO 63105

Dear Mr. Westfall:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

The purpose of this letter is to transmit to you a copy of the Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site. This document identifies the tasks to be conducted by the Department of Energy (DOE) during the formal environmental review process to be applied to three groups of properties in the St. Louis area, collectively referred to as the St. Louis Site. The properties are the St. Louis Downtown Site, the St. Louis Airport Site, and the Latty Avenue Properties (including the Hazelwood Interim Storage Site).

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Sincerely,

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628
92-038

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Robert Dierker, Jr.
Assistant City Counselor
City of St. Louis
City Hall, Room 314
St. Louis, MO 63103

Dear Mr. Dierker, Jr.:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628

92-039

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. David R. Bohm
Assistant City Counselor
City of St. Louis
City Hall, Room 314
St. Louis, MO 63103

Dear Mr. Bohm:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628 92-040

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Honorable Vincent C. Schoemehl, Jr.
Mayor, City of St. Louis
Tucker and Market Streets
St. Louis, MO 63103

Dear Mayor Schoemehl:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Honorable Conrad W. Bowers
Mayor, City of St. Ann
10405 St. Charles Rock Rd.
St. Ann, MO 63074

Dear Mayor Bowers:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628
92-042

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Ed Carlstrom
City Manager
City of Hazelwood
415 Elm Grove
Hazelwood, MO 63042

Dear Mr. Carlstrom:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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David Adler

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Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628 92-043

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Honorable Glennon Robinson
Mayor, City of Hazelwood
415 Elm Grove
Hazelwood, MO 63042

Dear Mayor Robinson:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. William Powers
City Manager
City of Berkeley
6140 North Hanley Road
Berkeley, MO 63134

Dear Mr. Powers:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Lester K. Price, Director
Former Sites Restoration Division
U.S. Department of Energy
Oak Ridge Field Office
P.O. Box 2001
Oak Ridge, TN 37831-8723.

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-045 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Honorable William Miller
Mayor, City of Berkeley
6140 North Hanley Road
Berkeley, MO 63134

Dear Mayor Miller:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

The purpose of this letter is to transmit to you a copy of the Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site. This document identifies the tasks to be conducted by the Department of Energy (DOE) during the formal environmental review process to be applied to three groups of properties in the St. Louis area, collectively referred to as the St. Louis Site. The properties are the St. Louis Downtown Site, the St. Louis Airport Site, and the Latty Avenue Properties (including the Hazelwood Interim Storage Site).

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DOE is beginning the process necessary to finish cleanup of the St. Louis Site. Because of the complex nature of these cleanup actions and because two of the properties are on the National Priorities List, DOE will conduct a formal study process as required by the Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Additionally, DOE must meet the requirements of the National Environmental Policy Act (NEPA). The purpose of the combined study process is to select the best alternatives for controlling the contamination.

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Sincerely,

David G. Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-046 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Thomas Richter
Lambert-St. Louis International Airport
P.O. Box 10036
St. Louis, MO 63145

Dear Mr. Richter:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-047 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

General Donald Bennett
Lambert-St. Louis International Airport
P.O. Box 10036
St. Louis, MO 63145

Dear General Bennett:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-048 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. James Zerega
U.S. Army Corps of Engineers
210 Tucker Blvd., North
St. Louis, MO 63101-1986

Dear Mr. Zerega:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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92-049 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Rowena Michaels, Director
EPA Community Relations
Region VII
726 Minnesota Avenue
Kansas City, KS 66101

Dear Ms. Michaels:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Former Sites Restoration Division

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92-050 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Greg McCabe
Superfund Section, U.S. EPA
Region VII
726 Minnesota Avenue
Kansas City, KS 66101

Dear Mr. McCabe:

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92-051 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. James W. Wagoner II
Acting Br Chief, Eastern Area
Prog. Div., Office of Envir.
Restoration, EM-421
19901 Germantown Road
Germantown, MD 20874

Dear Mr. Wagoner:

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092-052 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Joan Bray
Congresswoman Horn's Office
9666 Olive Boulevard
Suite 115
St. Louis, MO 63132

Dear Ms. Bray:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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92-053 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Mark Stroker
Congresswoman Horn's Office
9666 Olive Boulevard
Suite 115
St. Louis, MO 63132

Dear Mr. Stroker:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

The purpose of this letter is to transmit to you a copy of the Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site. This document identifies the tasks to be conducted by the Department of Energy (DOE) during the formal environmental review process to be applied to three groups of properties in the St. Louis area, collectively referred to as the St. Louis Site. The properties are the St. Louis Downtown Site, the St. Louis Airport Site, and the Latty Avenue Properties (including the Hazelwood Interim Storage Site).

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Comments on any of these plans or on the public meeting should be forwarded by February 7, 1992 to:

Lester K. Price, Director
Former Sites Restoration Division
U.S. Department of Energy
Oak Ridge Field Office
P.O. Box 2001
Oak Ridge, TN 37831-8723.

Requests to provide comments or to ask questions at the public meeting should either be submitted immediately before the meeting or should be forwarded in writing to the same address above by January 22, 1992. If you have any additional questions related to the review of the plans or the public meeting please contact me at (615) 576-0948, or leave a message at 1-(800) 253-9759 and a member of the FUSRAP staff will return your call.

Sincerely,

David G. Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Mary Renick
Congressman Gephardt's Office
9959 Gravois Road
St. Louis, MO 63123

Dear Ms. Renick:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

The purpose of this letter is to transmit to you a copy of the Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site. This document identifies the tasks to be conducted by the Department of Energy (DOE) during the formal environmental review process to be applied to three groups of properties in the St. Louis area, collectively referred to as the St. Louis Site. The properties are the St. Louis Downtown Site, the St. Louis Airport Site, and the Latty Avenue Properties (including the Hazelwood Interim Storage Site).

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Lester K. Price, Director
Former Sites Restoration Division
U.S. Department of Energy
Oak Ridge Field Office
P.O. Box 2001
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Sincerely,

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-055 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Mr. Frederick Searcy
Congressman Clay's Office
6197 Delmar
St. Louis, MO 63112

Dear Mr. Searcy:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

The purpose of this letter is to transmit to you a copy of the Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site. This document identifies the tasks to be conducted by the Department of Energy (DOE) during the formal environmental review process to be applied to three groups of properties in the St. Louis area, collectively referred to as the St. Louis Site. The properties are the St. Louis Downtown Site, the St. Louis Airport Site, and the Latty Avenue Properties (including the Hazelwood Interim Storage Site).

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Sincerely,

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

084628

92-056

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Karla Roeber
Senator Danforth's Office
8000 Maryland Avenue
Suite 440
St. Louis, MO 63105

Dear Ms. Roeber:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

The purpose of this letter is to transmit to you a copy of the Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site. This document identifies the tasks to be conducted by the Department of Energy (DOE) during the formal environmental review process to be applied to three groups of properties in the St. Louis area, collectively referred to as the St. Louis Site. The properties are the St. Louis Downtown Site, the St. Louis Airport Site, and the Latty Avenue Properties (including the Hazelwood Interim Storage Site).

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David G. Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Clair Elsberry
Senator Danforth's Office
1233 Jefferson Street
Jefferson City, MO 65109

Dear Ms. Elsberry:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

92-058 084628

Department of Energy

Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831—

January 15, 1992

Ms. Joann Digman
Senator Bond's Office
8000 Maryland Avenue
Suite 1050
Clayton, MO 63105

Dear Ms. Digman:

TRANSMITTAL OF SCOPING AND PLANNING DOCUMENT FOR THE DEPARTMENT OF ENERGY'S ST. LOUIS SITE

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Sincerely,

David Adler

David G. Adler, Site Manager
Former Sites Restoration Division

Enclosure: Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

Distribution List Work Plan
for the RI/FS-EIS for the St. Louis Site
January 1992

Ms. Joann Digman
Senator Bond's Office
8000 Maryland Avenue
Suite 1050
Clayton, MO 63105

Ms. Clair Elsberry
Senator Danforth's Office
1233 Jefferson Street
Jefferson City, MO 65109

Ms. Karla Roeber
Senator Danforth's Office
8000 Maryland Avenue
Suite 440
St. Louis, MO 63105

Mr. Frederick Searcy
Congressman Clay's Office
6197 Delmar
St. Louis, MO 63112

Ms. Mary Renick
Congressman Gephardt's Office
9959 Gravois Road
St. Louis, MO 63123

Mr. Mark Stroker
Congresswoman Horn's Office
9666 Olive Boulevard
Suite 115
St. Louis, MO 63132

Ms. Joan Bray
Congresswoman Horn's Office
9666 Olive Boulevard
Suite 115
St. Louis, MO 63132

Ms. Patti Hazel
DOE Public Information Office
9200 Latty Avenue
P.O. Box 4085
Hazelwood, MO 63042
(7 copies of Work Plan,
1 copy of Community Relations Plan)

Mr. James W. Wagoner II
Acting Br Chief, Eastern Area
Prog. Div., Office of Envir.
Restoration, EM-421
19901 Germantown Road
Germantown, MD 20874
(2 copies)

Mr. Greg McCabe
Superfund Section, U.S. EPA
Region VII
726 Minnesota Avenue
Kansas City, KS 66101
(3 copies Work Plan)

Ms. Rowena Michaels, Director
EPA Community Relations
Region VII
726 Minnesota Avenue
Kansas City, KS 66101

Mr. James Zerega
U.S. Army Corps of Engineers
210 Tucker Blvd., North
St. Louis, MO 63101-1986

Mr. John Montre
St. Louis Public Library
Governmental Information Section
1301 Olive Street
St. Louis, MO 63103
(1 copy of Work Plan, 1 copy
of Community Relations Plan)

Ms. Lee Kiesling
St. Louis County Library
Prairie Commons Branch
915 Utz Lane
Hazelwood, MO 63042
(1 copy of Work Plan, 1 copy
of Community Relations Plan)

Gen. Donald Bennett
Lambert-St. Louis International
  Airport
P.O. Box 10036
St. Louis, MO 63145

Mr. Thomas Richter
Lambert-St. Louis International
  Airport
P.O. Box 10036
St. Louis, MO 63145

Honorable William Miller
Mayor, City of Berkeley
6140 North Hanley Road
Berkeley, MO 63134

Mr. William Powers
City Manager
City of Berkeley
6140 North Hanley Road
Berkeley, MO 63134

Honorable Glennon Robinson
Mayor, City of Hazelwood
415 Elm Grove
Hazelwood, MO 63042

Mr. Ed Carlstrom
City Manager
City of Hazelwood
415 Elm Grove
Hazelwood, MO 63042

Honorable Conrad W. Bowers
Mayor, City of St. Ann
10405 St. Charles Rock Rd.
St. Ann, MO 63074

Honorable Vincent C. Schoemehl, Jr.
Mayor, City of St. Louis
Tucker and Market Streets
St. Louis, MO 63103

Mr. David R. Bohm
Assistant City Counselor
City of St. Louis
City Hall, Room 314
St. Louis, MO 63103

Mr. Robert Dierker, Jr.
Assistant City Counselor
City of St. Louis
City Hall, Room 314
St. Louis, MO 63103

Mr. George R. Westfall
County Executive
County Government Center
7900 Forsyth Blvd.
Clayton, MO 63105

Dr. Alpha F. Bryan, Director
St. Louis County Dept. of
  Comm. Health & Medical Care
111 S. Meramec Avenue
Clayton, MO 63105

Mr. Christopher E. Byrne
St. Louis County Dept. of Comm.
  Health & Medical Care
111 S. Meramec Avenue
Clayton, MO 63105

Mr. Tracy Mehan III, Director
State of Missouri
Dept. of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Mr. Jack Frauenhoffer
Mallinckrodt, Inc.
Mallinckrodt and Second St.
P.O. Box 5439
St. Louis, MO 63147

Mr. Roger Keller, Attorney
Mallinckrodt, Inc.
675 McDonnell Boulevard
P.O. Box 5840
St. Louis, MO 63134

Mr. Dean Jarboe
Futura Coatings
9200 Latty Avenue
Hazelwood, MO 63042

Mr. Daryl Roberts, Chief
Bureau of Envir. Epidemiology
Missouri Dept. of Health
P.O. Box 570, 1730 East Elm
Jefferson City, MO 65102

Ms. Kay Drey
Missouri Coalition for the
  Environment
515 West Point Avenue
University City, MO 63130

084628

Ms. Nancy Lubiewski
vironmental Quality Commission
St. Maurice
lorissant, MO 63031

LR_0455

DOE/OR/21949-271.1

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-91OR21949

Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the St. Louis Site

St. Louis, Missouri

December 1991

4.35 2002.1

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DOE/OR/21949-271.1

WORK PLAN FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY-ENVIRONMENTAL IMPACT STATEMENT FOR THE ST. LOUIS SITE

ST. LOUIS, MISSOURI

DECEMBER 1991

Prepared for

United States Department of Energy

Oak Ridge Field Office

Under Contract No. DE-AC05-91OR21949

Bechtel National, Inc., Oak Ridge, Tennessee, and

Argonne National Laboratory, Argonne, Illinois

Bechtel Job No. 14501

084028

FOREWORD

This work plan has been prepared to document the actions and evaluations made during the scoping and planning phase of the remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS) conducted at the St. Louis, Missouri, site. Remedial action at the St. Louis site is being planned as part of the Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program.

Because portions of the St. Louis site are on the Environmental Protection Agency's (EPA) National Priorities List, the response actions (i.e., removal actions and remedial actions) to be carried out by DOE at the site are subject to review by EPA, the Missouri Department of Natural Resources, and the public under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act. Section 120(a)(1) of CERCLA as amended clarified the applicability of CERCLA to hazardous sites owned or controlled by federal departments and agencies; thus remedial actions at hazardous DOE sites must satisfy the requirements of CERCLA. Executive Order 12580 delegated to DOE the authority to conduct CERCLA response actions at sites under its control. Consistent with this order, DOE is the lead agency for remedial actions at the St. Louis site. DOE plans and activities for the site are being overseen by EPA Region VII, and a formal interagency agreement coordinating DOE's and EPA's respective roles has been signed. The major elements of the agreement are described in Subsection 1.4.2.

CERCLA requires that an RI/FS be performed to support the evaluation and selection of remedial action alternatives. In addition, DOE activities must be conducted in compliance with the National Environmental Policy Act (NEPA), which requires consideration of the environmental consequences of a proposed action as part of its decision-making process. It is DOE policy to integrate the requirements of the CERCLA and NEPA processes for remedial actions at sites for which it has responsibility. Under this policy, the CERCLA process is supplemented, as appropriate, to meet the procedural and documentational requirements of NEPA up to, and including, preparation of an EIS. This work plan (1) summarizes site-specific background and characterization data, (2) identifies the types and amounts of contaminants at the site and presents a conceptual site model that identifies potential routes of human exposure to these contaminants, (3) identifies data gaps and delineates how planned activities will satisfy data needs, and (4) describes the approach that will be used to evaluate potential remedial action alternatives. This work plan also includes descriptions of project organization and project controls, and schedules for tasks to be performed to fulfill the requirements of both CERCLA and NEPA.

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The conclusion of the RI/FS-EIS process is the issuance of a record of decision that states what remedial action alternative will be conducted at the site to control or alleviate problems associated with contamination for which DOE is responsible.

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FIGURES

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UNITS OF MEASURE

C	Celsius
cfs	cubic feet per second
Ci	curie
cm	centimeter
cms	cubic meters per second
cpm	counts per minute
dpm	disintegrations per minute
F	Fahrenheit
ft	foot
g	gram
gpm	gallons per minute
h	hour
ha	hectare
in.	inch
kg	kilogram
km	kilometer
L	liter
m	meter
meg	milliequivalent
mg	milligram
mi	mile
ml	milliliter
mm	millimeter
mph	miles per hour
mR	milliroentgen
mrad	millirad
μCi	microcurie
μg	microgram
μmho	micromho
μR	microroentgen
oz	ounce

UNITS OF MEASURE
(continued)

pcf	pounds per cubic foot
pCi	picocurie
ppb	parts per billion
ppm	parts per million
s	second
WL	working level
yd	yard
yr	year

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ACRONYMS

AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
BNAE	base/neutral and acid extractable
BNI	Bechtel National, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CRP	community relations plan
CSR	Code of State Regulations
DOE	Department of Energy
DOE-OR	Department of Energy Field Office, Oak Ridge
DQO	data quality objective
EIS	environmental impact statement
EP	extraction procedure
EPA	Environmental Protection Agency
EWDAA	Energy and Water Development Appropriations Act
FFA	federal facilities agreement
FS	feasibility study
GC/MS	gas chromatography/mass spectrometry
FUSRAP	Formerly Utilized Sites Remedial Action Program
HISS	Hazelwood Interim Storage Site
MSL	mean sea level
MED	Manhattan Engineer District
MDNR	Missouri Department of Natural Resources
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants

ACRONYMS
(continued)

NRC	Nuclear Regulatory Commission
ORAU	Oak Ridge Associated Universities
ORNL	Oak Ridge National Laboratory
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PDCC	project document control center
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFW	Roy F. Weston, Inc.
RI	remedial investigation
ROD	record of decision
SAIC	Science Applications International Corporation
SLAPS	St. Louis Airport Site
SLDS	St. Louis Downtown Site
SOW	statement of work
SRM	standard reference material
TDS	total dissolved solids
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TMA/E	Thermo Analytical/Eberline
TOC	total organic carbon
TOX	total organic halides
VOC	volatile organic compound
WBS	work breakdown structure

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) is conducting a comprehensive review and analysis leading to remedial action for a set of properties located in Hazelwood, Berkeley, and St. Louis, Missouri, under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The properties, collectively referred to as the St. Louis site, are:

- The St. Louis Downtown Site (SLDS) and vicinity properties
- The St. Louis Airport Site (SLAPS) and vicinity properties
- The Latty Avenue Properties [Hazelwood Interim Storage Site (HISS), Futura Coatings, Inc., and vicinity properties]

The vicinity properties are residential, commercial, and municipal properties near SLDS, SLAPS, and the Latty Avenue Properties that were radioactively contaminated as a result of uranium processing at SLDS and subsequent transportation to and storage of processing residues at SLAPS and HISS. HISS, operated by DOE, is a temporary storage site currently owned by Jarboe Realty and Investment Company. Excavated soils from several properties in the vicinity of HISS are currently stored at HISS pending a decision on their final disposition.

FUSRAP was established in 1974 by the U.S. Atomic Energy Commission (AEC), a predecessor of DOE. The major goal of decontamination under FUSRAP is to eliminate potential hazards to the public and the environment from sites containing residual contamination remaining from activities carried out under contract to the Manhattan Engineer District (MED) and AEC or at other sites that Congress has authorized DOE to remedy. The primary authorizing legislations for FUSRAP are the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Atomic Energy Act of 1954; and the Energy and Water Development Appropriations Acts (EWDAA) of 1984 and 1985, which added four sites to the program. A more detailed history of the St. Louis site is presented in Subsection 2.2.

SLAPS, the SLAPS vicinity properties, and the Latty Avenue Properties have been placed on the Environmental Protection Agency's (EPA) National Priorities List, a list of sites identified for remedial action under CERCLA as amended by the Superfund Amendments and Reauthorization Act, hereinafter referred to simply as CERCLA.

This document is intended to (1) provide background information on the St. Louis site, (2) present available information on the types and extent of contamination present on the site,

(3) describe the proposed steps leading to final remedial action, and (4) provide an opportunity for public input to the remedy selection process.

1.1 GENERAL SITE INFORMATION

The general locations of SLDS, SLAPS and SLAPS vicinity properties, and the Latty Avenue Properties are shown in Figure 1-1. SLDS, currently owned by Mallinckrodt, Inc., is located on the eastern border of St. Louis, near the Mississippi River. SLAPS lies immediately north of Lambert-St. Louis International Airport, east of Coldwater Creek. Near SLAPS are 94 residential and commercial vicinity properties, some of which are radioactively contaminated as a result of MED/AEC activities, material transfer, utility line construction, and flooding. The Latty Avenue Properties are within the city limits of Hazelwood and Berkeley, 3.2 km (2 mi) northeast of the control tower of the airport. Detailed descriptions of the properties are presented in Subsections 2.1 and 2.3.

SLDS is an 18.2-ha (45-acre) tract located in a highly industrialized area. Ten plants currently operating at the facility produce various chemical products. From 1942 to 1957, several MED/AEC operations were conducted at the facility, including processing and producing various forms of uranium compounds and pure uranium metal. Radiological surveys conducted thus far have shown that portions of the facility have alpha and beta-gamma levels exceeding current federal guidelines (ORNL 1981, BNI 1990a). The major radioactive contaminants at SLDS are uranium-238, radium-226, and thorium-230. Concentrations in soil range from 1.3 to 95,000 pCi/g and 0.4 to 5,400 pCi/g for uranium-238 and radium-226, respectively. Thorium-230 concentrations range from 0.3 to 98,000 pCi/g (BNI 1990a). Surveys of six vicinity properties associated with SLDS identified five of them as radioactively contaminated. Subsections 2.1.1, 2.2.1, and 2.4 provide additional information on SLDS and its vicinity properties.

SLAPS, owned by the City of St. Louis, is an 8.8-ha (21.7-acre) tract located 24 km (15 mi) northwest of downtown St. Louis and 0.8 km (0.5 mi) south of HISS. In 1946, MED acquired SLAPS to store residues from uranium processing conducted at SLDS. The property was fenced to prevent public access. Most of the wastes and residues were stored on open ground, although some contaminated materials and scrap were buried at the western end of the property. Surveys conducted since 1976 indicated elevated concentrations of uranium-238, radium-226, thorium-230,

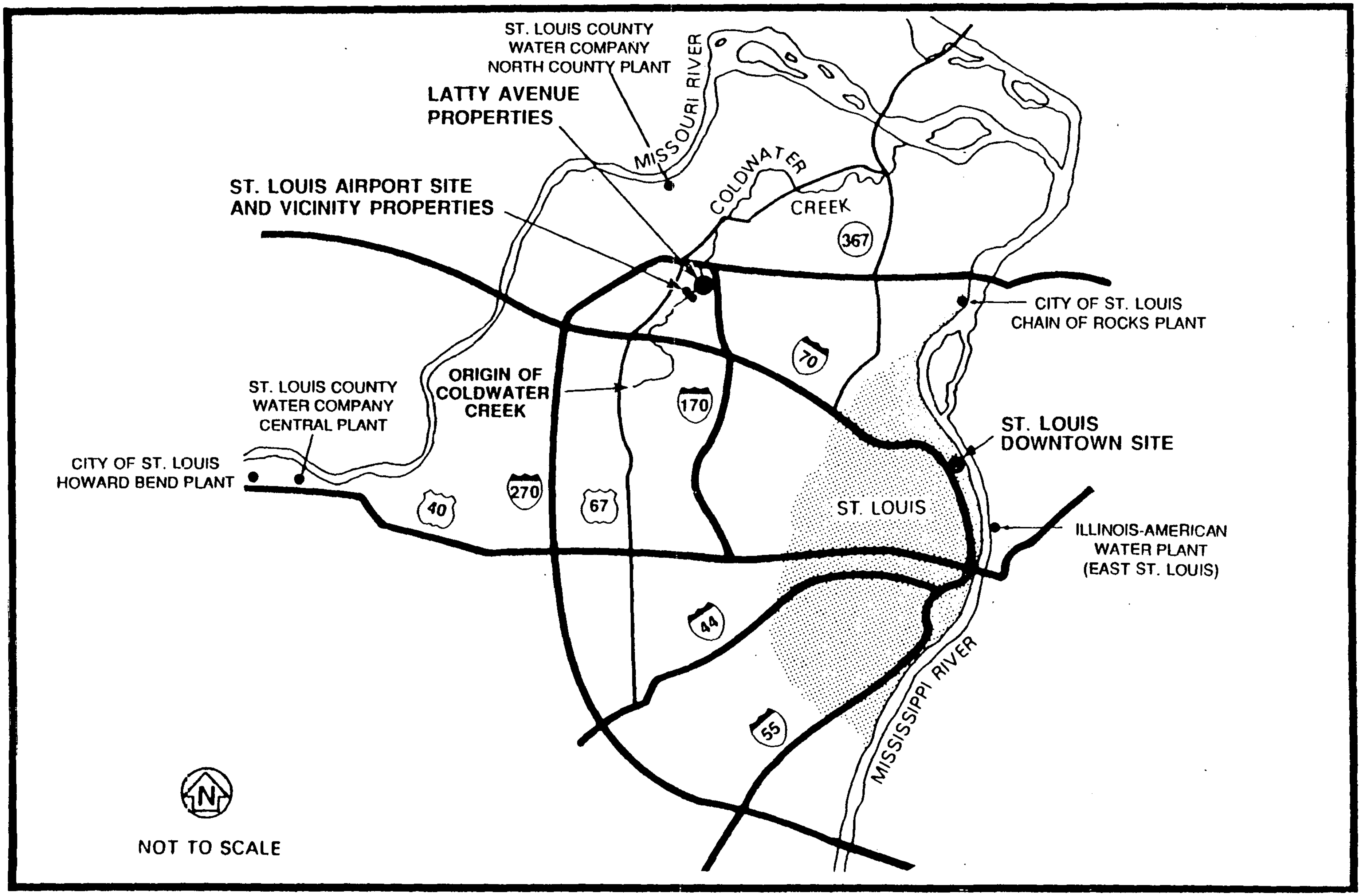

FIGURE 1-1 LOCATIONS OF FUSRAP PROPERTIES IN THE ST. LOUIS, MISSOURI, AREA

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and thorium-232 (ORNL 1979, BNI 1987a). The characterization at SLAPS conducted by Bechtel National, Inc. (BNI) from 1986 to 1990 showed radioactive contamination at depths as great as 5.5 m (18 ft). Soil analyses identified elevated levels of radium-226, thorium-230, thorium-232, and uranium-238 ranging from less than 0.3 to 2,700 pCi/g, 1.0 to 2,600 pCi/g, less than 0.5 to 50.4 pCi/g, and less than 3.0 to 1,600 pCi/g, respectively (BNI 1987a). Subsections 2.1.2, 2.2.2, and 2.4 provide additional information about SLAPS and its vicinity properties.

The Latty Avenue Properties are composed of HISS on the eastern side, Futura Coatings on the western portion, and vicinity properties; HISS and Futura, currently owned by Jarboe Realty and Investment Company, cover approximately 4.5 ha (11 acres). In 1966, Continental Mining and Milling of Chicago, Illinois, purchased process wastes at SLAPS and stored them at the Latty Avenue Properties during 1966 and 1967. Between 1967 and 1973, most of the residues were dried and shipped to Canon City, Colorado. Various excavations and renovations were conducted at the Latty Avenue Properties in the late 1970s. Currently, contaminated debris and soil from these decontamination efforts are stored at HISS. BNI characterization studies at HISS and Futura showed thorium-230 as the major contaminant, with smaller amounts of uranium-238 and radium-226. At HISS, thorium-230 concentrations range from 0.8 to 790 pCi/g; at Futura, concentrations range from 1.1 to 2,000 pCi/g (BNI 1987b,c). Subsections 2.1.3, 2.2.3, and 2.4 provide additional information about the Latty Avenue Properties.

In 1985, DOE directed Oak Ridge National Laboratory (ORNL) to perform a radiological survey of the roads thought to have been used to transport contaminated materials to SLAPS and HISS, including parts of Hazelwood Avenue, Pershall Road, and McDonnell Boulevard. Results showed gamma exposure rates in excess of background levels, and results for soil showed thorium-230 to be the major contaminant (ORNL 1986a).

Surveys of the properties conducted before the BNI characterization indicated radioactive contamination in excess of current DOE guidelines and spelled out the need for further study. ORNL conducted surveys at SLDS in 1977, at SLAPS from 1976 to 1978, and along Latty Avenue in 1981 and 1984 (ORNL 1981, ORNL 1979, ORNL 1986b,c). The latest BNI characterization studies, more comprehensive in their scope than earlier surveys, showed some radionuclide concentrations in excess of currently acceptable guidelines on approximately two-thirds of the properties surveyed.

Surveys of all vicinity properties associated with SLAPS and the Latty Avenue Properties have shown thorium-230 to be the major contaminant, even though in certain spots, other radionuclides are considered contaminants of concern (BNI 1990b).

Although some areas of radioactivity in soil at SLDS, SLAPS, HISS, and Futura were found to be several times applicable DOE residual radioactivity guidelines, there appear to be no immediate health risks to workers or people living in the vicinity of these properties, given current property use. In general, levels of radioactivity in soil are low across most of these properties. In addition, access to these properties is restricted, and members of the general public are not allowed entry.

Given the low levels of radioactivity in soil on the vicinity properties (substantially lower levels than found in the restricted areas) and the current land use, there appear to be no immediate health risks to property occupants. For a more detailed discussion of the contaminants of concern and any associated health risks, see Section 3.0.

Because of the extensive amount of information already known about the St. Louis site (including sampling and analysis data, the history of uranium processing at SLDS, the types of ores and chemicals used in the actual processing, and the transport of waste materials from SLDS to SLAPS and HISS), extensive additional sampling should not be required to begin evaluation of alternatives for remedial action.

1.2 JUSTIFICATION AND OBJECTIVES FOR THE PROPOSED ACTION

The primary threat to human health and the environment associated with the St. Louis site is the potential for uncontrolled release of contaminants from exposed surfaces and subsurface disposal areas. Possible mechanisms that could result in release of contaminants are infiltration and percolation, wind dispersal, gaseous emissions, surface runoff, and disturbance by humans or animals (see Section 3.0). Direct exposure to gamma-emitting radiation at the site is also a possibility. Release from the materials currently stored at HISS and SLAPS could occur, e.g., as a result of discontinuation of facility maintenance in the future. Therefore, permanent disposition of stored materials and cleanup and disposition of currently uncontained materials are necessary for the long-term protection of human health and the environment in the area.

The overall objective of remedial action at the St. Louis site is to eliminate, reduce, or otherwise mitigate the potential for exposure to radioactive and chemical contaminants. Specific objectives of the remedial action process are to:

- Thoroughly delineate the boundaries of contamination at the site
- Assess potential risks to human health and the environment that could result from exposure to site contaminants

- Minimize potential health hazards to personnel conducting characterization and remedial action activities
- Mitigate any immediate hazards associated with site conditions
- Assess potential remedial action alternatives and select and implement a permanent remedy

All remedial action activities at the St. Louis site will be conducted in accordance with CERCLA and applicable or relevant and appropriate requirements (ARARs) (see Subsection 3.9).

1.3 ENVIRONMENTAL COMPLIANCE PROCESS

Remedial and removal actions that will be conducted by DOE at the St. Louis site are being coordinated with EPA Region VII under CERCLA. In addition, all DOE activities must be conducted in compliance with the National Environmental Policy Act (NEPA), which requires that the environmental consequences of a proposed action be considered as part of the decision-making process for that action. It is DOE policy to integrate the requirements of the CERCLA and NEPA processes for remedial actions at sites for which it has responsibility. The remedial investigation/feasibility study (RI/FS) conducted under CERCLA is the primary process for environmental compliance associated with DOE remedial actions. Under this integrated policy, the CERCLA process is supplemented, as appropriate, to meet the procedural and documentational requirements of NEPA, which may include preparation of an environmental impact statement (EIS). Hence, this RI/FS-EIS work plan outlines the approach for remediating the St. Louis site in a manner consistent with both CERCLA and NEPA requirements.

A key element of the integrated CERCLA/NEPA process is to determine the level of environmental analysis appropriate under NEPA. This determination is a function of many factors, including the complexity of a proposed action, the likelihood for significant environmental impacts, and the potential for considerable public interest. Reasonable alternatives to be considered as part of the proposed action include off-site disposal at a new disposal site or use of on-site treatment and/or disposal technologies that may require bench-scale or pilot testing. Due to these considerations and the associated potential for significant impact, the scope of this action is such that an EIS is anticipated for NEPA compliance. Hence, DOE is proposing to conduct an RI/FS-EIS process for environmental compliance at the St. Louis site. Under this process, DOE will follow the RI/FS process developed by EPA for environmental compliance under CERCLA and add to this process those elements required to satisfy the EIS process under NEPA.

It is DOE policy to prepare an EIS implementation plan to record the results of the NEPA scoping process and to present the approach for preparation of an EIS. Such a plan is prepared following completion of the NEPA scoping process. The NEPA scoping process is initiated when a notice of intent describing the proposed actions is published in the Federal Register and distributed to interested agencies and persons who may be affected. As indicated by the RI/FS-EIS schedule presented in Section 6.0, this draft work plan will be made available for public comment and agency review concurrently with the publication of the Federal Register notice. During the public comment period, DOE intends to hold a public meeting to obtain and factor public input into the scope of the RI/FS-EIS for the site. This public meeting is currently scheduled for early 1992. An EIS implementation plan will be prepared and appended to the revised work plan (as Appendix F) following the public meeting. The content of the implementation plan will conform to DOE guidelines for NEPA compliance.

Interim response actions (i.e., removal actions taken before completion of the RI/FS-EIS process) are possible for the St. Louis site. Typically, these interim actions will involve removal of contaminated materials from an area and subsequent interim storage pending selection of a comprehensive remedy for wastes generated by cleanup of the St. Louis site. Appropriate NEPA and CERCLA compliance documentation will be prepared prior to implementing these interim measures. Specifically, engineering evaluation/cost analysis reports will be prepared and submitted for public review before interim removal actions are implemented. Removal actions currently projected include cleanup of contaminated materials from vicinity properties at SLAPS and SLDS and subsequent temporary storage of the resulting materials.

This draft RI/FS-EIS work plan describes the history, environmental setting, and nature and extent of contamination at the St. Louis site (Section 2.0) and presents an initial evaluation of contamination at the site (Section 3.0). This evaluation addresses potential contaminant sources, environmental transport mechanisms and receptors, and data gaps. In addition, this work plan identifies preliminary response objectives, technologies, and alternatives for site remediation (Section 3.0). Activities planned to obtain the data needed for completion of the RI/FS-EIS process and the 14 standard tasks for completing an RI/FS are also presented (Sections 4.0 and 5.0). Finally, the work plan describes the organization, project controls, and schedules that will be employed to fulfill the requirements of the proposed studies (Sections 6.0 and 7.0).

1.4 EXTERNAL INVOLVEMENT

1.4.1 Coordination with Other Agencies

Executive Order 12580 delegated to DOE the authority to conduct remedial action at sites under its control. Consistent with this order, DOE is the lead agency for remedial action at the St. Louis site. DOE plans and activities for the site are being overseen by EPA Region VII and are also being coordinated with appropriate Missouri state agencies, including the Missouri Department of Natural Resources (MDNR). Through the community relations plan (CRP) for the St. Louis site, DOE also provides for the participation of federal and state legislators, local and county officials, and the general public in the decision-making process for site remediation.

DOE has initiated and will continue routine meetings with EPA and MDNR to discuss plans and other information relevant to the RI/FS-EIS. Site tours have been given to representatives of EPA Region VII and MDNR, and because extensive RI work has already been conducted at the site, a bibliography of related literature has been provided so that agencies can request copies of these reports.

1.4.2 Summary of the Federal Facilities Agreement

DOE and EPA Region VII negotiated a federal facilities agreement (FFA) defining the specific responsibilities and interactions of both agencies regarding DOE's remedial action activities at the St. Louis site. The final agreement was signed in June 1990.

The FFA states that the intent of the agreement is to:

- Ensure that the environmental impacts associated with past and present activities at the St. Louis site are thoroughly investigated and that appropriate remedial action is taken as necessary to protect public health or welfare and the environment

- Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at the St. Louis site in accordance with CERCLA, the National Oil and Hazardous Substances Contingency Plan (NCP), and Superfund guidance and policy

- Facilitate cooperation, exchange of information, and participation of the parties in such actions

In addition, specific elements of the agreement are included to:

- Identify operable unit alternatives that are appropriate for the site before implementation of the final remedial action(s)

- Establish requirements for the performance of an RI to fully determine the nature and extent of the threat to public health or welfare and the environment caused by the release or potential release of FUSRAP waste at the site

- Establish requirements for the performance of an FS to identify, evaluate, and select alternatives in accordance with CERCLA for the appropriate remedial actions(s) to prevent, mitigate, or abate the release or potential release of FUSRAP waste at the site

- Identify the nature, objectives, and schedule of response actions to be taken at the site; response actions will attain that degree of cleanup of hazardous substances, pollutants, or contaminants mandated by CERCLA

- Implement the selected remedial action(s) in accordance with CERCLA, the NCP, and Executive Order 12580

- Provide for operation and maintenance of any remedial action(s) selected, as necessary

- Ensure compliance with federal and state hazardous waste laws and regulations for matters covered by the FFA

As defined in the FFA, "FUSRAP waste" is specifically limited to:

- All wastes, including but not limited to radioactively contaminated wastes resulting from or associated with uranium manufacturing or processing activities conducted at the St. Louis site

- All radioactive contamination related to past uranium processing at SLDS and exceeding DOE remedial action levels on any vicinity property

Also included is any chemical or nonradioactive contamination on vicinity properties that would be in either of the following categories:

- Contamination that is mixed or commingled with radioactive contamination exceeding DOE action levels
- Contamination that originated at SLDS or was associated with specific uranium processing activities at SLDS that resulted in the radioactive contamination

1.4.3 Public Participation

DOE is committed to a program of public participation in the remedial action process for the St. Louis site. A formal CRP has been developed as an ancillary document to this work plan. The CRP describes a program to gather information from the affected community, inform the public of ongoing and planned activities, and facilitate public input to the decision-making process. Through this program, DOE interacts with the public using such mechanisms as news releases and fact sheets, public meetings, discussions with local interest groups, response to public comments, and maintenance of a public repository for documents and information related to the site. The CRP is discussed in further detail in Subsection 5.2.

2.0 SITE BACKGROUND AND SETTING

The history of site operations and disposal practices, physical characteristics of the site (including vicinity properties that may require remediation), land use, and environmental setting are provided in Subsections 2.1 through 2.3. The nature and extent of contamination is discussed in Subsection 2.4; interim response actions conducted to date are summarized in Subsection 2.5.

2.1 GENERAL SITE DESCRIPTION

2.1.1 St. Louis Downtown Site and Vicinity Properties

SLDS is in an industrialized area on the eastern border of St. Louis, about 90 m (300 ft) west of the Mississippi River and approximately 17.7 km (11 mi) southeast of SLAPS. SLDS, presently owned by Mallinckrodt, Inc., is an operating plant producing various chemical products. The property encompasses approximately 18.2 ha (45 acres) and includes numerous buildings and facilities (Figure 2-1). SLDS is traversed by tracks of three railroad lines, and several spurs service the property from the main lines. The property is fenced, and Mallinckrodt security is maintained 24 hours per day. Although not part of the property referred to as SLDS, there are six associated vicinity properties used for industrial and commercial operations (see Figure 2-2).

Water runoff is controlled by a system of combined sewers that direct excess flow to the Mississippi River. The property has an extensive network of utility lines both above and below grade. Below-grade utilities include sewer, sprinkler, water, telephone, electric, plant process piping, and natural gas lines. Overhead utilities include electric and telephone wires and plant process piping.

2.1.2 St. Louis Airport Site and Vicinity Properties

SLAPS is in St. Louis County, approximately 24 km (15 mi) from downtown St. Louis and immediately north of the Lambert-St. Louis International Airport. SLAPS is bounded by the Norfolk and Western Railroad and Banshee Road on the south, Coldwater Creek on the west, and McDonnell Boulevard and adjacent recreational fields on the north and east. The property covers 8.8 ha (21.7 acres) and is enclosed by security fencing. Land uses adjacent to the property are varied. Because of its proximity to the airport, more than two-thirds of the land within a half-mile radius of the property is used for transportation-related purposes. The remaining land in the

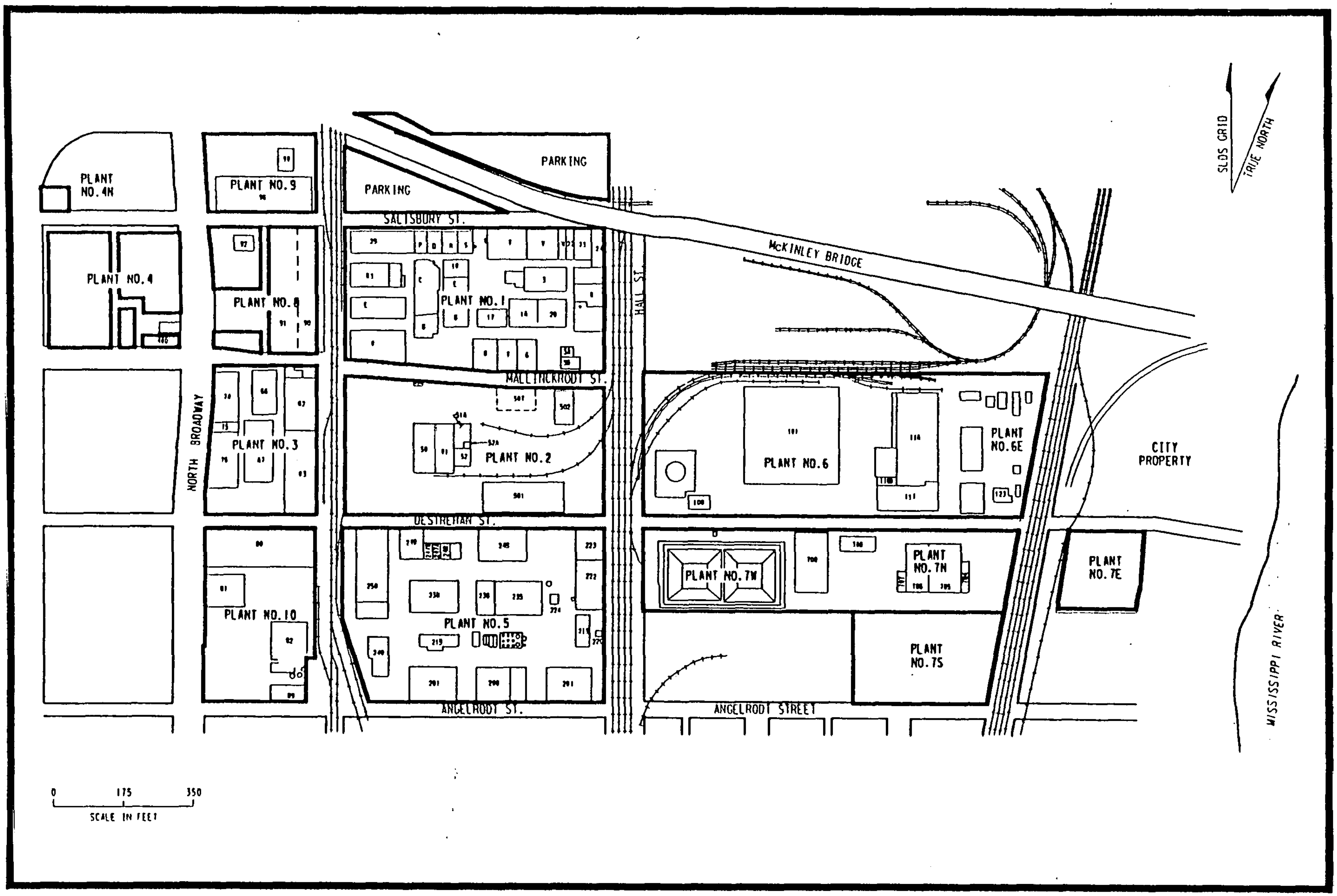

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FIGURE 2-1 PLAN VIEW OF THE ST. LOUIS DOWNTOWN SITE

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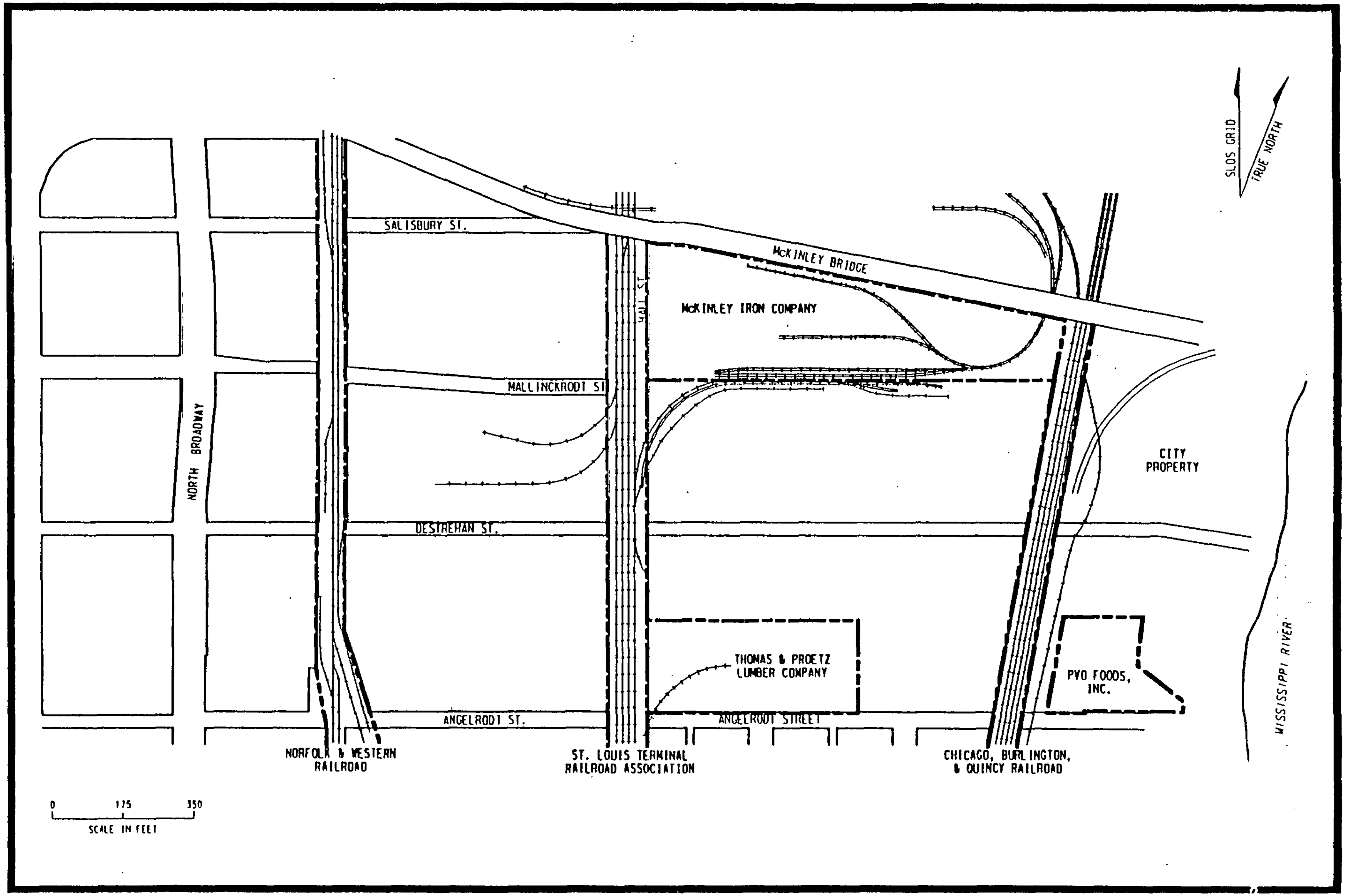

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FIGURE 2-2 PLAN VIEW OF THE ST. LOUIS DOWNTOWN SITE VICINITY PROPERTIES

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immediate vicinity is primarily commercial and recreational. Current uses of land are more thoroughly described in Subsection 2.3.6. There are no permanent buildings or facilities remaining at SLAPS; these were demolished and buried on site under 0.3 to 1 m (1 to 3 ft) of clean material in 1969. Additional fill material and rubble were placed at SLAPS in 1971, 1977, and 1978. The property is grassy, with a slight incline from the east. Maintenance and surveillance, including environmental monitoring, are the only activities currently taking place at SLAPS.

No utility lines are associated with SLAPS. A water main crosses the northwestern corner and runs parallel to the property on the north. A small on-site line connected to the water main supplies a trailer used as storage space. There are no sewer lines on the property, and the trailer is serviced by a holding tank.

SLAPS vicinity properties include Coldwater Creek to the west and its vicinity properties, adjacent ball fields to the north and east, Norfolk and Western Railroad properties, Banshee Road to the south, ditches to the north and south, and the St. Louis Airport Authority property to the south. Also included are the haul roads: McDonnell Boulevard, Pershall Road [1.8 km (1.1 mi) north of SLAPS], Hazelwood Avenue [1.3 km (0.8 mi) northeast of SLAPS], Eva Avenue, Frost Avenue, and vicinity properties. These haul roads are believed to have been used during waste transfer among the properties. The haul road vicinity properties include 67 commercial, industrial, and residential properties located immediately adjacent to the haul roads. Figure 2-3 shows the locations of SLAPS and its vicinity properties.

2.1.3 Latty Avenue and Vicinity Properties

The Latty Avenue Properties at 9200 Latty Avenue include HISS on the eastern half and Futura Coatings on the western half. These properties cover a 4.5-ha (11-acre) tract in the city limits of Hazelwood and are approximately 3.2 km (2 mi) northeast of the control tower of the Lambert-St. Louis International Airport. The six Latty Avenue vicinity properties are adjacent to Latty Avenue and HISS; some are within the corporate limits of the City of Berkeley. HISS is a fairly level [elevation ranges from 157 to 159 m (514 to 522 ft)] grassy area containing two stockpiles of contaminated soil and debris in interim storage, access roads, a vehicle decontamination facility, a 12- by 12-ft office trailer, and a 24- by 56-ft public information trailer. Maintenance and surveillance, including environmental monitoring, currently take place at HISS. In 1977, while preparing the western portion of the property for commercial use, the present owner demolished one building, excavated several areas to level the property, paved several areas, and erected a number of new buildings. The material excavated was placed in interim storage at HISS. A chain-link fence completely surrounds both properties. Figures 2-3 and 2-4 show the locations and current configurations of the Latty Avenue Properties.

The Latty Avenue Properties are zoned for industrial use, and the surrounding area is primarily industrial and commercial. Stormwater runoff flows off site into ditches that drain into Coldwater Creek. The property is served by city water and electricity, with overhead electric and telephone lines, and by underground gas and sanitary sewer lines extending to the Futura buildings; however, there are no sanitary sewer lines to HISS and the facilities are serviced with holding tanks. Storm sewer lines run along the eastern boundary of the property.

The vicinity properties are relatively level and have been developed with commercial buildings, paved parking lots, and open, grassy areas fronting the length of Latty Avenue. Figure 2-4 also shows relative sizes of the Latty Avenue vicinity properties.

Additional details regarding SLDS, SLAPS, Latty Avenue Properties, and their respective vicinity properties are presented in Table 2-1.

2.2 SITE HISTORY

2.2.1 St. Louis Downtown Site and Vicinity Properties

From 1942 to 1957, the former Mallinckrodt Chemical Works performed work at SLDS (Figure 2-1) under contracts with MED and AEC. Several operations were performed, including process development and production of various forms of uranium compounds and metal, and recovery of uranium metal from residues and scrap (Mason 1977).

From 1942 to 1945, MED/AEC activities were carried out in areas designated as Plants 1 and 2 and in the original Plant 4 (now Plant 10). In 1946, manufacturing of uranium dioxide from pitchblende ore began at the newly constructed Plant 6. Uranium ore was digested in acid and filtered to form uranyl nitrate. A solvent extraction procedure and denitration were used to form uranium oxide. Fluorination with hydrofluoric acid was then initiated to create uranium tetrafluoride, which subsequently led to the production of uranium metal. Plant 6 operations ended in 1954. The pitchblend and radium equipment remained in place until AEC decontaminated the plant in 1958 (Mason 1977).

From 1948 through 1950, decontamination activities were conducted and supervised by Mallinckrodt personnel at Plants 1 and 2. These decontamination efforts were conducted to meet AEC criteria in effect at that time, and the plants were released in 1951 for use without radiological restrictions (Mason 1977).

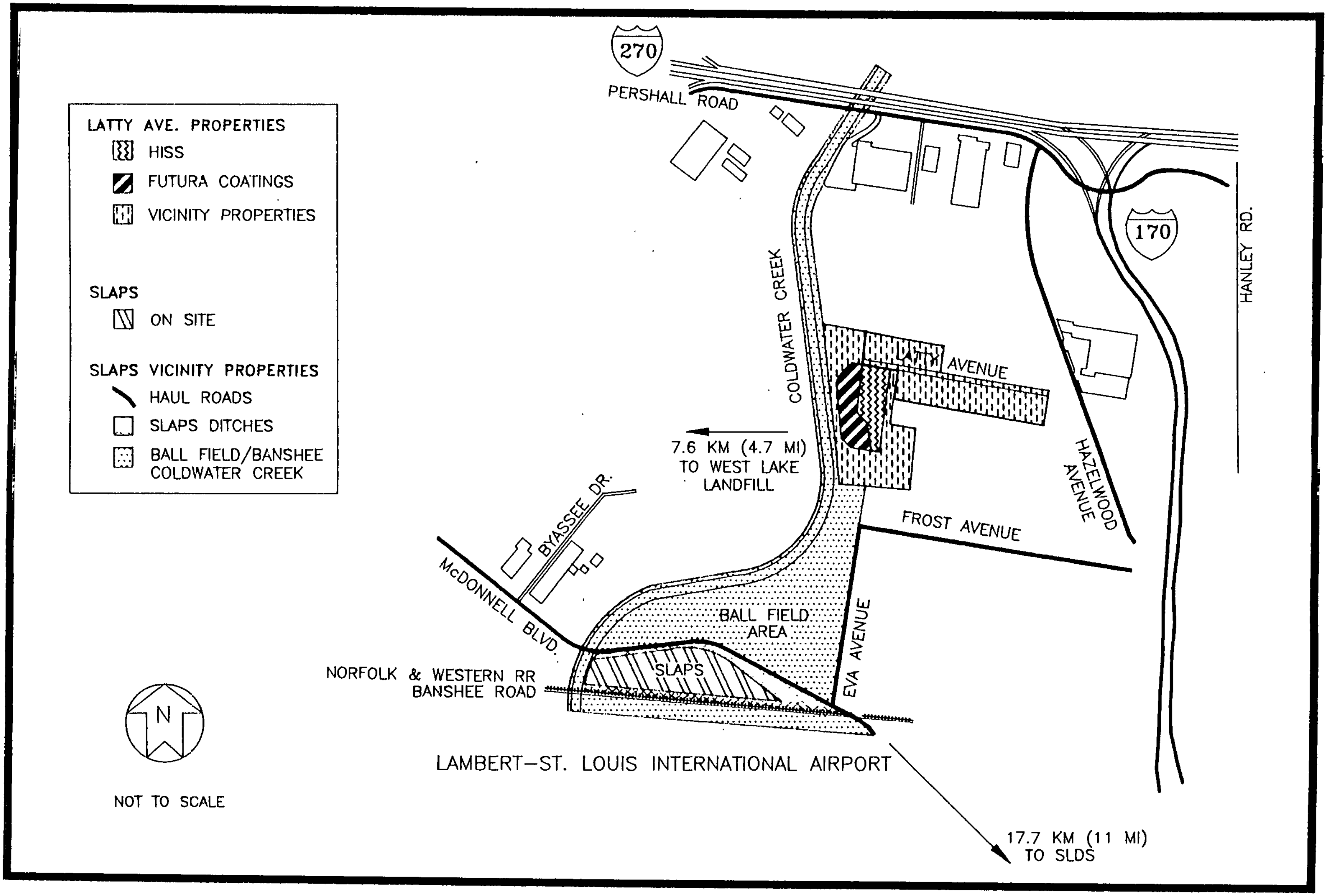

FIGURE 2-3 LOCATIONS OF SLAPS, LATTY AVENUE PROPERTIES, AND VICINITY PROPERTIES

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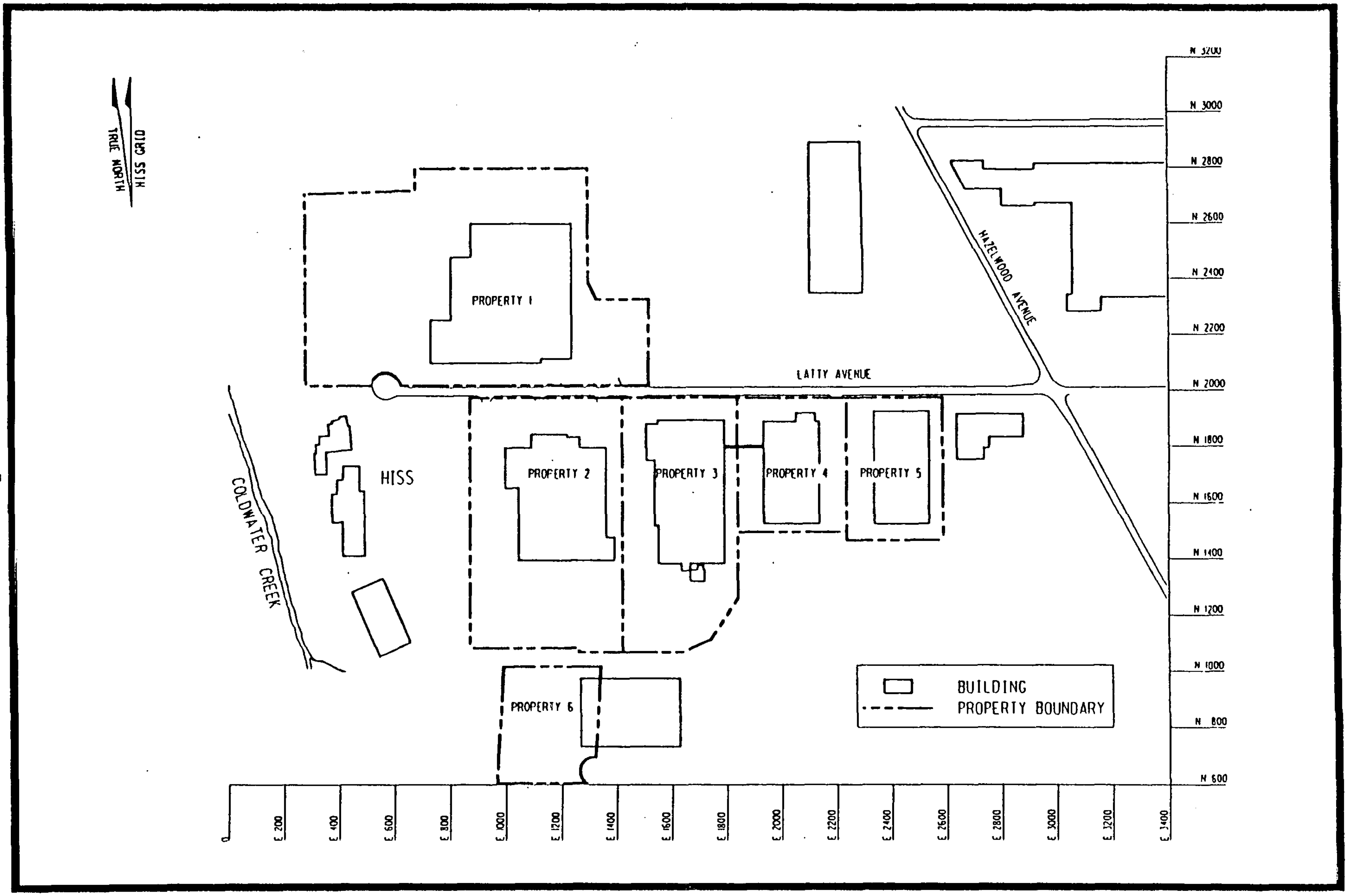

FIGURE 2-4 LOCATIONS OF LATTY AVENUE AND VICINITY PROPERTIES

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TABLE 2-1

STATUS OF THE ST. LOUIS SITE PROPERTIES

Property	Type of Property	Status[a]	Reference(s)[b]
Mallinckrodt Chemical	Industrial	R,C	ORNL 1981; BNI 1990a
McKinley Iron Co.	Industrial	R	-[c]
Thomas & Proetz Lumber Co.	Commercial	R	-[c]
PVO Foods, Inc.	Commercial	R	-[c]
Norfolk & Western Railroad	Industrial	R	-[c]
St. Louis Terminal Railroad Association	Industrial	R	-[c]
Chicago, Burlington & Quincy Railroad	Industrial	R	-[c]
Norfolk & Western Railroad adjacent to 9200 Latty Avenue	Commercial	R	BNI 1990b
Norfolk & Western Railroad adjacent to Hanley Road	Commercial	R	BNI 1990b
Norfolk & Western Railroad south of SLAPS	Commercial	R	BNI 1990b
Norfolk & Western Railroad adjacent to Coldwater Creek	Commercial	R	BNI 1990b
Norfolk & Western Railroad adjacent to Hazelwood Avenue and south of Latty Avenue	Commercial	R	BNI 1990b
Norfolk & Western Railroad adjacent to Hazelwood Avenue and north of Latty Avenue	Commercial	R	BNI 1990b
Norfolk & Western Railroad adjacent to Eva Avenue	Industrial	R	BNI 1990b
Latty Avenue[d]	Municipal	A,R	ORNL 1986a; BNI 1990b

TABLE 2-1

(continued)

Property	Type of Property	Status[a]	Reference(s)[b]
McDonnell Boulevard	Municipal	R	ORNL 1986a; BNI 1990b
Hazelwood Avenue	Municipal	R	ORNL 1986a; BNI 1990b
Pershall Road	Municipal	R	ORNL 1986a; BNI 1990b
Haul Roads Vicinity Property 1	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 2	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 3	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 4	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 5	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 6	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 7	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 8	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 9	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 10	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 11	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 12	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 13	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 14	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 14A	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 15	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 16	Municipal	R	BNI 1990b

TABLE 2-1
(continued)

Property	Type of Property	Status[a]	Reference(s)[b]
Haul Roads Vicinity Property 17	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 18	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 19	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 20	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 20A	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 21	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 22	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 23	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 24	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 25	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 26	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 27	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 28	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 29	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 30	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 31	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 31A	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 32	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 33	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 34	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 35	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 37	Municipal	R	BNI 1990b

TABLE 2-1

(continued)

Property	Type of Property	Status[a]	Reference(s)[b]
Haul Roads Vicinity Property 38	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 39	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 40	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 41	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 42	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 43	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 44	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 45	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 46	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 47	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 48	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 48A	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 49	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 50	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 51	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 52	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 53	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 54	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 55	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 56	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 57	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 58	Municipal	R	BNI 1990b

TABLE 2-1
(continued)

Property	Type of Property	Status[a]	Reference(s)[b]
Haul Roads Vicinity Property 59	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 60	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 61	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 62	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 63	Municipal	R	BNI 1990b
Haul Roads Vicinity Property 63A	Municipal	R	BNI 1990b
Coldwater Creek	Municipal	R,C	COE reports; BNI 1990b
Coldwater Creek Vicinity Property 1	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 2	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 3	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 4	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 5	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 6	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 7	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 8	Municipal	R	BNI 1990b
Coldwater Creek Vicinity Property 9	Municipal	R	BNI 1990b

TABLE 2-1
(continued)

Property	Type of Property	Status[a]	Reference(s)[b]
Coldwater Creek Vicinity Property 10	Municipal	R	BNI 1990b
Banshee Road	Municipal	R	BNI 1990b
Ditches north and south of SLAPS	Municipal	R	BNI 1983; 1987a; 1990b
St. Louis Airport Site	Municipal	R,C	BNI 1985a, 1985b, 1986a, 1987a, 1987d, 1988a, 1989a, 1989b, 1990c
St.Louis Airport Authority Property	Municipal	R	BNI 1990b
Ball Field Area	Municipal	R,C	BNI 1990b
Futura Coatings, Inc.[d]	Municipal	R,C,A	BNI 1990b
Hazelwood Interim Storage Site[d]	Municipal	R,C,A	BNI 1985c,d,e; 1986b; 1987b,e; 1988b; 1989b,c; ORNL 1977; 1986b,c
Latty Avenue Vicinity Property 1	Municipal	R	BNI 1990b
Latty Avenue Vicinity Property 2	Municipal	R	BNI 1990b
Latty Avenue Vicinity Property 3	Municipal	R	BNI 1990b
Latty Avenue Vicinity Property 4	Municipal	R	BNI 1990b
Latty Avenue Vicinity Property 5	Municipal	R	BNI 1990b
Latty Avenue Vicinity Property 6	Municipal	R	BNI 1990b

TABLE 2-1

(continued)

Page 7 of 7

[a]C= Chemical characterization completed on property.
R= Radiological characterization completed on property.
A= Remedial action performed on property.

[b]BNI = Bechtel National, Inc.; ORNL = Oak Ridge National Laboratory; COE = Corps of Engineers.

[c]Radiological characterization of property completed but report not yet published.

[d]Only part of property remediated.

During 1950 and 1951, operations began at Plants 6E and 7. The original Plant 4 (now Plant 10) was modified and used as a metallurgical pilot plant for processing uranium metal until it was closed in 1956. AEC operations in Plant 6E ended in 1957, and AEC managed the decontamination efforts in Plants 4 and 6E, returning them to Mallinckrodt for use without radiological restrictions in 1962 (Mason 1977). Contaminated buildings, equipment, and soils from Plants 4 and 6E were removed. Some buildings that existed in 1962 have since been razed, and some new buildings have been constructed at the former locations of Plants 4 and 6. Plant 7 was used for storing reactor cores, removing metallic uranium from salt by a wet grinding/mill flotation process, and continuous processing of green salt (uranium tetrafluoride) beginning in 1951 (Mason 1977). Plant 7 closed in 1957 and was released for use with no radiological restrictions in 1962 following decontamination. Plant 7 is now used primarily for storage.

In 1977, ORNL conducted a radiological survey of portions of SLDS at the request of DOE (ORNL 1981). Results of this survey showed surface alpha and beta-gamma radiation levels and radionuclide concentrations in soil in excess of limits for release of the property for use without radiological restrictions. Elevated external gamma radiation levels were measured at some outdoor locations and in some of the buildings.

Subsequent SLDS characterization activities showed that radioactive contamination could be present on six adjacent properties. Although historical information does not indicate whether these properties were used for MED/AEC activities conducted at SLDS, such use was possible. Radiological surveys of the vicinity properties were conducted by BNI in 1988 and 1990.

2.2.2 St. Louis Airport Site and Vicinity Properties

SLAPS was acquired by MED/AEC in 1946. From 1946 until 1966, the property was used to store residues (uranium-bearing material generated as a by-product of uranium processing) from SLDS. The residues were transported from SLDS to SLAPS by rail and by truck, possibly along the roads now called the haul roads. In 1966, the wastes were purchased by the Continental Mining and Milling Company, removed from SLAPS, and placed in storage at 9200 Latty Avenue under Nuclear Regulatory Commission (NRC) license. Figure 2-5 shows approximate areas of storage for various residues and wastes. There were ten areas containing pitchblende raffinate, raffinate, barium sulfate cake, uranium tailings, metal scrap, storage barrels, and dolomite slag.

In an agreement between the U.S. Government and the St. Louis Airport Authority and at the request of the City of St. Louis, ownership of SLAPS was transferred in 1973 by quitclaim deed from

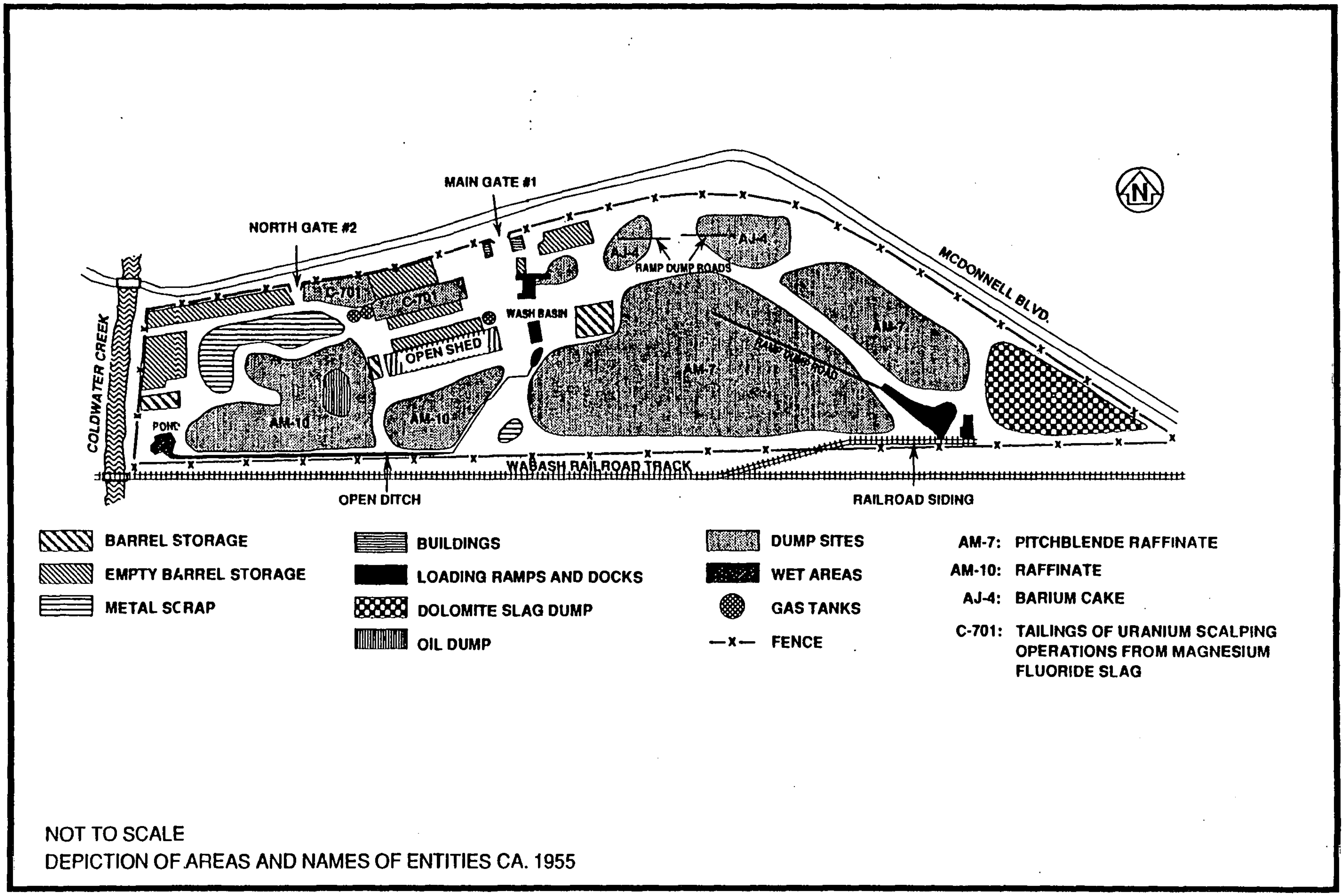

FIGURE 2-5 FORMER AREAS OF USE AND WASTE STORAGE AT SLAPS

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AEC to the St. Louis Airport Authority. The EWDAA of 1985 authorized DOE to reacquire the property from the city for use as a permanent disposal site.

Radioactive contamination of the SLAPS vicinity properties may have been caused by runoff from SLAPS or by spillage during transport of residues from SLDS to SLAPS and from SLAPS to Latty Avenue. Railroad cars may have been used to transport wastes to and from SLAPS, and material from these cars could have spilled onto the railroad property and migrated onto adjacent properties. In addition, road and underground utility improvement activities have resulted in dispersion of contaminants to adjacent land.

The ball field property was used by the St. Louis Airport Authority as a disposal area for construction wastes during construction activities at the airport. This waste and debris have no connection with MED/AEC work; records indicate that wood debris was burned and buried at the ball field area.

2.2.3 Latty Avenue and Vicinity Properties

The residues transferred from SLAPS to the Latty Avenue Properties in 1966 included 11.8 metric tonnes (13 tons) of uranium and 29,500 metric tonnes (32,500 tons) of leached barium sulfate containing about 6.3 metric tonnes (7 tons) of uranium. All of these residues and wastes were deposited directly on the ground. Commercial Discount Corporation of Chicago purchased the residues in January 1967 and, after drying them, shipped much of the material to Cotter Corporation facilities in Canon City, Colorado. The material remaining at Latty Avenue was sold to Cotter in 1969, and Cotter dried and shipped some of the residues remaining at 9200 Latty Avenue to its mills in Canon City in 1970. Remaining residues included approximately 9,100 metric tonnes (10,000 tons) of Colorado raffinate (a term given to the residue by those who did the original processing at Mallinckrodt) and 7,900 metric tonnes (8,700 tons) of leached barium sulfate.

In 1973, Cotter shipped undried Colorado raffinate to Canon City and transported the leached barium sulfate plus 30 to 40 cm (12 to 18 in.) of topsoil for dilution purposes to West Lake Landfill in Bridgeton, Missouri. Cotter informed the NRC of this activity in early 1974.

In 1976, NRC measurements of radiation levels and radionuclide concentrations in soil indicated that residual uranium and thorium concentrations and exposure levels at HISS and Futura exceeded existing guidelines for use of the property without radiological restrictions. ORNL performed a radiological characterization of the properties in 1977, before their occupation by the present owner. Surface contamination exceeding DOE guidelines for thorium and radium was found in and around the buildings and in the soil to depths of 45 cm (18 in.) (ORNL 1977).

In June 1977, the building and grounds at 9200 Latty Avenue were purchased by Mr. E. Dean Jarboe, who currently operates Futura Coatings, Inc. Mr. Jarboe prepared the property for use by demolishing some buildings and erecting some new ones and clearing a 1.4-ha (3.5-acre) tract of land surrounding them. Material resulting from this cleanup [approximately 9,900 m^3 (13,000 yd^3)] was placed in interim storage on the eastern portion of the property (HISS) (ORAU 1981).

In 1984, DOE directed BNI to provide radiological support for remediation of a section of property along Latty Avenue under consideration for street improvements by the cities of Berkeley and Hazelwood. Approximately 10,700 m^3 (14,000 yd^3) of contaminated soil was added to the existing pile at HISS as a result of this cleanup effort and cleanup of an area at HISS used for office trailers and a decontamination pad. Based on results of surveys performed during support of road and drainage improvement projects long Latty Avenue, 3,517 m^3 (4,600 yd^3) of contaminated soil was removed and placed in a second storage pile at HISS in 1986. The total volume of contaminated soil in storage at HISS is approximately 24,500 m^3 (32,000 yd^3).

2.3 ENVIRONMENTAL SETTING

2.3.1 Climate

The St. Louis area has a modified continental climate. Major regional air masses influence a four-season climate that has few prolonged periods of extreme cold, heat, or humidity. Snowfall has averaged less than 50 cm (20 in.) per winter season since 1930. Temperatures reach 0°C (32°F) or lower for fewer than 20 to 25 days in most years. Summers are warm, with maximum temperatures of 32°C (90°F) or higher occurring an average of 35 to 40 days per year. Normal annual precipitation for the St. Louis area is about 92 cm (35 in.). Winds are predominantly from the south, with a mean speed of 15 km/h (9.5 mph).

2.3.2 Geology and Stratigraphy

This section presents a summary of the geology of the St. Louis area, followed by a discussion of salient site-specific geologic information. Detailed descriptions of regional and site-specific geology may be found in BNI 1983b, 1985c, 1989d, and 1990a and Weston 1982.

St. Louis Area

The St. Louis area is located within the Central Stable Region of the Canadian Shield. The Precambrian crystalline rocks of the Canadian Shield are overlain by approximately 1,830 m (6,000 ft) of Paleozoic sedimentary rocks consisting of sequences of sandstones, shales, and limestones and Quaternary age unconsolidated glacial tills, loess, and fluvium from the major rivers in the area. A generalized stratigraphic column for the St. Louis area is presented in Figure 2-6, and a generalized bedrock geologic map is presented in Figure 2-7.

The bedrock units in the St. Louis area are nearly flat-lying, with a regional dip of less than 1 degree to the northeast resulting from flexure from the Ozark Dome. Structural features in the area include folds, domes, and faults. Although St. Louis is located in the tectonically inactive Central Stable Region, it is near the tectonically active Mississippi Embayment, which includes the New Madrid seismic zone. Estimates of earthquake intensity, for a 10 percent expectation during a 50-year period, range from VII to VIII on the Modified Mercalli intensity scale (BNI 1983b).

St. Louis Downtown Site

SLDS is located on the western edge of the Mississippi River, 11 km (7 mi) downstream of the confluence of the Mississippi and Missouri rivers, on the present-day floodplain of the Mississippi River. Figure 2-8 provides a generalized stratigraphic section and geologic description of the subsurface materials encountered during site investigations. A layer of rubble and fill (disturbed material) with an average thickness of 4 m (13 ft) is present over most of the property. Beneath the disturbed materials, unconsolidated deposits composed of stratified clays, silts, sands, and gravels are present. The unconsolidated deposits have been divided into an upper and lower unit. The upper unit is a clayey silt with interbedded silty clay, clay, silt, and sandy silt. The thickness of this unit ranges from 3 to 9 m (10 to 30 ft). Evaluation of soil boring data suggests that this unit is laterally continuous across the property. The lower unit is a silty sand that grades laterally to a sand toward the Mississippi River and is present only in the eastern portion of the property. The observed thickness of the unit ranges from 0 to 18.3 m (0 to 60 ft), increasing in thickness with increasing depth to bedrock and proximity to the Mississippi River. Beneath the unconsolidated deposits, a limestone bedrock unit is present. The depth to bedrock ranges from 5.9 m (19.5 ft) on the western side of the property to 24.4 m (80 ft) near the Mississippi River. The limestone is hard and microcrystalline and contains chert nodules. Examination of rock core samples indicates that the

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C – Cenozoic
Q – Quaternary
D – Devonian
S – Siluruan

Millions of Years Ago	Era	Period	Description	Thickness(ft)
Present – ~0.5	C	Q	GLACIAL TILLS, LOESS. ALLUVIUM.	0-315
~290 – 320	PALEOZOIC	CARBONIFEROUS	PENNSYLVANIAN CYCLOTHEMS OF SHALE, SILTSTONE, "DIRTY" SANDSTONES, COAL BEDS, AND THIN LIMESTONES.	0-365
320 – 370	PALEOZOIC	CARBONIFEROUS	MISSISSIPPIAN LIMESTONES, CHERTY LIMESTONES, DOLOMITIC LIMESTONES, SILTSTONES, SANDSTONES AND SHALES.	0-1100
370 – 415	PALEOZOIC	D	SANDSTONE, LIMESTONE; FISSILE CARBONACEOUS SHALE.	1-110
415 – 440	PALEOZOIC	S	CHERTY LIMESTONE.	1-200
440 – 500	PALEOZOIC	ORDOVICIAN	SILTY, CALCAREOUS, OR DOLOMITIC SHALE; ARGILLACEOUS LIMESTONE; MASSIVE LIMESTONES; ARGILLACEOUS DOLOMITES; SILTY SANDSTONES, CHERTY LIMESTONE GRADING TO QUARTZOSE SANDSTONE; SANDY AND CHERTY DOLOMITES AND SANDSTONE.	0 - 2275
500 – 565	PALEOZOIC	CAMBRIAN	CHERTY DOLOMITES, SILTSTONES, SANDSTONE AND SHALE FORMATIONS.	480 - 1430
565 –	PRECAMBRIAN		IGNEOUS AND METAMORPHIC ROCK. "CRYSTALINE BASEMENT."	

FIGURE 2-6 GENERALIZED STRATIGRAPHIC COLUMN FOR THE ST. LOUIS REGION

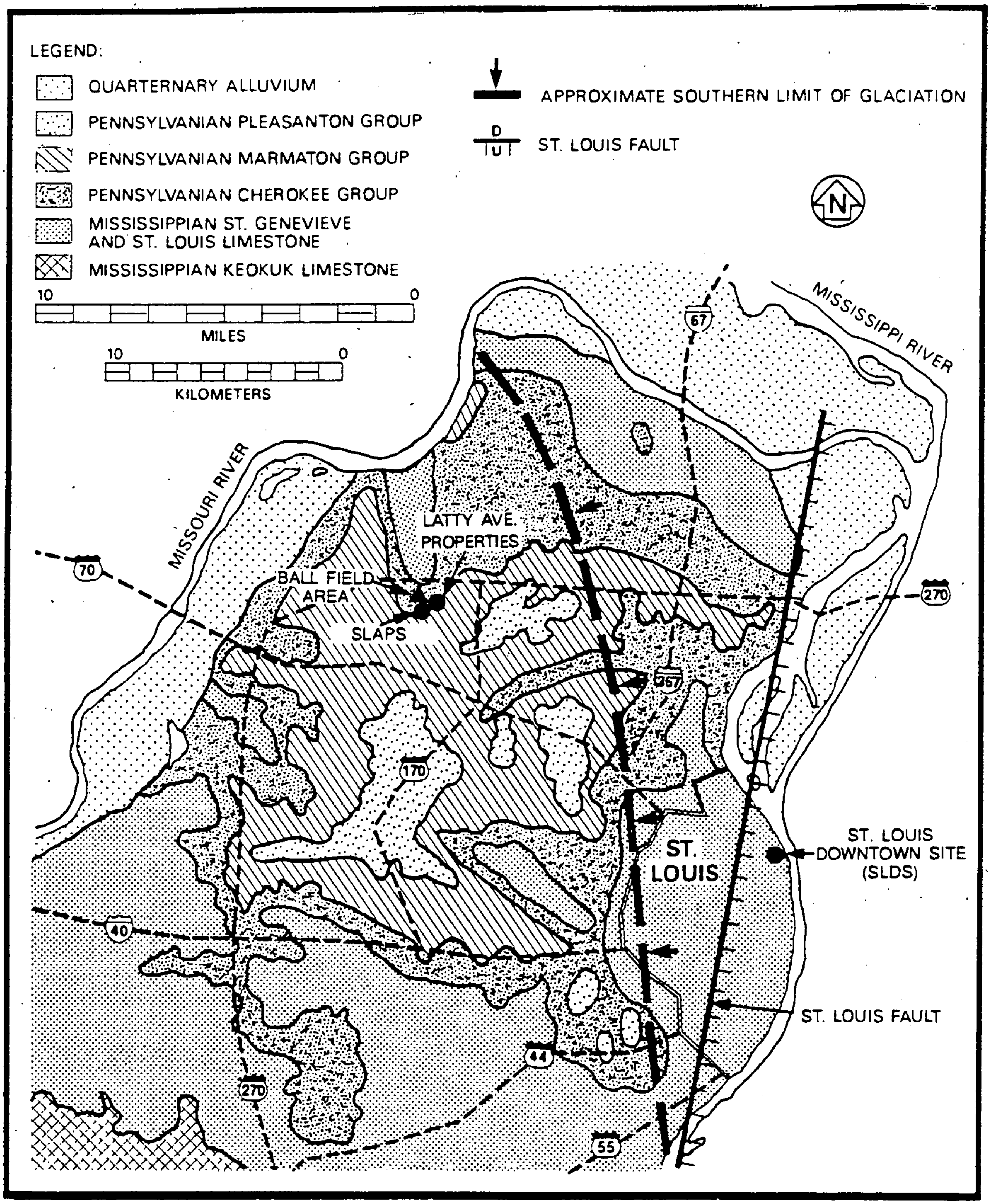

FIGURE 2-7 GENERALIZED BEDROCK GEOLOGIC MAP OF THE ST. LOUIS AREA

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Unit Designation	Graphic Column	Approximate Thickness (ft)	Description
NOT DESIGNATED		0-25	**RUBBLE and FILL** Grayish black (N2)to brownish black (5YR2/1). Dry to slightly moist, generally becoming moist at 5-6 ft and saturated at 10-12 ft. Slight cohesion, variable with depth, moisture content and percentage of fines present. Consistency or relative density is unrepresentative, due to large rubble fragments. Rubble is concrete, brick, glass, and coal slag. Percentage of fines as silt or clay increases with depth from 5 to 30 percent. Some weakly cemented aggregations of soil particles. Adhesion of fines to rubble increases with depth and higher moisture content. Degree of compaction is slight to moderate with frequent large voids.
UPPER UNIT		0-10	**Silty CLAY** Layers are mostly olive gray (5Y2/1), with some olive black (5Y2/1). Predominantly occurs at contact of undisturbed material, or at boundary of material with elevated activity. Abundant dark, decomposed organics. Variable percentages of silt and clay compostion.
		0-3	**CLAY** Layers are light olive gray (5Y5/2), or dark greenish gray (5GY4/1). Slightly moist to moist, moderate cohesion, medium stiff consistency. Tends to have lowest moisture content. Slight to moderate plasticity.
		0-15	**Interbedded CLAY, Silty CLAY, SILT and Sandy SILT** Dark greenish gray (5GY4/1) to Light olive gray (5Y6/1). Moist to saturated, dependent on percentage of particle size. Contacts are sharp, with structure normal to sampler axis to less than 15 degrees downdip. Layer thicknesses are variable, random in alternation with no predictable vertical gradation or lateral continuity. Some very fine-grained, rounded silica sand as stringers. Silt is dark mafic, biotite flakes. Some decomposed organics.
		0-10	**Sandy SILT** Olive gray (5Y4/1). Moist with zones of higher sand content saturated. Slight to moderate cohesion, moderate compaction. Stiff to very stiff consistency, rapid dilatancy, nonplastic. Sand is well sorted, very fine and fine-grained rounded quartz particles.
LOWER UNIT		0-30	**Silty SAND and SAND** Olive gray (5Y4/1). Saturated, slight cohesion, becoming noncohesive with decrease of silt particles with depth. Dense, moderate compaction. Moderate to well-graded, mostly fine- and medium-grained, with some fine- and coarse-grained particles. Mostly rounded with coarse grains slightly subrounded. Gradual gradation from upper unit, Silty SAND has abundant dark mafic/biotite flakes. Sand is well-graded, fine gravel to fine sand. Mostly medium-grained, with some fine-grained and few coarse-grained and fine gravel.
BEDROCK UNIT		0.5-12	**LIMESTONE** Light olive gray (5Y4/1) with interbedded chert modules. Generally hard to very hard; difficult to scratch with knife. Slightly weathered, moderately fresh with little to no discoloration or staining. Top 5 ft is moderately fractured, with 99 percent of joints normal to the core axis. Joints are open, planar, and smooth. Some are slightly discolored with trace of hematite staining.

FIGURE 2-8 GENERALIZED STRATIGRAPHIC COLUMN FOR SLDS

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upper 1.5 m (5 ft) of the limestone is moderately fractured (200- to 600-mm spacing), with the discontinuities oriented normal to the core axis.

St. Louis Airport Site and Ball Field Area

Figure 2-9 presents a generalized stratigraphic column for SLAPS and the ball field area, based on information collected from site investigations. The site stratigraphy is divided into six units. The upper four units are composed of Holocene and Pleistocene unconsolidated materials including fill, loess, lacustrine, and glacial deposits. These unconsolidated materials range in thickness from 15.2 to 24.4 m (50 to 80 ft) across the properties. Beneath the unconsolidated deposits, bedrock units include Pennsylvanian undifferentiated cyclothem deposits and Mississippian limestone. Pennsylvanian undifferentiated rocks comprise the upper bedrock unit in the eastern portion of the SLAPS/ball field property. Mississippian limestone comprises the rest of the unit.

Soil samples were collected and analyzed to characterize the physical and geochemical properties of the undisturbed unconsolidated deposits. Table 2-2 summarizes the results of these tests. Discussions of test methodology are presented in BNI 1989b and Weston 1982. A listing of individual test results is presented in Appendix G. Results of the laboratory soil testing and visual observations of the samples indicate that the lacustrine deposits (unit 3) are, based on their physical properties, divided into three subunits (3T, 3M, and 3B). Subunits 3T and 3B (top and bottom of unit 3) have similar properties, but subunit 3M (middle of unit 3) exhibits different physical properties. This subunit is a high plasticity clay whose permeability is one to two orders of magnitude lower than the remainder of unit 3. Subunit 3M is thought to play a major role in groundwater flow and solute transport at the SLAPS/ball field properties. The areal distribution of this subunit was found to be discontinuous. Figure 2-10 is a map of the approximate areal distribution of subunit 3M. [Note: The well identifiers on Figure 2-10 and other figures provide information about the locations of each well. For example, B16W02S (or D) may be broken down as follows: B - Bechtel-installed borehole or well; 16 - last two digits of work breakdown structure (WBS) (i.e., SLDS WBS number is 116); W - well; 02 - well number; S - shallow aquifer (or D - deep aquifer).]

Another finding from examination of Table 2-2 is that the uranium distribution ratios for unit 2 (loess) are 10 to 20 times higher than those for unit 3 (lacustrine deposits). Uranium was the only radionuclide used in distribution ratio measurements because, under normal geochemical conditions, uranium is the most mobile of the common radionuclides at the properties. Roy F. Weston, Inc. (RFW) examined the clay mineralogy of loess and the lacustrine deposits using X-ray diffraction data

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Period	Epoch	Formation	Columnar Section		Description
	HOLOCENE	FILL/TOPSOIL		0-14	**UNIT 1** Fill – Sand, silt, clay, concrete, rubble Topsoil – Organic silts, clayey silts, wood, fine sand.
		LOESS (CLAYEY SILT)		11-32	**UNIT 2** Clayey silts, fine sands, mottled with frequent iron oxide staining, scattered roots, and organic material. Occasional fossils.
		LACUSTRINE SERIES: SILTY CLAY		19-75 9-27	**UNIT 3** Silty clay with scattered organic blebs and peat stringers. Moderate plasticity. Moist to saturated.**(3T)**
		VARVED CLAY		0-8	Two boreholes only – in ball field area.**(3M)**
		CLAY		0-26	Dense, stiff, moist, highly plastic clay. Not present in eastern portion of site.**(3M)**
		SILTY CLAY		10-29	Similar to upper silty clay. Probable unconformable contact with highly plastic clay.**(3B)**
		BASAL CLAYEY & SANDY GRAVEL		0-6	**UNIT 4** Glacial clayey gravels, sands, and sandy gravels. Mostly chert. Infrequent distribution over site.
PENNSYLVANIAN		PENNSYLVANIAN (undifferentiated)		0-35	BEDROCK, **UNIT 5**: Cycles of silty clay/shale, lignite/coal, sandstone, and siltstone. Erosionally truncated by glaciolacustrine sequences.
MISSISSIPPIAN		ST. GENEVIEVE (?) LIMESTONE		10+	BEDROCK, **UNIT 6**: Hard, white to olive, well cemented limestone with interbedded shale laminations.

FIGURE 2-9 GENERALIZED STRATIGRAPHIC COLUMN FOR SLAPS AND THE BALL FIELD AREA

TABLE 2-2

LABORATORY SOIL TESTING SUMMARY FOR SLAPS AND THE BALL FIELD AREA

Unit[a]	Specific Gravity	Water Content (%)	Gradation Sand (%)	Gradation Fines (%)	Atterberg Limits Liquid Limit	Atterberg Limits Plastic Limit	Atterberg Limits Plasticity Index	Dry Density (pcf)	Geometric Mean Vertical Lab Permeability (cm/s)	Uranium Distribution Ratio (ml/g)	Effective Cation Exchange Capacity (meq/100 g soil)	Void Ratio	Unified Soil Classification[b]
2	2.52	24	10	90	33	24	9	94	1.0E-06	168	149	0.697	ML-CL
3T and 3B	2.42	22	10	90	35	20	15	95	2.0E-06	11	172	0.647	CL
3M	2.34	24	8	92	66	25	41	82	5.5E-08	8	200	0.856	CH
4	2.30	23	47	53	--[c]	--[c]	--[c]	--[c]	1.0E-06	--[d]	--[d]	0.799	GC-SM-CL

[a]All values are arithmetic means except as noted.

[b]Unified soil classification: ML = Inorganic silts, silty or clayey fine sands
CL = Low plasticity clays, gravelly clays, silty clays, sandy clays
CH = High plasticity clays, fat clays
GC = Clayey gravels, poorly graded gravel-sand-clay mixtures
SM = Silty sand, sand-silt mixtures.

[c]Not tested due to high sand content.

[d]Not tested.

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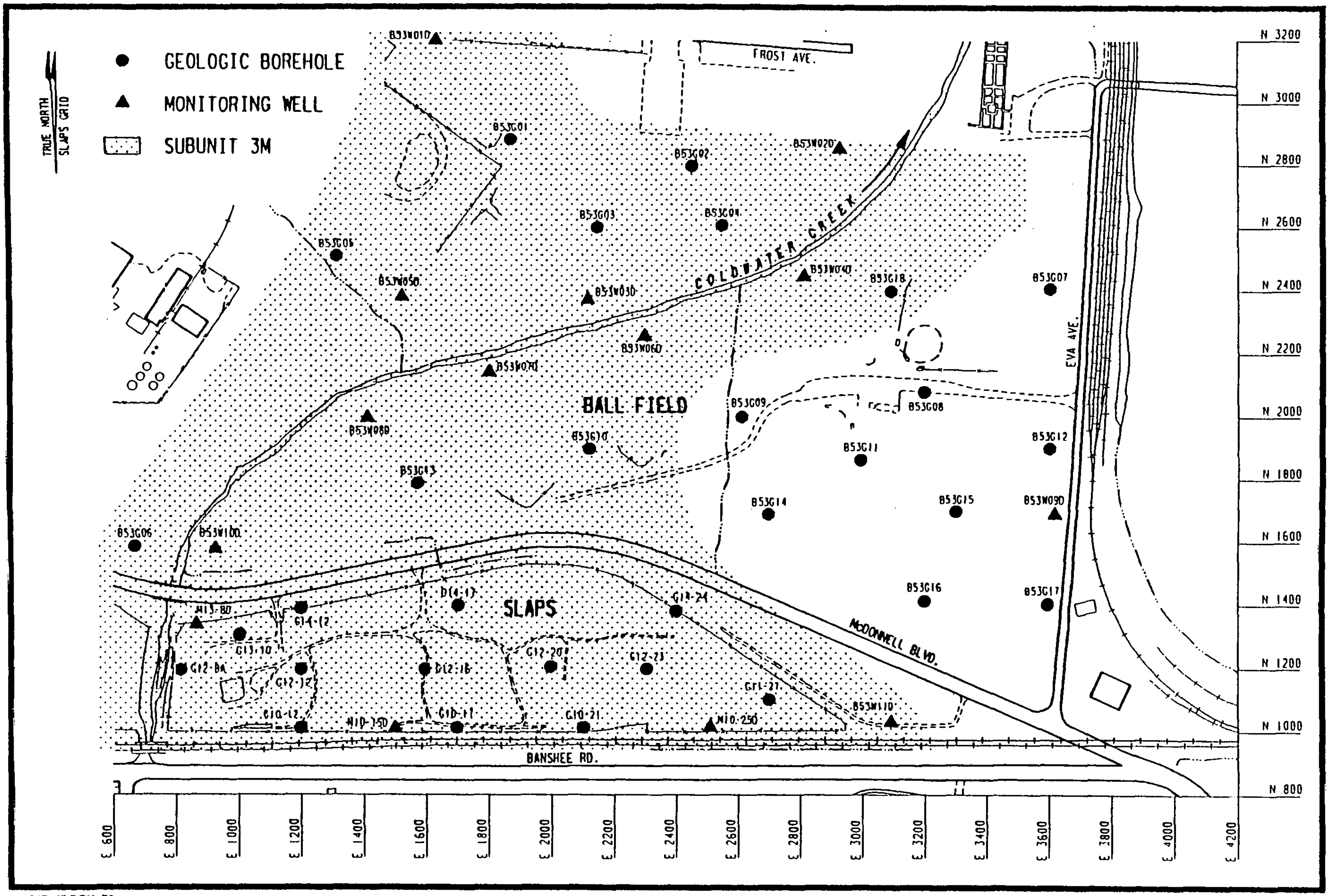

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FIGURE 2-10 APPROXIMATE EXTENT OF SUBUNIT 3M IN THE SLAPS/BALL FIELD AREA

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(Weston 1982). Their investigation revealed that the clay mineralogy of the loess is dominated by smectite (and other complex mixed layer silicates) while the lacustrine deposits are dominated by illite or illite-chlorite assemblages. The complex mixed layer silicates have greater sorptive capacity than illite or chlorite. The effective cation exchange capacities for the two units do not show a significant disparity, indicating that the dominant sorptive mechanism is adsorption rather than ion exchange.

Latty Avenue Properties

The stratigraphy of HISS and Futura is similar to that observed at the SLAPS/ball field properties. A single geologic borehole (HISS-9A) was drilled to a depth of 18.3 m (60 ft) to facilitate characterization of the site stratigraphy. The stratigraphy is divided into:

- 0 to 6.7 m (0 to 22 ft) of loess (analogous to unit 2 at SLAPS)
- 6.7 to 14.6 m (22 to 48 ft) of lacustrine deposits (analogous to unit 3T)
- 14.6 to 18.3 m (48 to 60 ft) of lacustrine deposits (analogous to unit 3M)

The presence of glacial deposits underlying the lacustrine deposits and the depth to bedrock at the Latty Avenue properties has not been determined. Due to the proximity of HISS and Futura to SLAPS and the ball field area, the soil properties at each are thought to be similar.

2.3.3 Hydrology, Hydrogeology, and Water Quality

This section summaries the regional and site-specific hydrology and hydrogeology. Detailed discussions of hydrology and hydrogeology are presented in BNI 1985c, 1989d, and 1990a and Weston 1982.

St. Louis Area

The major surface water bodies are the Mississippi, Missouri, and Meramec rivers, which supply most of the drinking and industrial water for the St. Louis area including St. Louis, Missouri; East St. Louis, Illinois; and Granite City, Illinois (Figure 1-1). Approximately 82 percent of the

1,200 million gallons of water used daily in the St. Louis area is pumped from the Mississippi River; the other 18 percent is pumped from the Meramec and Missouri rivers near St. Charles (BNI 1990a). All but one of the water supply intakes for these cities are located upstream of SLDS; East St. Louis draws a small percentage of its water from an intake located on the east bank of the river, approximately 3.2 km (2 mi) downstream of SLDS. The Mississippi River intakes for the City of St. Louis are well upstream (approximately 7 mi) of SLDS. The Chain-of-Rocks water treatment plant is located at approximately mile 190 on the Mississippi River; SLDS is approximately at mile 182.5. The confluence of the Missouri River into the Mississippi River is approximately at mile 195 (river mile 0 on the Missouri River)(Department of the Army 1977). Upstream of its confluence with the Missouri River, Mississippi River water is generally of good quality except for being very hard. Downstream of the confluence, however, the water tends to have high turbidity resulting from sediment transport and an increase in mineralization. Water from the Missouri River is moderately mineralized, hard, and highly turbid; treatment is necessary for most uses. The Meramec River water is generally of good quality; it is hard and the turbidity is normally low (Miller et. al. 1974).

The principal aquifers in the St. Louis area are located in the alluvial deposits associated with the major rivers. Well yields of up to 190 L/s (3,000 gpm) have been reported for production wells pumping from these alluvial aquifers. Aquifers are also known to exist in the Silurian through Pennsylvanian age bedrock formations. In the St. Louis area, the bedrock aquifers typically yield less than 3 L/s (50 gpm), and water quality tends to deteriorate with depth as a result of increasing salinity and increased concentrations of other dissolved minerals. The chemical quality of groundwater from the alluvial aquifers is generally good, but the water is very hard and contains high concentrations of iron and manganese (Miller et. al. 1974).

St. Louis Downtown Site

The dominant surface water feature at SLDS is the Mississippi River, which is located near the eastern edge of the property. As mentioned previously, the rivers are the major water supply source for the St. Louis area. All but one of the water supply intakes for the area are located upstream of SLDS; East St. Louis draws a portion of its water from an intake located on the eastern bank of the river, approximately 3.2 km (2 mi) downstream of SLDS.

SLDS is underlain by a portion of the Mississippi River alluvial aquifer. The alluvial aquifer at SLDS is composed of the upper and lower units of the unconsolidated deposits. The silt and sandy silt layers within the upper unit represent water-bearing strata that are thought to be in hydraulic connection with the silty sand and sand of the lower unit. The alluvial aquifer is underlain by limestone bedrock. The upper portion of the bedrock is a water-bearing zone with groundwater occurring in secondary porosity features (fractures). Primary (matrix) porosity of the limestone is low, resulting in groundwater flow primarily through secondary porosity features. The boreholes penetrating the bedrock did not reveal any strata that could act as an aquitard to isolate the bedrock from the alluvial aquifer. Thus, the upper bedrock is thought to be hydraulically connected to the alluvial aquifer.

The relationship of the alluvial aquifer to the Mississippi River was investigated using groundwater level and river stage data. Figure 2-11 is a hydrograph showing groundwater elevations from four wells monitoring the lower unit and river stage elevations. The hydrograph suggests that there is a correlation between river stage fluctuations and groundwater level fluctuations. To quantify this correlation, regression analyses were performed. Correlation coefficients obtained from the regression analyses ranged from 0.93 to 0.99 indicating good correlation between the data (a correlation coefficient of 1 indicates perfect correlation). This suggests that the alluvial aquifer is in hydraulic connection with the Mississippi River.

Figure 2-12 is a potentiometric surface map created from groundwater level and river stage measurements taken on June 9, 1989. The figure shows that the general direction of groundwater flow is toward the Mississippi River. However, near the river, there is an anomalous depression in the potentiometric surface that is thought to represent a transient condition created by river stage fluctuations. When the river stage rises, a temporary reversal of groundwater flow occurs, created by recharge from the river.

The potentiometric surface map and available site data were used to develop a conceptualization of groundwater flow at the property. Recharge to the area groundwater system is thought to occur by off-site inflow through the upper unconsolidated unit and bedrock, from infiltration of precipitation, and through river bed infiltration at the Mississippi River. Infiltration of precipitation at SLDS appears to be a minor source of recharge because of the large percentage of surface area that contains impervious or diversionary features (i.e., asphalt roads, parking lots, and buildings). The area groundwater system discharges to the Mississippi River during low river stage, as underflow beneath the river, and, possibly, as recharge to the bedrock groundwater system.

Investigations conducted at the property include measurement of aquifer characteristics that are related to groundwater flow and solute transport in the groundwater system. A summary of

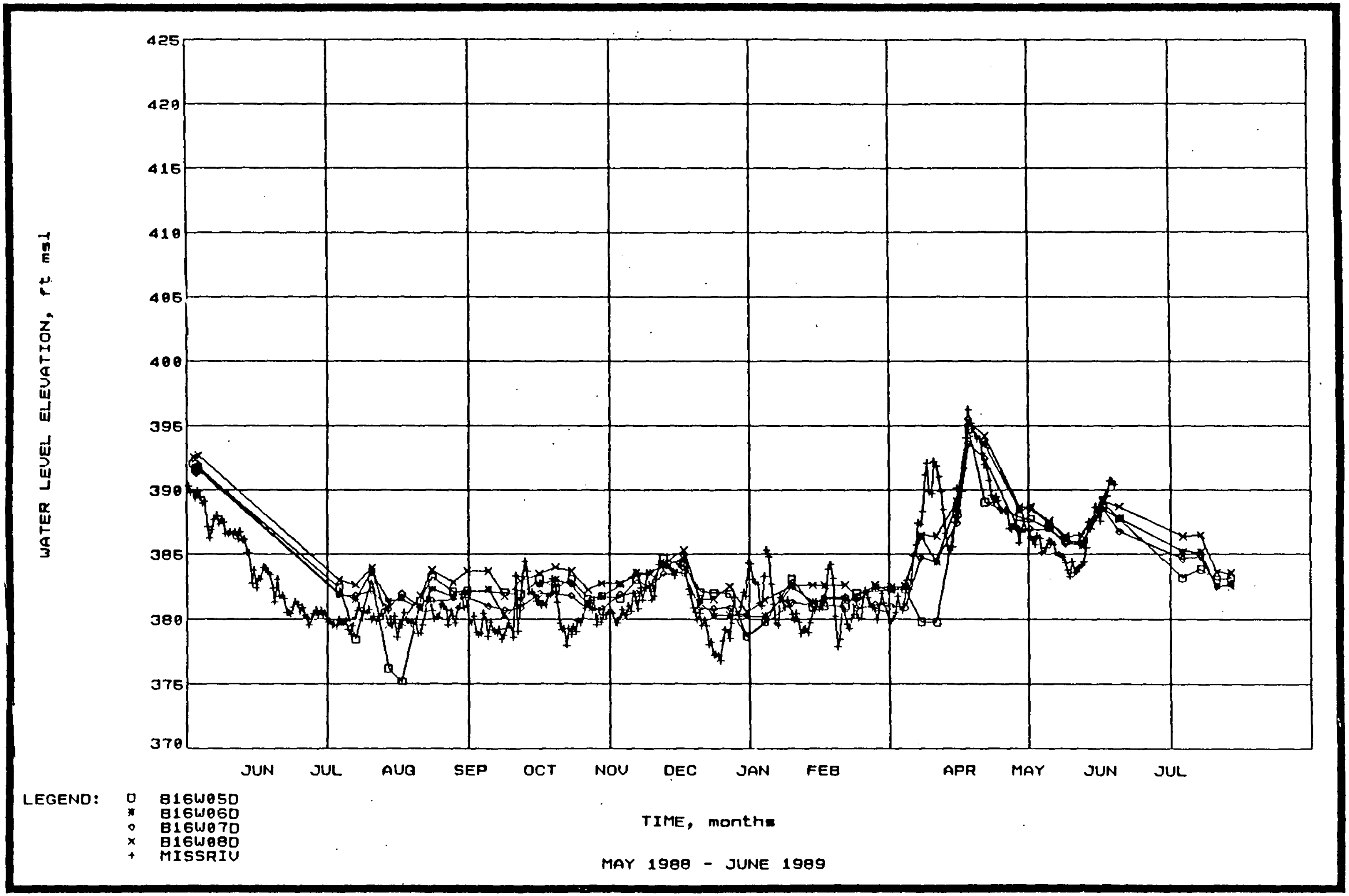

FIGURE 2-11 HYDROGRAPHS OF MONITORING WELLS OF UNCONSOLIDATED DEPOSITS AT SLDS

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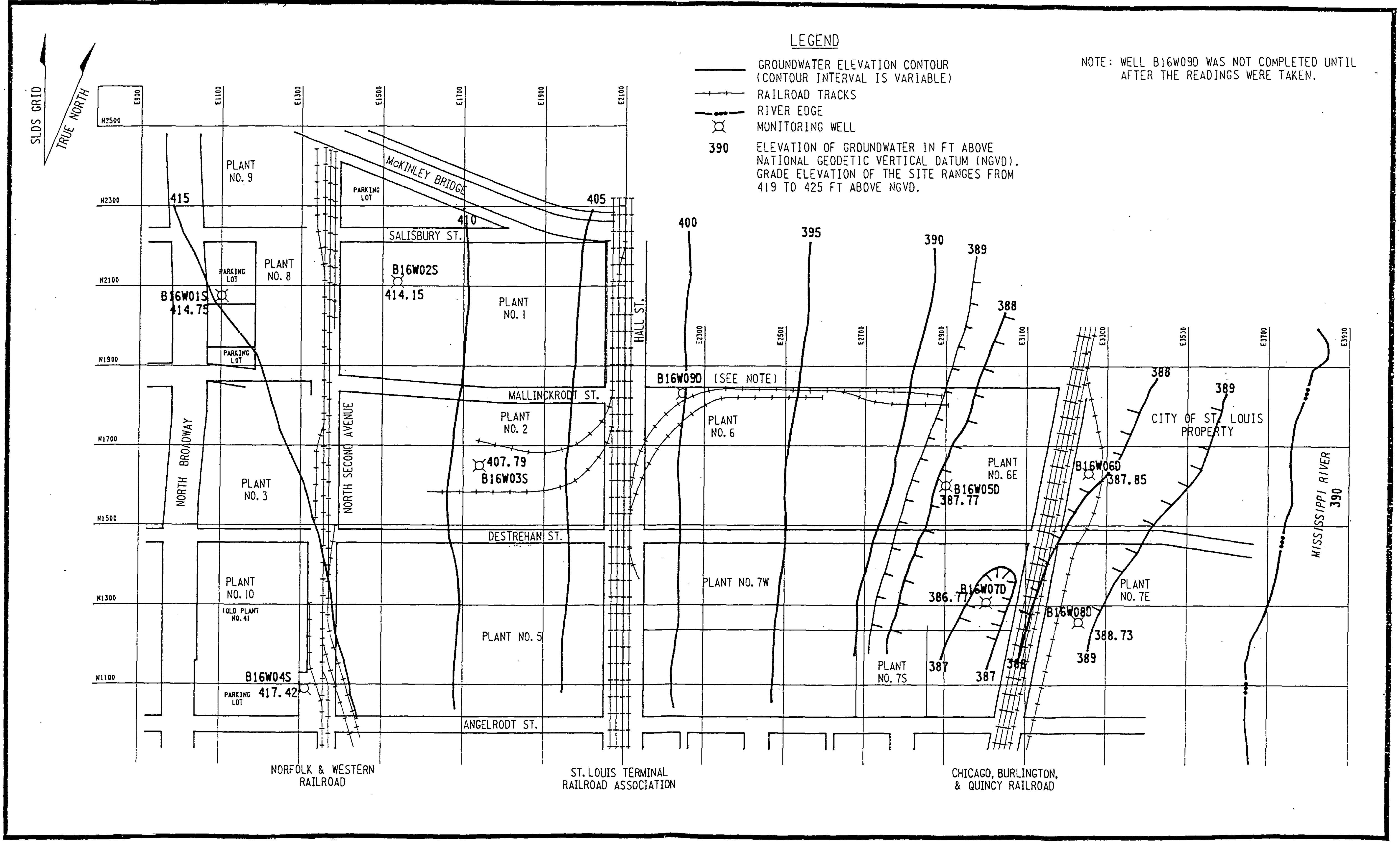

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FIGURE 2-12 POTENTIOMETRIC SURFACE FOR SLDS, JUNE 9, 1989 these measurements is presented in Table 2-3. The measurement methodologies and results are discussed in BNI 1990a. Insufficient information is available to quantify the average linear groundwater velocity at the property; however, based on the materials present and the measured hydraulic gradients, the average linear groundwater velocity is estimated to be 3 to 6 m/yr (10 to 20 ft/yr) in the lower unit and 0.03 to 0.3 m/yr (0.1 to 1 ft/yr) in the upper unit. The uranium distribution ratio for the upper unit indicates that transport of uranium would be significantly retarded relative to groundwater movement. Based on soil properties from similar geologic settings and the uranium distribution ratio, the uranium migration rate is estimated to be 300 to 400 times slower than the groundwater velocity.

St. Louis Airport Site and Ball Field Area

The primary surface water feature at the SLAPS/ball field properties is Coldwater Creek, which is approximately 30 km (19 mi) long and drains an area of about 118 km^2 (46 mi^2); at McDonnell Boulevard, the creek has a drainage area of approximately 32 km^2 (12.3 mi^2) (Hauth and Spencer 1971). RFW performed a base flow survey of Coldwater Creek at SLAPS and determined that the average base flow was 0.07 cms (2.5 cfs) (Weston 1982). The creek discharges into the Missouri River, north of its confluence with the Mississippi River (Figure 1-1). Coldwater Creek is not used for drinking water; however, two municipal water intakes are present on the Mississippi River, downstream of the discharge of Coldwater Creek: the City of St. Louis Chain of Rocks Plant and the East St. Louis Plant. Water quality data for Coldwater Creek at high and low flow are presented in Table 2-4. The water samples were collected at crossing points of the creek with I-70 and I-270, which are upstream and downstream, respectively, of the properties. The pollutants of major concern are oil products transported into the stream by surface runoff from surrounding areas. Coldwater Creek empties into the Mississippi River at Missouri River mile 7 (Coldwater Creek mile 0) (Department of the Army 1977).

Hydrogeologic investigations indicate that two groundwater systems exist in the unconsolidated deposits at the properties. The upper groundwater system is contained in unit 2 and subunit 3T (loess and lacustrine deposits). The lower groundwater system is present in subunit 3B and unit 4 (lacustrine and glacial deposits). The two groundwater systems are separated by an aquitard composed of subunit 3M (lacustrine deposits). However, in the eastern portion of the properties, the aquitard is absent and the upper and lower groundwater systems become a single groundwater

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TABLE 2-3

SUMMARY OF GROUNDWATER FLOW AND SOLUTE TRANSPORT PARAMETERS FOR SLDS

Aquifer Characteristics	Hydrogeologic and Geochemical Properties
Upper Unit	
Observed saturated thickness	3 to 9 m (10 to 30 ft)
Hydraulic conductivity	9.9×10^{-5} cm/s (10 ft/yr)[a]
Distribution ratio for uranium	146 ml/g[a]
Effective cation exchange capacity	200 meq/100 g of soil[a]
Lower Unit	
Observed saturated thickness	0 to 10.3 m (0 to 60 ft)
Hydraulic conductivity	Not determined
Bedrock	
Observed thickness	Not determined
Hydraulic conductivity	1.1×10^{-3} to 5.1×10^{-4} cm/s (1,190 to 535 ft/yr)
Hydraulic gradient	0.01 to 0.02 [dimensionless]

[a]Only one test was conducted for this parameter.

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TABLE 2-4

RESULTS OF WATER QUALITY SAMPLING IN COLDWATER CREEK

Parameter[a]	September 28, 1981 (Dry Weather)		July 11, 1981 (Stormwater)	
	I-70	I-270	I-70	I-270
pH	7.7	7.8	--[b]	--[b]
Suspended solids	10-20	10-20	354	719
Total solids	582	531	--[b]	--[b]
Chemical oxygen demand	30	<20	--[b]	--[b]
Phenols	<0.05	0.05	--[b]	--[b]
Cyanide	<0.1	<0.1	--[b]	--[b]
Ammonia	<0.5	<0.5	--[b]	--[b]
Mercury	0.0003	0.0001	<0.0002	<0.0002
Arsenic	0.02	0.01	<0.02	0.02
Barium	0.29	0.21	0.08	0.09
Cadmium	<0.01	<0.01	<0.001	<0.001
Chromium	0.1	<0.01	0.01	0.004
Copper	<0.01	0.05	0.02	0.01
Lead	0.07	0.08	0.25	0.03
Nickel	0.03	0.02	0.006	<0.005
Selenium	<0.01	<0.01	<0.02	<0.02
Zinc	0.09	0.09	0.15	0.06
Aluminum	--[b]	--[b]	2.66	1.35
Iron	--[b]	--[b]	2.88	1.32
Manganese	--[b]	--[b]	0.23	0.27

[a]pH is expressed in standard units; all other parameters are expressed in mg/L.

[b]Not measured.

Source: Letter, B. A. Rains, St. Louis Metropolitan Sewer District, to Argonne National Laboratory, November 12, 1981.

system. Comparison of groundwater level measurements from two monitoring wells screened in the Pennsylvanian undifferentiated bedrock with those from wells screened in the lower overburden suggests that the bedrock is hydraulically connected to the unconsolidated deposits.

Typical hydrographs for monitoring wells screened in the upper and lower portions of the unconsolidated deposits are shown in Figures 2-13 and 2-14. The hydrographs for monitoring wells screened in the upper system show the groundwater levels to be variable, with up to 2.7 m (9 ft) of variation over the course of a year. The hydrographs for monitoring wells screened in the lower groundwater system show less variability, approximately 1.5 m (5 ft) or less during a year. The higher variability in the upper system is thought to be a result of the greater influence of individual precipitation events and evapotranspiration effects on the upper groundwater system.

Figures 2-15 and 2-16 present potentiometric surface maps of the upper and lower groundwater systems for June 23, 1989. The upper groundwater system shows a north-northwestern flow direction, generally toward Coldwater Creek. The lower groundwater system shows a northwest-western flow direction. Both potentiometric surfaces indicate that the southeastern corner of SLAPS is the upgradient end of the properties.

Comparison of groundwater level elevations for shallow and deep monitoring well pairs shown on the potentiometric surface maps (M10-25S and D, M10-15S and D, M10-8S and D, and M13.5-8.5S and D) indicates that a head differential between the upper and lower systems is present. In the eastern and central portions of SLAPS, the groundwater level elevations show a head differential of between 0.3 and 2.4 m (1.2 and 7.7 ft), which is indicative of a downward flow potential (from the upper to the lower groundwater system). In the western portion of SLAPS, head differentials of -0.6 to -1.2 m (-2 to -4 ft) occur, which is indicative of an upward flow potential (from the lower to the upper groundwater system). The change from downward flow potential to upward flow potential is probably a result of a lowering of the head in the upper groundwater system by seepage into the Coldwater Creek channel.

The available hydrogeologic data for the properties were used to develop a conceptualization of the groundwater flow. Recharge to the upper groundwater system is thought to occur from off-site inflow of groundwater, infiltration of precipitation, vertical seepage from the lower groundwater system where upward flow potentials exist, and, during high creek stage, from creek bed infiltration. Discharge from the upper groundwater system probably occurs by off-site outflow, seepage into Coldwater Creek during low creek stage, and vertical seepage into the lower groundwater system where downward flow potentials exist. Recharge to the lower groundwater system is thought to occur by off-site inflow, infiltration of precipitation (in the eastern portions of the properties, where the aquitard is absent), and vertical seepage from the upper groundwater

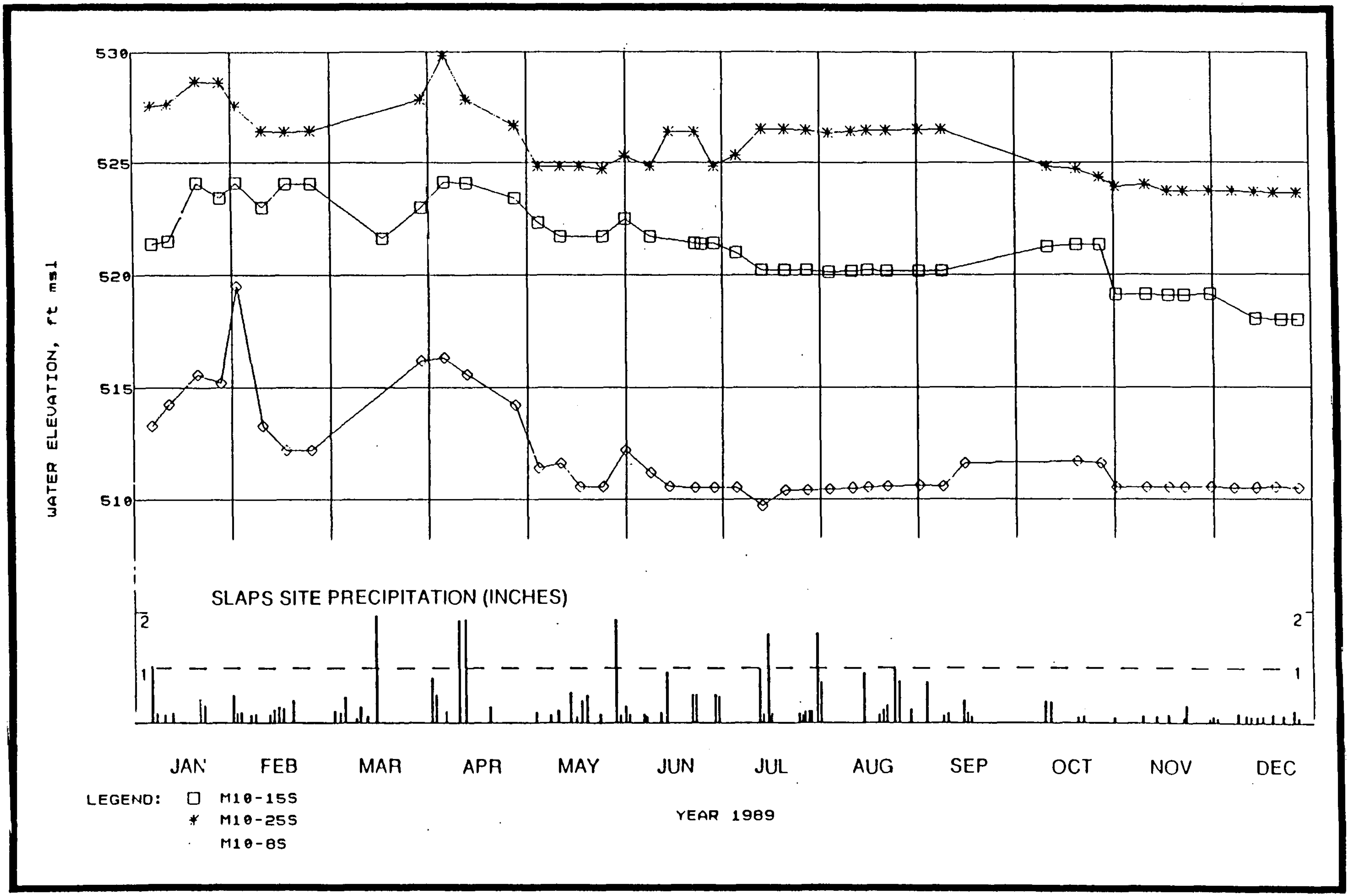

FIGURE 2-13 HYDROGRAPHS OF UPPER GROUNDWATER SYSTEM WELLS M10-15S, M10-25S, AND M10-8S

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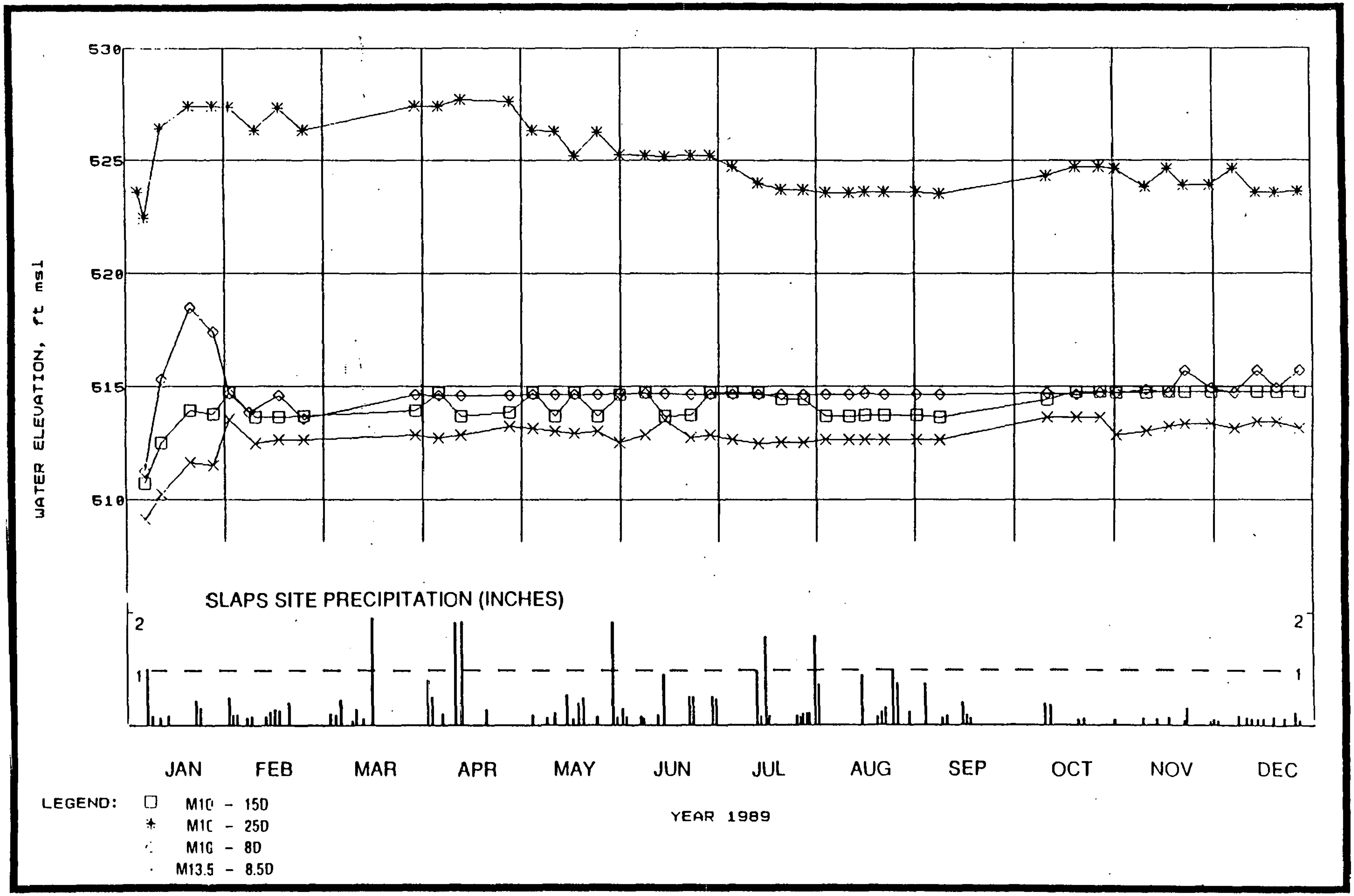

FIGURE 2-14 HYDROGRAPHS OF LOWER GROUNDWATER SYSTEM WELLS M10-15D, M10-25D, M10-8D, AND M13.5-8.5D

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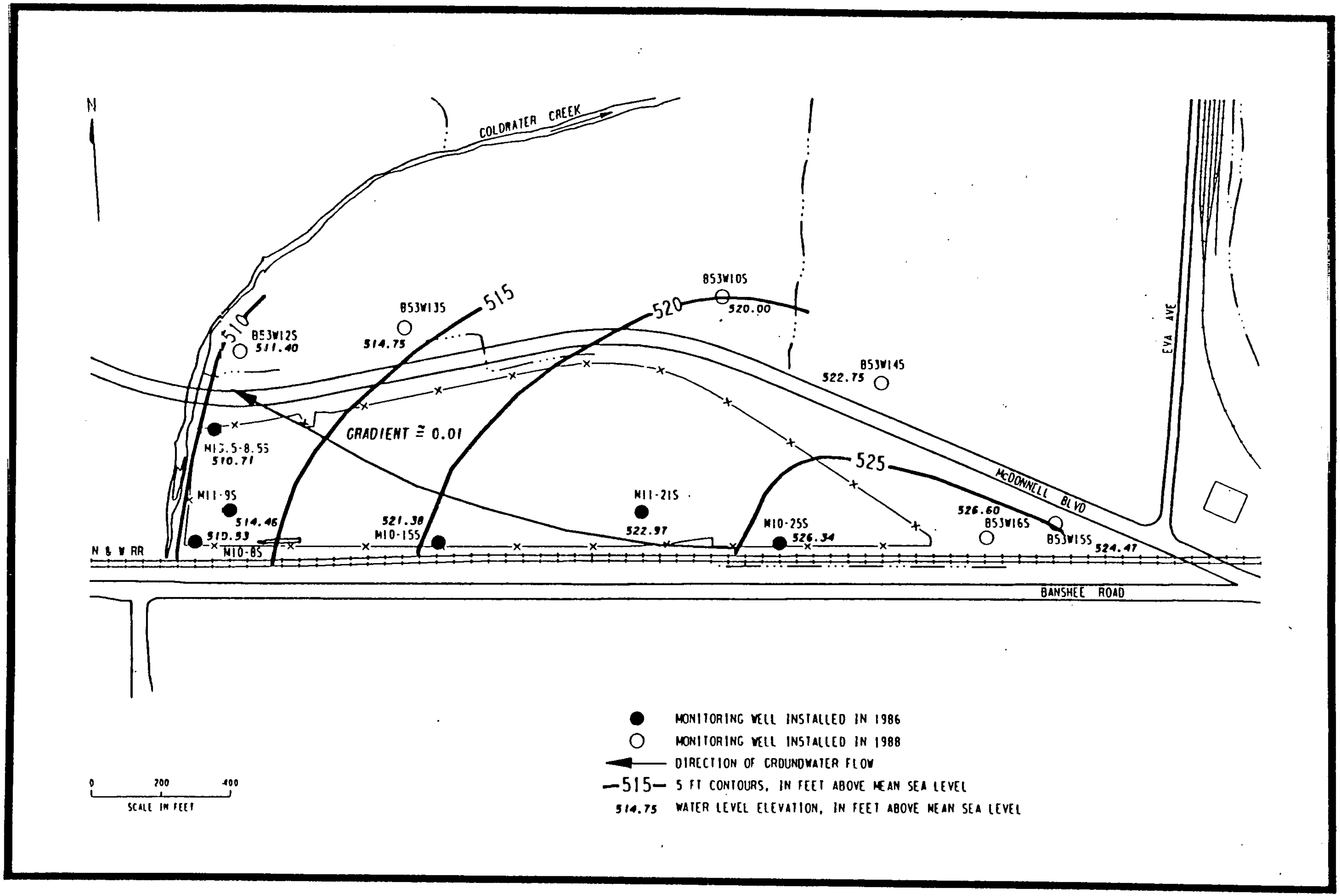

FIGURE 2-15 UPPER GROUNDWATER SYSTEM POTENTIOMETRIC SURFACE FOR SLAPS AND THE BALL FIELD AREA, JUNE 23, 1989

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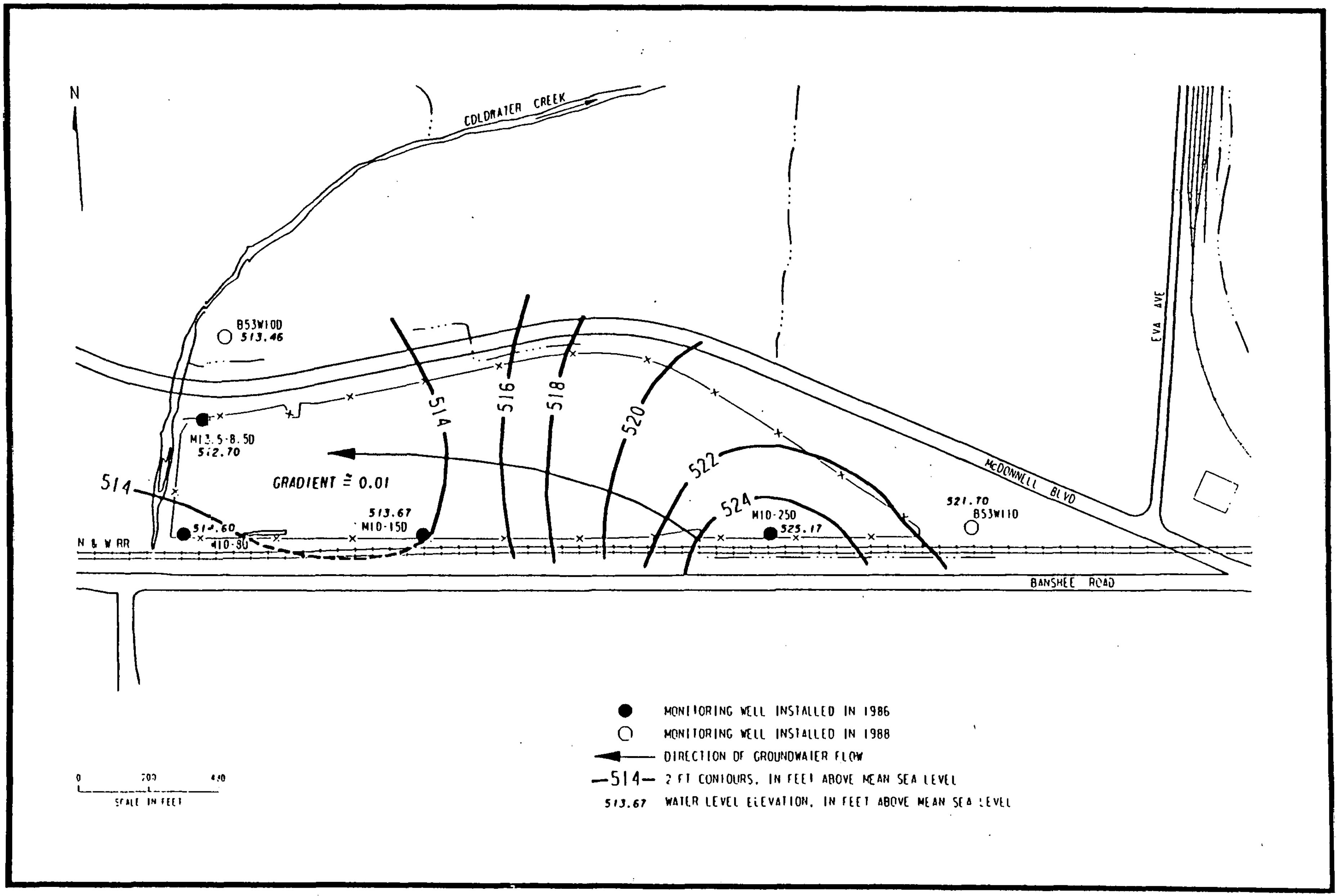

FIGURE 2-16 LOWER GROUNDWATER SYSTEM POTENTIOMETRIC SURFACE FOR SLAPS AND THE BALL FIELD AREA, JUNE 23, 1989

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system, where a downward flow potential exists. Discharge from the lower groundwater system probably occurs by off-site groundwater outflow and vertical seepage into the upper groundwater system where there is an upward flow potential.

Investigations conducted at the properties include measurement of hydrogeologic and hydrogeochemical parameters to determine the groundwater flow and solute transport characteristics of the site materials. These measurements are summarized in Table 2-5. Measurement methodologies and individual test results are presented in BNI 1989b, Weston 1982, and Appendix G. The calculated average linear groundwater velocities, shown on the table, for the upper groundwater system range from 2 to 10 times faster that those calculated for the lower groundwater system. The slower groundwater velocity in the lower system probably reflects the heterogeneity of the glacial deposits (unit 4), which vary from a clayey gravel to a silty clay. Calculation of vertical velocity through the aquitard (unit 3M) was not included on the table because of the number of variables associated with this unit (e.g. thickness, hydraulic gradient, flow direction, variations in depth of monitored intervals relative to the aquitard, and hydraulic conductivity variations). An estimate of the vertical velocity through the aquitard at well pair M10-15S and D can be made by using an aquitard thickness of 7.6 m (25 ft) and a head differential of 2.3 m (7.7 ft). The resulting average linear velocity (based on vertical hydraulic conductivities in Table 2-5) ranges from 0.003 to 0.2 m/yr (0.01 to 0.5 ft/yr). Thus, it would take a water molecule between 50 and 2,500 years to pass through the aquitard. The distribution ratios presented in Table 2-5 indicate that uranium migration is retarded relative to groundwater flow. The retardation factors for the upper groundwater system and aquitard can be estimated, assuming the distribution ratio approximates the distribution coefficient, from:

$$R = (1 + (p/n)\ K_d)$$

where:

R = retardation factor (dimensionless)

p = bulk density (g/cm^3)

n = porosity (dimensionless)

K_d = distribution coefficient ≈ distribution ratio (ml/g) (Gillham 1982)

The velocity of solute transport is related to the average linear groundwater velocity and the retardation factor by the expression:

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TABLE 2-5

SUMMARY OF GROUNDWATER FLOW AND SOLUTE TRANSPORT PARAMETERS FOR SLAPS AND THE BALL FIELD AREA

Aquifer Characteristics	Hydrogeologic and Geochemical Properties
Upper Groundwater System (Units 2 and 3T)	
Observed saturated thickness[a]	7.9 to 13.7 m (26 to 45 ft)
Mean hydraulic conductivity[b]	1.5×10^{-4} to 6.1×10^{-6} cm/s (0.42 to 0.02 ft/day)
Vertical hydraulic conductivity	2.0×10^{-4} to 1.4×10^{-8} cm/s (0.6 to 4×10^{-5} ft/day)
Hydraulic gradient	0.0071 to 0.015 [dimensionless]
Distribution ratio for uranium	19 to 329 ml/g
Effective cation exchange capacity	98 to 200 meq/100 g of soil
Bulk density	1.50 g/cm^3 (94 pcf)
Total porosity[c]	0.40
Average linear velocity[d]	0.04 to 1.75 m/yr (0.13 to 5.75 ft/yr)
Aquitard (Unit 3M)	
Observed thickness	0 to 7.9 m (0 to 26 ft)
Mean hydraulic conductivity[b]	3.1×10^{-5} cm/s (0.09 ft/day)[e]
Vertical hydraulic conductivity	7×10^{-7} to 1.4×10^{-8} cm/s (0.002 to 4×10^{-5} ft/day)
Head differential across aquitard[f]	-1.2 to 2.3 m (-4 to 7.7 ft)
Distribution ratio for uranium	8 ml/g[g]
Effective cation exchange capacity	187 to 214 meq/100 g of soil
Bulk density	1.31 g/cm^3 (82 pcf)
Total porosity[c]	0.46
Lower Groundwater System (Units 3B and 4)	
Observed saturated thickness[a]	2.4 to 9.1 m (8 to 30 ft)
Mean hydraulic conductivity[b]	2.0×10^{-4} to 1.2×10^{-6} cm/s (0.57 to 0.003 ft/day)
Vertical hydraulic conductivity	1.7×10^{-5} to 2×10^{-8} cm/s (0.05 to 5.7×10^{-5} ft/day)
Hydraulic gradient	0.0034 to 0.0064 (dimensionless)
Bulk density	1.47 g/cm^3 (92 pcf)
Total porosity[c]	0.44
Average linear velocity[d]	0.003 to 0.92 m/yr (0.01 to 3.03 ft/yr)

TABLE 2-5

(continued)

Acquifer Characteristics	Hydrogeologic and Geochemical Properties
Bedrock (Units 5 and 6)	
Pennsylvanian undifferentiated	
Observed thickness	0 to 10 m (0 to 33 ft)
Horizontal hydraulic conductivity	Not determined
Mississippian limestone	
Observed thickness	Not determined
Horizontal hydraulic conductivity	1.1×10^{-5} to 7.5×10^{-7} cm/s (0.03 to 0.002 ft/day)

[a]Thicknesses are exclusive of areas where aquitard is missing.

[b]$K_m = (K_h K_v)^{0.5}$, where K_m is the mean hydraulic conductivity, K_h is the horizontal hydraulic conductivity, and K_v is the vertical hydraulic conductivity.

[c]Total porosity determined from mean void ratios presented on Table 2-2 using the relation: porosity = void ratio/(1 + void ratio).

[d]Average linear velocity = $(K_m i)/n$, where K_m is the mean hydraulic conductivity, i is the hydraulic gradient, and n is the total porosity.

[e]Only one test was conducted for this parameter.

[f]Based on 6/28/89 water level measurements. Negative values indicate upward flow potential and positive values indicate downward flow potential.

[g]Two tests were conducted for this parameter.

$V_s = V_g / R$

where:

V_s = velocity of solute transport (length/time)

V_g = average linear groundwater velocity (length/time)

R = retardation factor (dimensionless)

The retardation factors for the upper groundwater system range from 72 to 1,234, and for the aquitard is 23. Thus, the uranium migration rates are between 72 and 1,234 times slower than the average linear groundwater velocity. The uranium migration rate through the aquitard is approximately 23 times slower than groundwater movement. Thus, for the previously described conditions at wells M10-15S and D, dissolved uranium would take between 1,150 and 57,500 years to migrate through the aquitard.

Latty Avenue Properties

The primary surface water feature in the HISS/Futura area is Coldwater Creek. The creek's hydrologic features are discussed in the SLAPS/ball field hydrology section. Surface water quality samples were collected from drainage ditches at HISS and Futura and from Coldwater Creek, 1.6 km (1 mi) downstream of the property to determine concentrations of radioactive constituents. Concentrations of lead-210, radium-226, and thorium-230 in the samples range from less than 1 to 7, less than 1 to 2, and less than 1 to 2 pCi/L, respectively [all values are below the maximum permissible concentrations specified in 10 Code of Federal Regulations (CFR) Part 20].

Hydrogeologic investigations at the property have focused on the uppermost groundwater system. Figure 2-17 presents typical hydrographs for groundwater levels in wells monitoring the uppermost groundwater system. The hydrographs indicate that groundwater levels typically do not vary by more than 1.5 m (5 ft) over the course of a year.

Figure 2-18 is a potentiometric surface map of HISS and Futura for March 22, 1989. The map shows that the groundwater flow direction is radial, i.e. flow is away from the property in all directions. The mechanism for the creation of this radial flow pattern is under investigation, but the center of the radial pattern appears to be associated with an area of poor surface drainage on the eastern edge of the HISS stockpile area.

Groundwater flow patterns suggest that recharge to the upper groundwater system is occurring in the east central area of the property. Discharge from the uppermost groundwater system occurs as off-site outflow of groundwater, with a portion of this groundwater probably discharging into

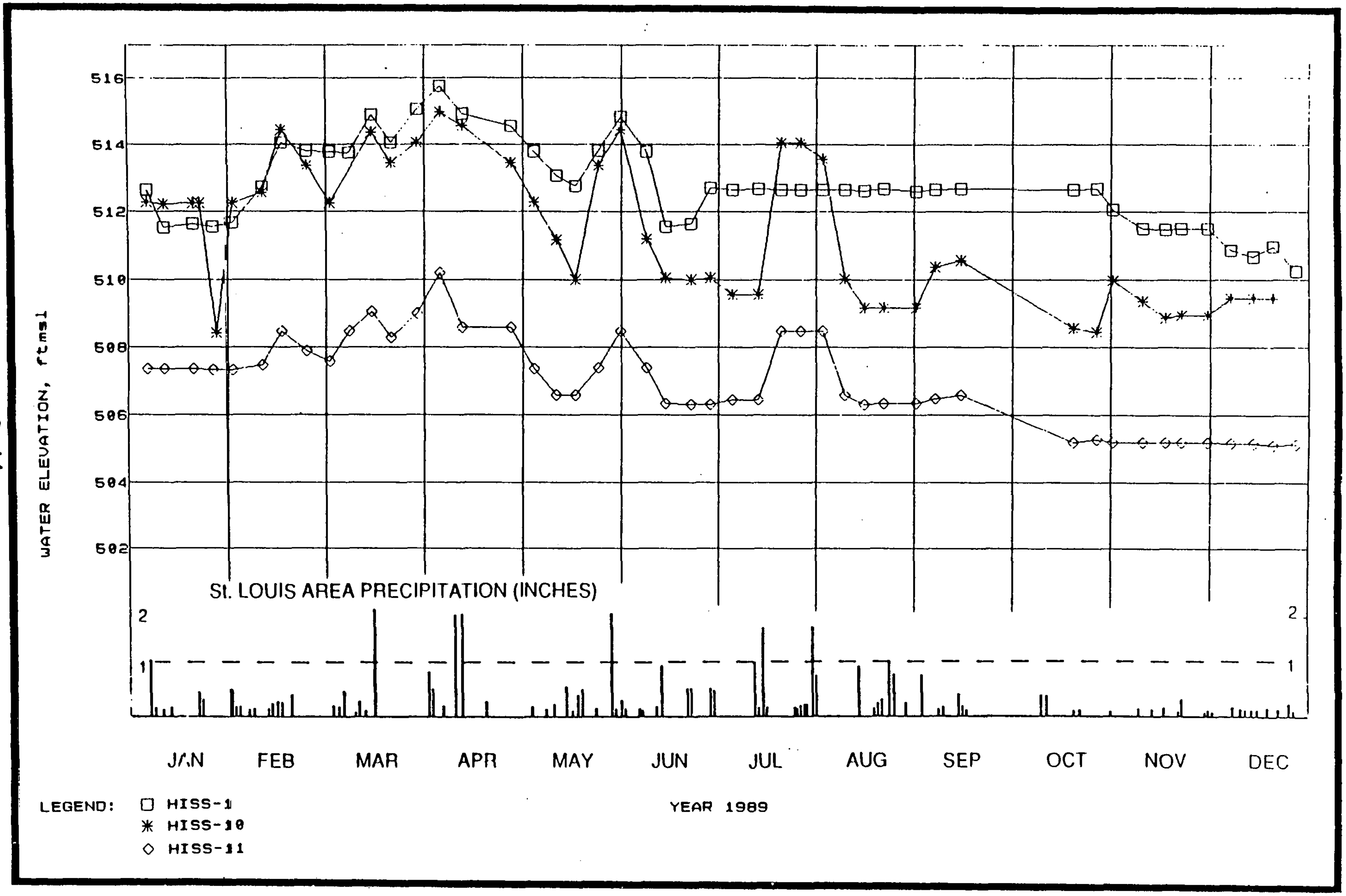

FIGURE 2-17 HYDROGRAPHS OF WELLS HISS-1, HISS-10, AND HISS 11

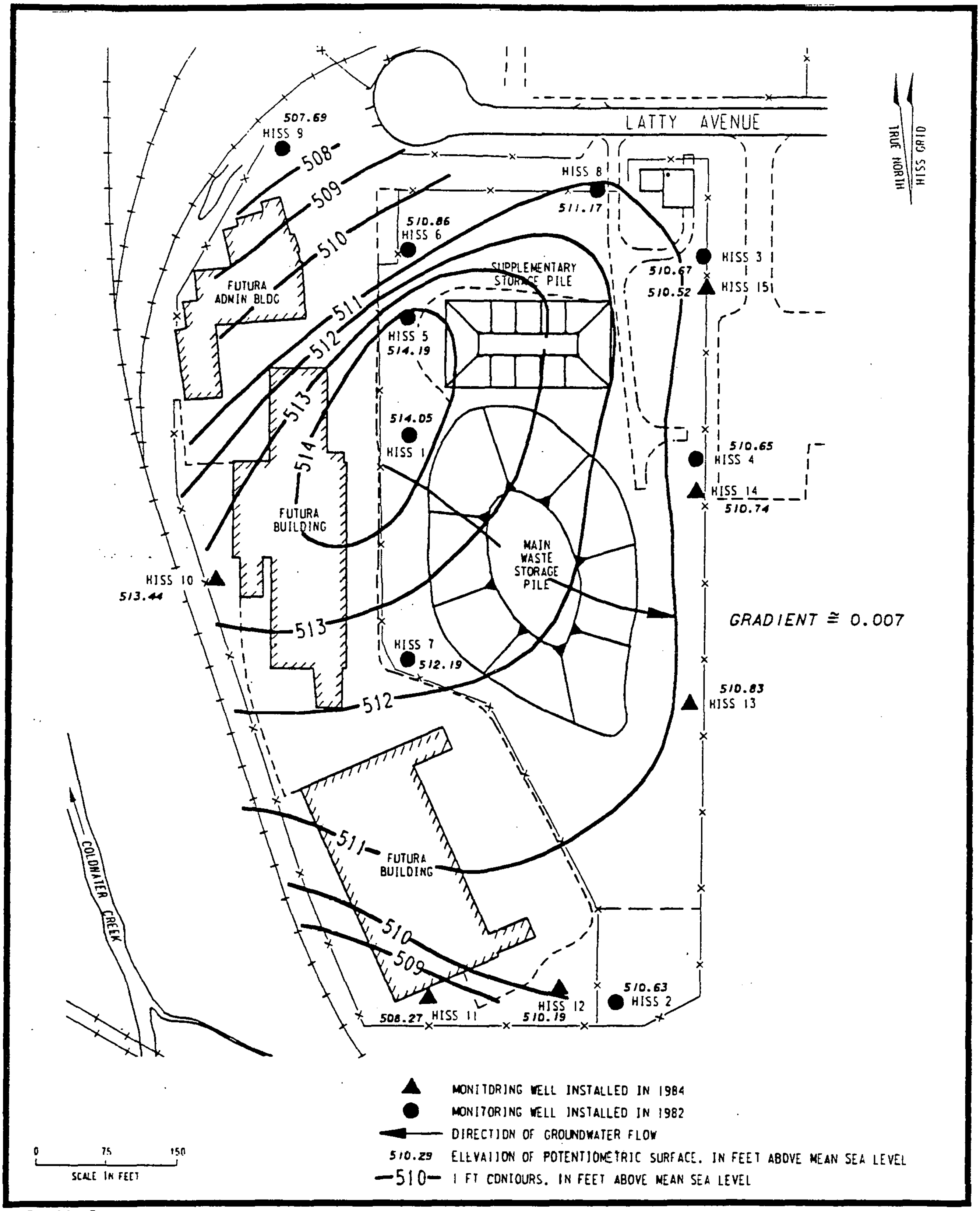

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FIGURE 2-18 POTENTIOMETRIC SURFACE FOR HISS/FUTURA, MARCH 23, 1989

Coldwater Creek during low creek stage. Discharge may also be occurring as vertical flow to a lower groundwater system, but insufficient information is available to characterize this potential flowpath.

Hydrogeologic parameters, measured to determine the groundwater flow characteristics of the uppermost groundwater system, are summarized in Table 2-6. Measurement methodologies and results are presented in BNI 1985c and 1990d. The average linear velocities fall within the same general range as those determined at the SLAPS/ball field properties for the upper groundwater system. Although no distribution ratio measurements have been taken on property soils, the proximity of HISS and Futura to the SLAPS/ball field properties and the similar appearance of the soils suggest that the distribution ratios are similar. Thus, uranium migration is significantly retarded relative to groundwater flow.

2.3.4 Ecological Resources

Typical trees and shrubs of floodplain forests in the area include silver maple, eastern cottonwood, willow, hackberry, elm, ash, and box elder (Bragg and Tatschl 1977). Box elder predominates in the lowland area near Coldwater Creek. Site vegetation consists of a mixture of prairie species, disturbance-related aggressive species, and remnants of landscape plantings, i.e., plants typical to old fields and less-maintained landscaped lawns. Typical species include various grasses, wild carrot, asters, clover, dandelion, goldenrod, dock, milkweed, ragweed, and thistle.

The vertebrate fauna of the area consists of species that have adapted to urban encroachment. Species of birds observed on the St. Louis site include grasshopper sparrow, house sparrow, rock dove, mourning dove, red-winged blackbird, grackle, starling, cardinal, goldfinch, warbler, mallard, common crow, and robin. Mammals are represented by opossum, prairie mole, white-footed mouse, house mouse, Norway rat, short-tailed shrew, striped skunk, squirrel, and cottontail rabbit. Burrowing mammals (e.g., woodchuck and eastern mole) have ranges and habitats that encompass the site.

Other than the Mississippi River near SLDS, Coldwater Creek is the major aquatic habitat in the immediate area. Aquatic flora and fauna of Coldwater Creek downstream of the airport are restricted to species tolerant of the polluted water and turbid, silty conditions. These conditions are probably the result of contamination (e.g., from gasoline and oil) and high sediment yield in the runoff waters from the surrounding industrial facilities. Fish in Coldwater Creek downstream of the airport include carp, green sunfish, black bullhead, and seven species of minnows and suckers. The invertebrate community is dominated by aquatic worms (Tubificidae) and midge larvae (Chironomidae).

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TABLE 2-6

SUMMARY OF GROUNDWATER FLOW PARAMETERS FOR HISS AND FUTURA

Aquifer Characteristics	Hydrogeologic and Geochemical Properties
Observed saturated thickness	3 to 6.7 m (10 to 22 ft)
Hydraulic conductivity	1.1×10^{-5} to 1.0×10^{-3} cm/s (0.03 to 2.9 ft/day)
Hydraulic gradient	0.007 to 0.013
Average linear groundwater velocity[a]	0.06 to 10 m/yr (0.02 to 34 ft/yr)

[a]Average linear groundwater velocity = Ki/n, where: n = porosity, which is assumed to be 0.4 (value for unit 2 at the SLAPS/ball field properties).

According to the U.S. Department of Interior, Fish and Wildlife Service, Columbia Field Office, the only federally threatened or endangered species that may occur in the vicinity of the site is the bald eagle. Although the bald eagle has been observed in St. Louis County, most observations have been of migrating and wintering individuals along the Missouri River. Furthermore, there is no critical habitat for the bald eagle near the site (Dept. of Interior 1989).

2.3.5 Historical Resources

Within one mile of SLDS are two landmarks listed on the National Register of Historic Places. Also, almost the entire area west and northwest of the property and west of I-70 is included in the official historic district of Hyde Park. In addition, there is one location in Hazelwood listed on the National Register of Historic Places (East-West Council 1980). Although DOE does not expect any adverse effect on any of these landmarks, the state Historical Preservation Office will be contacted for confirmation; DOE expects the office to issue a determination of no effect.

2.3.6 Land Use

The greater St. Louis metropolitan area is a diverse hub of transportation, commerce, and industry. Land use within a 1.6-km (1-mi) radius of SLDS represents a mixture of public, agricultural, industrial, commercial, and residential activities. The Mark Twain Freeway (I-70) is located along the western border of SLDS.

SLAPS is zoned for industrial use. The south-central and eastern portions of the property are in the approach zones of runways 17 and 24, respectively, at the adjacent Lambert-St. Louis International Airport. Consequently, the height of any developments on these portions of SLAPS will be limited to maximums imposed by the Federal Aviation Administration (St. Louis Airport 1980; R. W. Booker & Associates 1981; City of Hazelwood undated). At present, SLAPS is used only for temporary storage of drums containing drill spoils and other radioactive waste resulting from DOE characterization activities. The nearest population center is more that 2.4 km (1.5 mi) north of the property. More than two-thirds of the land within 0.8 km (0.5 mi) of the property is used for transportation-related purposes, primarily Lambert-St. Louis International Airport. Land immediately adjacent to the property is used for transportation, commercial, industrial, and recreational purposes, or is vacant.

The roads around SLAPS are heavily traveled during the work week and provide major access to employment centers in the area. The transient population within approximately 1.6 km (1 mi) of the property includes 37,000 full-time workers. Average daily traffic in 1982 was 43,000 vehicles on Lindbergh Boulevard and about 21,000 vehicles on McDonnell Boulevard in the area of Lindbergh Boulevard. The vehicle count was about 16,000 per day on McDonnell Boulevard near SLAPS, about 18,000 per day on McDonnell Boulevard north of Airport Road, and about 32,000 per day south of Airport Road. About 10,000 vehicles per day use Banshee Road between Lindbergh and McDonnell Boulevards (Missouri Department of Highways 1982).

The Latty Avenue Properties are zoned for industrial use, and the surrounding area is primarily industrial and commercial. Because of the industrial development in the area, Latty Avenue is used primarily by large trucks carrying supplies and equipment and by employees driving personal vehicles to and from industries adjacent to Latty Avenue (Argonne 1984).

Three spurs of the Norfolk and Western Railroad parallel the western boundary of HISS. The main spur is owned by Norfolk and Western; Wagner Electric Corporation, a landowner on the northern side of Latty Avenue, owns the others. The easternmost spur is unused, but the other two are used for deliveries in the industrial area around HISS (Argonne 1984; Crotwell 1983). The HISS property currently houses two temporary waste storage piles, a 12- by 56-ft trailer used as office space for the property caretaker, and a 24- by 56-ft trailer used as a public information office.

The residential areas nearest HISS are about 0.5 km (0.3 mi) to the east in the City of Berkeley. Located about 1.2 to 1.6 km (0.75 to 1.0 mi) east and southeast of the property in Hazelwood and Berkeley are several high-density residential areas that include single-family houses and apartment buildings (R. W. Booker & Associates 1981; City of Hazelwood undated; Peat et al. 1980).

2.3.7 Surface Features

Following closeout of the St. Louis MED/AEC operations at SLDS, buildings owned by the government were demolished or ownership was transferred to Mallinckrodt as part of the contract settlement. Several plants within the Mallinckrodt facility containing about 60 buildings were involved in the operations; fewer than 20 remain. Several new buildings constructed at the facility have been used for commercial chemical production since 1962. The surface of SLDS has been drastically altered by man. The original area slope to the Mississippi River is evident, but all other irregularities that may have existed have been modified.

The surface of SLAPS varies from 4.5 to 6.0 m (15 to 20 ft) above Coldwater Creek and slopes from east to west. The property surface is generally flat; however, because the fill placed over the property in the early 1970s was not spread evenly, compacted, or revegetated, differential settling and erosion have occurred, resulting in an irregular surface.

The ground surface at Futura Coatings and HISS ranges from about 157 m (513 ft) above mean sea level (MSL) near Latty Avenue to about 161 m (525 ft) above MSL near the pile. The largest of the two existing contaminated piles is approximately 8 m (26 ft) high (Surdex 1984). The surface slopes gently from the waste pile at HISS to the west and south toward Coldwater Creek.

2.3.8 Surface Water

The natural drainage of SLDS has been eliminated by urban development, and storm runoff is now controlled by a system of sewers equipped with weirs to direct excess flow to the river. Levees completed in the 1960s have prevented frequent flooding of the property by the Mississippi River. Protection against flooding is provided up to a river stage of 16 m (52 ft) with 0.6 m (2 ft) of freeboard. The 500-year flood stage is estimated to be 14 m (47 ft) or 134 m (440 ft) above MSL.

The only surface water near SLAPS and the vicinity properties is Coldwater Creek, which borders the western side of SLAPS. Coldwater Creek originates about 5.8 km (3.6 mi) south of the property, flows for a distance of 153 m (500 ft) along the western side of SLAPS, and discharges into the Missouri River about 24 km (15 mi) northeast of the property. The average flow measured near the airport in September 1978 was about 0.09 m^3/s (3 ft^3/s) (DOE 1980).

The Latty Avenue Properties are within the Coldwater Creek drainage basin, about 0.8 km (0.5 mi) downstream of SLAPS. The creek originates approximately 7.4 km (4.6 mi) south of the properties. HISS is about 61 m (200 ft) east of the creek. Based on drainage areas, the 7-day, 10-year low flow of Coldwater Creek at HISS is estimated to be about 0.04 m^3/s (1.5 ft^3/s). Stormwater runoff flows off site to the north into a stormwater drain along Latty Avenue that drains into Coldwater Creek (Argonne 1984).

The 100-year flood level at HISS is about 159 m (520 ft) above MSL. Therefore, in the event of a flood of 100-year or greater magnitude, the majority of the property, including the base of the contaminated waste piles, would be inundated. The two existing piles, and any future construction on the property, is protected to a level 0.7 m (2 ft) above the 100-year flood level (Argonne 1984; FEMA 1977).

2.4 NATURE AND EXTENT OF CONTAMINATION

This section discusses the origins and nature of radioactive, nonradioactive, and chemical contamination at the St. Louis site. The discussion is based on information compiled from reports of previous surveys and historical information about operations conducted at SLDS and various material transfers to the other FUSRAP locations in St. Louis.

Extensive sampling and analysis has been carried out to characterize the nature and extent of contamination at the St. Louis site. To the extent practicable, the work was based on site history and previous radiological surveys. The major objectives of the sampling were to (1) determine the vertical and horizontal bounds of radioactive contamination and any chemical contamination associated with it, (2) identify and quantify the contaminants present, and (3) assess the potential health hazards from the contamination to workers performing remedial action.

2.4.1 Origins of Contamination

Contamination being addressed by FUSRAP at the St. Louis site originated from uranium and thorium processing operations carried out at the former Mallinckrodt Chemical Works, now known as SLDS, between 1942 and 1957 (see Subsection 2.2). Processes conducted at that time included (1) manufacturing of uranium dioxide (UO_2) and uranium trioxide (UO_3) in production quantities from pitchblende; (2) production of uranium tetrafluoride [green salt (UF_4)]; (3) production of uranium derby metal (subsequently vacuum-recast to form purified ingot metal); (4) machining of uranium metal rods for reactor fuel slugs; (5) conversion of UF_4 to UO_2 or uranium oxide (U_3O_8) (black oxide); (6) recovery of scrap uranium metal; (7) production of uranyl fluoride (UO_2F_2); (8) extraction and concentration of thorium-230 from pitchblende raffinate; and (9) experimental processing of very-low-enrichment UF_4. During the period of operation under MED/AEC, the company processed more than 45,000 metric tonnes (50,000 tons) of natural uranium products at the facility in St. Louis. Figure 2-19 is a flowchart of uranium processing operations conducted at SLDS.

Pitchblende used as one of the feedstocks at SLDS contained approximately 0.3 Ci of radium per ton of uranium. This feedstock was separated into radium-226 and its daughters, along with sulfate and other unwanted impurities. This residue fraction, called K-65, was not processed or concentrated further but was transported to DOE facilities in Ohio and New York, where it is currently in storage. Process materials sent to SLAPS included pitchblende raffinate residues,

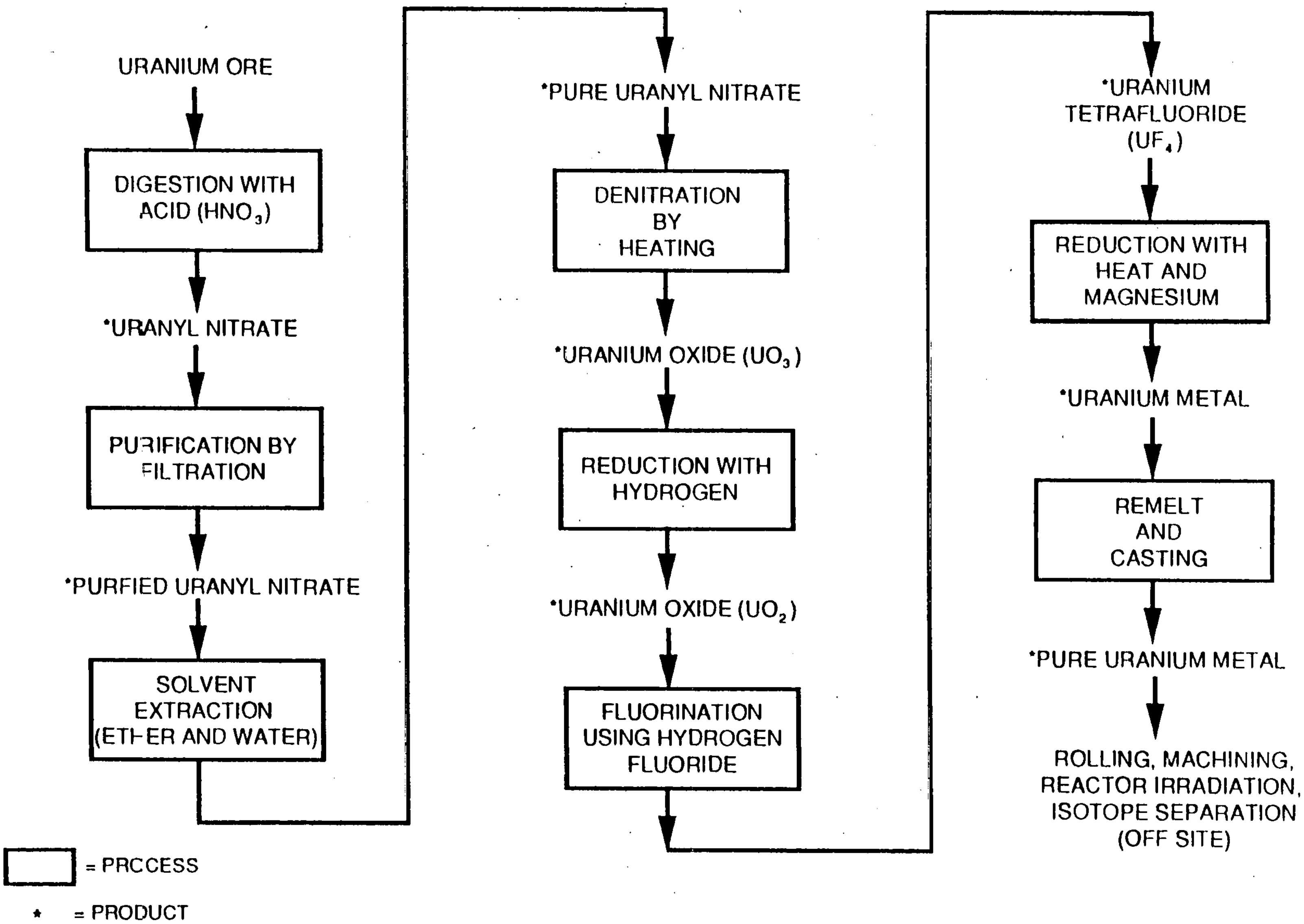

FIGURE 2-19 URANIUM PROCESSING AT SLDS

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radium-bearing residues, barium sulfate cake, Colorado raffinate residues, and contaminated scrap. (Raffinate is the residue remaining after extraction of a liquid with a solvent.) Most of the residues were stored in bulk on open ground. In the mid 1960s, most of the residues were sold and removed from SLAPS. The structures were demolished, buried on site, and covered with 0.3 to 1 m (0 to 3 ft) of clean fill material. It is believed that the rubble was buried primarily in the western portion of the property. Figure 2-5 shows former areas of land use and waste storage at SLAPS. Subsequently, residues were transferred from SLAPS to the Latty Avenue Properties in 1966 (Subsection 2.2.3).

Since MED/AEC activities ceased at SLDS in 1957, portions of the current facility, Plant 6, have been used to store columbium-tantalum ore, which contains uranium and thorium and is an NRC-licensed material. Mallinckrodt, Inc., prepares tantalum and columbium products for use in several industries and currently maintains an NRC license to recover the tantalum and columbium from ores and slags through chemical operations. The chemical processing is performed in Plant 5 buildings. Potassium compounds, including naturally occurring potassium-40, are stored in warehouses at Plants 6, 7N, and 7W. Even though columbium-tantalum ore and potassium-40 have been handled at SLDS, both are low-level radioactive materials and neither was associated with MED/AEC activities; they are not, therefore, subject to FUSRAP activities.

Uranium-238, radium-226, thorium-230, and thorium-232 were selected as indicator parameters for the radiological portion of the RI. These four radionuclides were selected based on the half-lives of the radionuclides in the associated decay chains, historical information on the radionuclides in the ore, and a source term analysis that was conducted for each property. For the source term analysis, selected samples were analyzed for uranium-238, uranium-235, uranium-234, thorium-227, thorium-232, thorium-230, actinium-227, radium-228, radium-226, radium-224, lead-210, and polonium-210. The results of the source term analyses are presented in Appendix C.

Background and Current Cleanup Guidelines

Radionuclides associated with uranium processing also occur naturally in soil at low levels. To determine the naturally occurring levels of these radionuclides in soil in the St. Louis area, background data were collected before the start of the characterization activities (Table 2-7). (Background concentrations of radionuclides found in groundwater and surface water and of radon in air at distances of 8 to 32 km (5 to 20 mi) from SLAPS and 8 to 24 km (5 to 15 mi) from HISS are included in Subsection 2.4.2.) Figure 2-20 shows the locations from which background samples

TABLE 2-7

BACKGROUND RADIATION LEVELS AND RADIONUCLIDE CONCENTRATIONS IN SOIL IN THE ST. LOUIS AREA

Measurement Location[a]	Gamma Exposure Rate at 3 ft (μR/h)[b]	Near-Surface Gamma Radiation (cpm)	Radionuclide Concentration (pCi/g ± 2 sigma)					
			Uranium-234	Uranium-235	Uranium-238	Radium-226	Thorium-232	Thorium-230
1	10	10,000	1.2 ± 0.3	< 0.1	1.2 ± 0.3	0.9 ± 0.4	1.0 ± 0.6	1.2 ± 0.3
2	10	9,000	1.0 ± 0.2	< 0.1	1.0 ± 0.2	0.9 ± 0.4	1.0 ± 0.5	1.3 ± 0.3
3	10	10,000	1.2 ± 0.2	0.1 ± 0.1	1.0 ± 0.2	0.9 ± 0.4	1.1 ± 0.3	1.5 ± 0.5
Average	10	10,000	1.1 ± 0.2	0.1 ± 0.1	1.1 ± 0.2	0.9 ± 0.4	1.0 ± 0.5	1.3 ± 0.4

[a]Locations 1 and 2 are approximately 2.8 km (1.8 mi) northwest and southeast, respectively, of the airport. Location 3 is approximately 17.2 km (10.7 mi) southeast of the airport.

[b]These are gross measurements; no window was used.

Source: BNI 1987a.

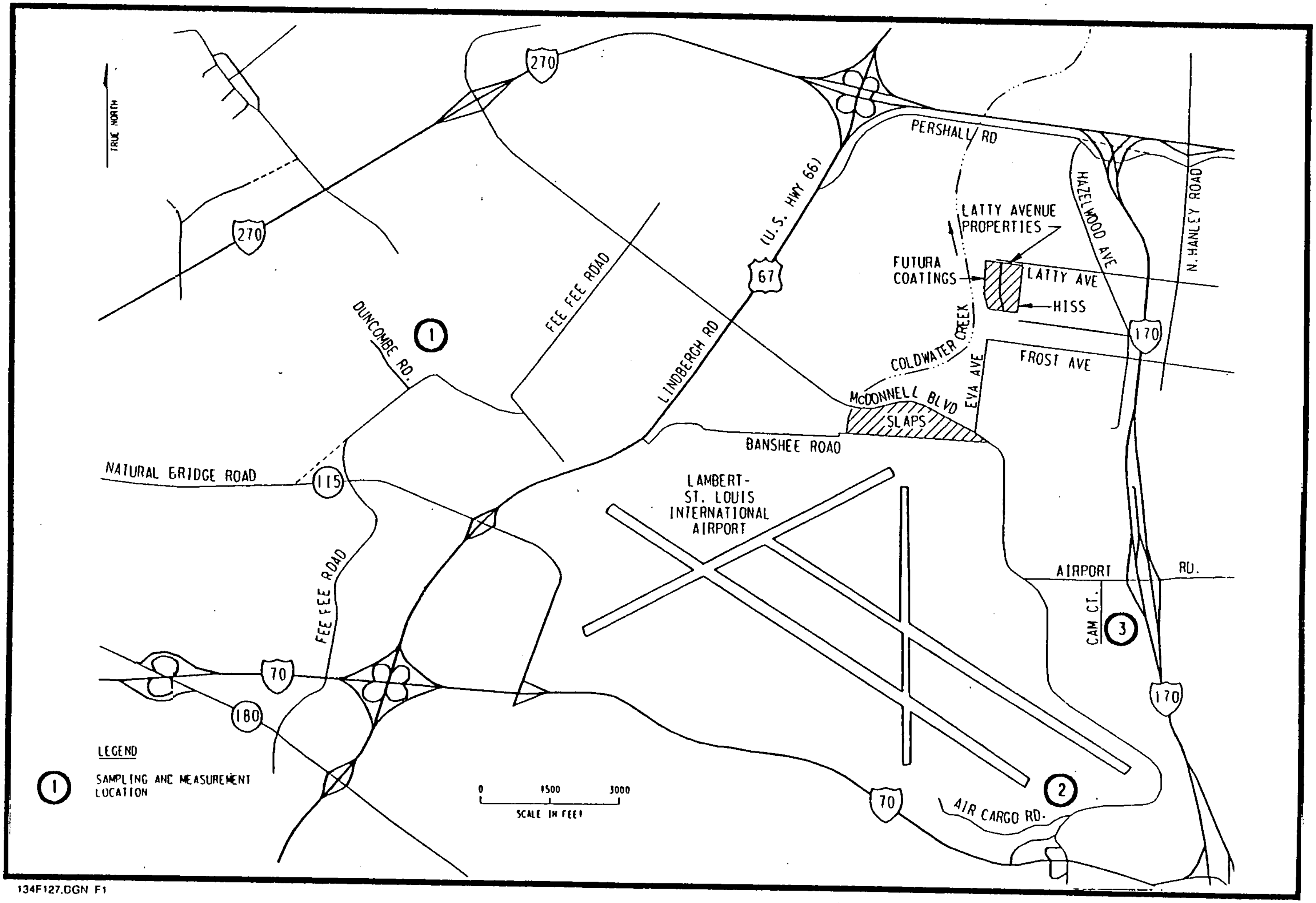

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FIGURE 2-20 BACKGROUND SAMPLING AND MEASUREMENT LOCATIONS IN THE ST. LOUIS AREA

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and measurements were taken. Location 1 is open, grassy land with no trees and with no structures within about 0.2 km (0.1 mi). It is owned by the City of St. Louis and is expected to become part of the airport during planned expansion. Location 2 is also open, grassy land with no trees; there are no structures within 0.5 km (0.3 mi). Location 3 is an open grassy area with trees; it is near a school surrounded by a park and near a gasoline station.

Current DOE guidelines governing remedial action for radiological constituents in soil and on building surfaces at the St. Louis site are presented in Table 2-8. Appendix A provides DOE Order 5400.5, residual radioactive material guidelines. Guidelines for uranium in soil are calculated by DOE on a site-specific basis; for the St. Louis site, 50 pCi/g of residual uranium-238 in soil is assumed, based on the residual radioactive material code (RESRAD) computer model. This assumption is very conservative, and the final cleanup criteria will be part of the ARAR determination for the site. DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are ALARA.

Analytical results for metals from SLAPS, SLDS, and the Latty Avenue Properties were compared with concentration ranges for metals in soil at various locations in the United States and other parts of the world. Mobile ion concentrations at SLAPS and the Latty Avenue Properties were compared with background concentrations. Table 2-9 shows the ranges of metal concentrations found in typical natural soils.

2.4.2 Radiological Conditions

Radiological conditions at SLDS and vicinity properties, SLAPS and vicinity properties, and the Latty Avenue Properties are discussed in the following subsections.

St. Louis Downtown Site

In 1977, ORNL conducted a radiological survey of portions of SLDS at the request of DOE. Results from this survey of the buildings show alpha and beta-gamma surface radioactivity levels and radionuclide concentrations in soil exceeding DOE limits for release of the property for use without

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TABLE 2-8
SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonable achievable principles to set site-specific guidelines.

SOIL GUIDELINES

Radionuclide	Soil Concentration (pCi/g) Above Background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Other Radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES

Airborne Radon Decay Products

Generic guidelines for concentrations of airbome radon decay products shall apply to existing occupied or habitable structures on private property that has no radiological restrictions on its use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL[d]. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restrictions on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

Indoor/Outdoor Structure Surface Contamination

	Allowable Surface Residual Contamination[e] (dpm/100 cm^2)		
Radionuclide[f]	Average[g,h]	Maximum[h,i]	Removable[h,j]
Transuranics, Ra-226, Ra-228, Th-230, Th-228 Pa-231, Ac-227, I-125, I-129[k]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224 U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[l]	5,000 β - γ	15,000 β - γ	1,000 β - γ

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TABLE 2-8
(CONTINUED)

[a]These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If either thorium-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[b]These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100-m^2 surface area.

[c]If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/890/. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

[d]A working level (WL) is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

[e]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[f]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[g]Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[h]The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

[i]The maximum contamination level applies to an area of not more than 100 cm^2.

[j]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping tehniques to measure removable contamination levels if direct scan surveys indicate that total residual surface cotamination levels are within the limits for removable contamination.

[k]Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[l] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

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TABLE 2-9

COMPOSITION OF SOILS[a]

Page 1 of 2

Element	Mean (Range) in Dry Soil (mg/kg)
Aluminum	71,000 (10,000 - 300,000)
Antimony	(2 - 10)[b]
Arsenic	6 (0.1 - 40)
Barium	500 (100 - 3,000)
Beryllium	6 (0.1 - 40)
Boron	10 (2.0 - 100)
Bromine	5 (1 - 10)
Cadmium	0.06 (0.01 - 0.7)
Calcium	137,000 (7,000 - 500,000)
Carbon	200,000
Cerium	50
Cesium	6 (0.3 - 25)
Chlorine	100
Chromium	100 (5 - 3,000)
Cobalt	8 (1 - 40)
Copper	20 (2 - 100)
Fluorine	200 (30 - 300)
Gallium	30 (0.4 - 300)
Germanium	1 (1 - 50)
Hafnium	6
Iodine	5
Iron	38,000 (7,000 - 550,000)
Lanthanum	30 (1 - 5,000)
Lead	10 (2 - 200)
Lithium	30 (7 - 200)
Magnesium	5,000 (600 - 6,000)
Manganese	850 (100 - 4,000)
Mercury	0.03 (0.01 - 0.3)
Molybdenum	2 (0.2 - 5)
Nickel	40 (10 - 1,000)
Nitrogen	1,000 (200 - 2,500)
Oxygen	490,000
Phosphorus	650
Potassium	14,000 (400 - 30,000)
Radium	8×10^{-7} ($3 - 20 \times 10^{-7}$)
Rubidium	100 (20 - 600)
Scandium	7 (10 - 25)
Selenium	0.2 (0.01 - 2)
Silicon	330,000 (250,000 - 350,000)
Silver	0.1 (0.01 - 5)

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TABLE 2-9
(continued)

Element	Mean (Range) in Dry Soil (mg/kg)
Sodium	6,300 (750 - 7,500)
Strontium	300 (50 - 1,000)
Sulfur	700 (30 - 900)
Thallium	0.1
Thorium	5 (0.1 - 12)
Tin	10 (2 - 200)
Titanium	5,000 (1,000 - 10,000)
Uranium	1 (0.9 - 9)
Vanadium	100 (20 - 500)
Yttrium	50 (25 - 250)
Zinc	50 (10 - 300)
Zirconium	300 (60 - 2,000)

[a]The figures refer to oven-dried soils. Soils near mineral deposits have been omitted in computing ranges. Insufficient data are available for Ag, Be, Cd, Ce, Cs, Ge, Hf, Hg, La, Sb, Sn, Tl, and U, and the values quoted for these elements may require revision.

[b]The range shown is an estimate.

Source: Bowen, H. J. M., 1966. Trace Elements in Biochemistry, Academic Press, London.

radiological restrictions. For alpha surface contamination, the strictest limits applied to a group of radionuclides including radium-226 and thorium-230. The average and maximum limits for direct measurements are 100 and 300 dpm/100 cm^2, respectively; the removable alpha contamination guideline is 20 dpm/100 cm^2. These guidelines applied in areas where uranium ore was handled. In areas where uranium that contained no radium-226 was handled, less stringent guidelines of 5,000 and 15,000 dpm/100 cm^2 for average and maximum direct alpha measurements were applied. The removable alpha contamination guideline for those areas is 1,000 dpm/100 cm^2. Elevated external gamma radiation levels were measured at some outdoor locations and in some buildings. Radon and radon daughter concentrations in three buildings exceed guidelines for nonoccupational radiation exposure (ORNL 1981). Radon measurements in Building K1E average 6.4 pCi/L and are as high as 22 pCi/L. The highest radon concentrations in Buildings 52A and 101 are as high as 37 pCi/L and 69 pCi/L, respectively. The maximum radon daughter concentration of 0.07 WL was measured in Building 52A. Concentrations of uranium-238 up to 20,000 pCi/g and of radium-226 up to 2,700 pCi/g were found in subsurface soil during the exterior phase of this survey.

A 1988 radiological characterization conducted by BNI included performing walkover gamma radiation scans, measuring external gamma radiation levels, and collecting and analyzing surface and subsurface soil and groundwater samples. Results of the survey show that uranium-238, radium-226, thorium-232, and thorium-230 concentrations range from 1.3 to 95,000, 0.4 to 5,400, 0.4 to 700, and 0.3 to 98,000 pCi/g, respectively. The characterization results indicate surface contamination over many of the portions of SLDS surveyed. Soil sample analysis shows uranium-238, radium-226, thorium-232, and thorium-230 to be contaminants of concern (BNI 1990a).

Building surveys. Preliminary building surveys were conducted at SLDS in 1988 in 20 buildings (25, K1E, 50, 51, 51A, 52, 52A, 100, 101, 116, 116B, 117, 700, 704, 705, 706, 707, 708, 81, and 82) to determine whether radioactivity exceeding DOE guidelines was present. These buildings were included in the field investigation because of their use during and/or their proximity to MED/AEC operations. In addition, the roofs of 17 buildings (X, 501, R, P, Q, C, B, L, Z, 53, 56, F, G, 10, T, V, and W) were surveyed to determine whether emissions from buildings used for MED/AEC operations had contaminated adjacent building roofs. Because SLDS is an operating facility and interruptions of ongoing operations are necessary to perform comprehensive building surveys, only a limited characterization was conducted. In addition, the ongoing plant activities may render characterization findings invalid. Therefore, more detailed building surveys will be conducted immediately prior to remedial action. Surveys of the interiors of the plants, including the establishment of radon monitors on the ground floor or basement level of selected buildings, and building roofs were also conducted. The average density of sampling in the SLDS building survey was one reading at every grid intersection at 1-m (3-ft) intervals for floors and one reading at every grid intersection at 5-m (15-ft) intervals for ceilings, walls, and roofs. Some buildings exhibit beta-gamma measurements exceeding DOE guidelines, but little removable contamination was found and average gamma exposure rates do not exceed DOE guidelines. Roof contamination was found on four buildings. Additional roof surveys revealed that some of the adjacent buildings have residual radioactive contamination. In all cases, the roof surfaces exhibit direct alpha measurements that are below guidelines (BNI 1990a). Radiological information for specific buildings are summarized below. Background concentrations were not subtracted from data collected in the BNI surveys.

A natural uranium criterion of 5,000 dpm/100 cm^2 was used as the surface contamination guideline based on analytical results for building deposit samples. Because uranium-238 is the primary contaminant at SLDS, this is the guideline that will be used for initial determination of whether DOE guidelines for radionuclide contamination have been exceeded. In areas where radium-226 or thorium is the major contaminant, the DOE radionuclide guideline applicable to that situation will be applied for final remedial action. The purpose of this survey was to determine whether radioactivity exceeding DOE guidelines existed, not to determine the absolute boundaries of contamination. Cleanup will be conducted to yield ALARA levels.

Summary results of the 1977 ORNL and 1988 BNI surveys are included in the following text. In most cases, the results were consistent. Buildings are shown in Figure 2-1.

- Building 25 Most of the beta-gamma contamination was found on walls and floors, and most was found to be nonremovable. The average external gamma exposure rate is below DOE guidelines for habitable structures. Data from the 1988 survey of Building 25 are presented in Table 2-10 (BNI 1990a). The 1977 ORNL survey found that most measurements of alpha and beta-gamma contamination on surfaces are at background levels; some exceeding background were found on laboratory benches (ORNL 1981). Beta-gamma dose rates range from 0.5 to 20 mrad/h. All removable alpha or beta contamination is at or near background levels. An external gamma radiation exposure rate of 18 μR/h was measured on the second story. Radon grab samples yield an average radon-222 concentration of 0.6 pCi/L and a maximum concentration of 1.3 pCi/L (ORNL 1981).

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TABLE 2-10

BUILDING 25 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	0	160	19
Beta-gamma	0	164	89
Nonremovable Contamination (dpm/100 cm^2)			
<u>Alpha</u>			
Floors	6	13,238	590
Walls	2	1,904	40
Ceilings	7	72	31
Roofs	5	582	120
<u>Beta-gamma</u>			
Floors	43	620,619	17,000
Walls	29	151,718	1,900
Ceilings	127	1,349	600
Roofs	28	2,096	800
Exposure Rate (μR/h)	6	72	7
Radon (pCi/L)	<0.04	0.3	0.1

<u>Source</u>: BNI 1990a.

- Building K1E Beta-gamma contamination was found to be widespread and in excess of DOE guidelines for natural uranium on some of the walls and roofs. No removable contamination was found. Survey results for Building K1E are shown in Table 2-11 (BNI 1990a). The 1977 ORNL survey showed that beta-gamma residual surface radioactivity exceeds DOE guidelines for radium in several places. The average alpha contamination for the entire area is 500 dpm/100 cm^2. Measurements of direct and removable alpha and beta-gamma show no contamination. Radon measurements yield average concentrations ranging from 0.5 to 15.2 pCi/L and maximum concentrations ranging from 0.9 to 22 pCi/L (ORNL 1981).

- 50 Series Buildings This series consists of Buildings 50, 51, 51A, 52, and 52A. For all buildings (with the exception of 52A, in which the floors were inaccessible), most residual surface contamination was found on floors and walls. No removable contamination was detected. Survey results for these buildings are shown in Tables 2-12 through 2-16 (BNI 1990a). The 1977 ORNL survey showed Building 50 to have spots of elevated beta-gamma dose rates and/or alpha contamination exceeding uranium guidelines. No significant removable contamination was found on floors or walls. The Building 51 survey showed beta-gamma contamination on walls. External gamma radiation levels exceed background in several places. The Building 51A survey revealed low-level contamination to be widespread. Survey results for Building 52A showed little contamination on floors, but beta-gamma dose rates exceeding 1.0 mrad/h were found on the lower walls. The common roof area between Buildings 51A and 52A has background beta-gamma and alpha readings in most areas. In Building 52, beta-gamma dose rates exceed DOE guidelines in several spots, principally on lower walls. Radon measurements yield average concentrations on the 50 series buildings of 0.4 to 15 pCi/L and maximum concentrations from 0.5 to 37 pCi/L (ORNL 1981).

- Building 100 Residual radioactivity exceeding guidelines is present on all surfaces. No measurements for removable contamination were found to exceed DOE guidelines. Survcy rcsults arc summarized in Table 2-17 (BNI 1990a). The 1977 ORNL survey showed that observed beta-gamma dose rates are below DOE guidelines for radium. Alpha contamination was found to exceed guidelines. Overhead surfaces show no contamination (ORNL 1981).

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TABLE 2-11

BUILDING K1E SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	5	1.7
Beta-gamma	10	120	73
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	--[a]	--[a]	--[a]
Walls	7	91	37
Ceilings	7	70	33
Roofs	6	1,051	170
Beta-gamma			
Floors	--[a]	--[a]	--[a]
Walls	127	34,957	2,100
Ceilings	1,089	5,869	2,600
Roofs	69	27,204	1,500
Exposure Rate (μR/h)	18	200	48
Radon (pCi/L)	1.7	73.4	23.2

[a]No measurement taken.

Source: BNI 1990a.

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TABLE 2-12

BUILDING 50 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	0	3	0
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	5	190	20
Walls	6	621	80
Ceilings	--[a]	--[a]	--[a]
Roofs	7	254	59
Beta-gamma			
Floors	43	43,645	3,200
Walls	502	9,024	2,300
Ceilings	--[a]	--[a]	--[a]
Roofs	269	4,120	780
Exposure Rate (μR/h)	6	10	6
Radon (pCi/L)	<0.04	0.1	0.05

[a]Inaccessible.

Source: BNI 1990a.

TABLE 2-13

BUILDING 51 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	5	14	10
Nonremovable Contamination (dpm/100 cm^2)			
<u>Alpha</u>			
Floors	7	57	19
Walls	6	2,529	170
Ceilings	--[a]	--[a]	--[a]
Roofs	5	143	33
<u>Beta-gamma</u>			
Floors	43	110,639	3,100
Walls	43	268,406	27,700
Ceilings	--[a]	--[a]	--[a]
Roofs	525	2,750	--[b]
Exposure Rate (μR/h)	6	32	16
Radon (pCi/L)	0.1	0.3	0.2

[a]Inaccessible.

[b]Scanned; no direct measurements taken. Therefore, no average value for the roof could be calculated.

<u>Source</u>: BNI 1990a.

TABLE 2-14

BUILDING 51A SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	1	1
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	8	1,472	130
Walls	7	380	58
Ceilings	--[a]	--[a]	--[a]
Roofs	--[b]	--[b]	--[b]
Beta-gamma			
Floors	258	51,901	2,900
Walls	172	49,315	4,500
Ceilings	--[a]	--[a]	--[a]
Roofs	--[b]	--[b]	--[b]
Exposure Rate (μR/h)	6	18	10
Radon (pCi/L)	0.8	1.1	0.95

[a]Inaccessible.

[b]The 50 series includes Buildings 50, 51, 51A, 52, and 52A. Data obtained from the roof of Building 51 are also applicable to the other buildings in this series.

Source: BNI 1990a.

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TABLE 2-15

BUILDING 52 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	147[a]	--[a]	--[a]
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	18	680	85
Walls	7	5,397	230
Ceilings	7	108	50
Roofs	--[b]	--[b]	--[b]
Beta-gamma			
Floors	679	6,154	2,400
Walls	172	98,718	4,200
Ceilings	195	2,106	1,400
Roofs	--[b]	--[b]	--[b]
Exposure Rate (μR/h)	8	34	10
Radon (pCi/L)	<0.04	<0.04	<0.04

[a]One measurement taken.

[b]The 50 series includes Buildings 50, 51, 51A, 52, and 52A. Data obtained from the roof of Building 51 are also applicable to the other buildings in this series.

Source: BNI 1990a.

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TABLE 2-16

BUILDING 52A SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	139	183	160
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	--[a]	--[a]	--[a]
Walls	70	11,015	1,500
Ceilings	--[a]	--[a]	--[a]
Roofs	--[b]	--[b]	--[b]
Beta-gamma			
Floors	--[a]	--[a]	--[a]
Walls	1,414	250,817	29,000
Ceilings	--[a]	--[a]	--[a]
Roofs	--[b]	--[b]	--[b]
Exposure Rate (μR/h)	17	30	21
Radon (pCi/L)	0.5	0.6	0.55

[a]Inaccessible.

[b]The 50 series includes Buildings 50, 51, 51A, 52, and 52A. Data obtained from the roof of Building 51 are also applicable to the other buildings in this series.

Source: BNI 1990a.

TABLE 2-17

BUILDING 100 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	34	6
Beta-gamma	2	149	68
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	48	3,053	430
Walls	39	3,312	370
Ceilings	7	1,658	230
Roofs	17	23,510	6,900
Beta-gamma			
Floors	430	75,637	16,000
Walls	525	30,181	6,200
Ceilings	293	17,159	3,800
Roofs	865	41,570	25,000
Exposure Rate (μR/h)	6	7	6
Radon (pCi/L)	0.2	0.4	0.3

Source: BNI 1990a.

- Building 101 Beta-gamma measurements were taken only on floors because the building was constructed after MED/AEC operations at SLDS were completed. No readings exceed DOE guidelines. Beta-gamma measurements on the floors range from 258 to 2,193 dpm/100 cm^2, with 930 dpm/100 cm^2 as the average. Exposure rates range from 6 to 48 µR/h, with 24 µR/h as the average (BNI 1990a). Four radon monitoring stations were established; levels range from 0.5 to 4.8 pCi/L. Survey results are summarized in Table 2-18. The ORNL survey showed the average external gamma radiation level to be 15 µR/h. Average radon concentrations range from 1.3 to 12 pCi/L, and maximum concentrations range from 3.6 to 69 pCi/L (ORNL 1981).

- 116 Series Buildings The 116 series consists of Buildings 116, 116B, and 117. Most beta-gamma measurements in these buildings exceed DOE guidelines. No removable contamination was found. Results for these individual building surveys are summarized in Tables 2-19 through 2-21 (BNI 1990a). The 1977 ORNL survey showed low-level alpha contamination over much of the floor and lower wall surfaces. Nonremovable alpha measurements do not exceed DOE guidelines for natural uranium. In the large section of the building and on the second level, beta-gamma measurements exceed DOE uranium guidelines at some points. Inside Building 116B, all measurements are at the background level, but beta-gamma residual surface radioactivity exceeds guidelines in two areas on the roof. Building 117 contains beta-gamma radioactivity exceeding the DOE radium guidelines. Alpha contamination guidelines are exceeded over much of the floor and wall surfaces, but if uranium guidelines are applied, the values are well below contamination levels. Average radon concentrations range from 0.5 to 0.7 pCi/L, and maximum concentrations range from 0.7 to 1.1 pCi/L (ORNL 1981).

- Building 700 Most surfaces in Building 700 exceed DOE guidelines for residual surface; the contamination is nonremovable. Table 2-22 summarizes the survey results (BNI 1990a). The 1977 ORNL survey showed that beta-gamma residual surface radioactivity exceeds DOE guidelines for uranium at some spots on the floor and walls. The average radon concentration is 0.6 pCi/L, and the maximum concentration found is 0.9 pCi/L (ORNL 1981).

- 704 Series Buildings This series consists of Buildings 704, 705, 706, and 707. Most of the interior surfaces in these buildings have residual beta-gamma radioactivity exceeding DOE

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TABLE 2-18

BUILDING 101 SURVEY RESULTS

Parameter[a]	Min.	Max.	Average
Nonremovable Contamination (dpm/100 cm^2)			
<u>Beta-gamma</u>			
Floors	258	2,193	930
Exposure Rate (μR/h)	6	48	24
Radon (pCi/L)	0.5	4.8	1.8

<u>Source</u>: BNI 1990a.

[a]The scope of the survey in Building 101 was limited because the building was constructed after MED/AEC operations ceased.

TABLE 2-19

BUILDING 116 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	93	6.2
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	20	2,006	170
Walls	5	2,953	160
Ceilings	--[a]	--[a]	--[a]
Roofs	14	9,050	1,300
Beta-gamma			
Floors	150	929,058	19,000
Walls	43	137,041	2,600
Ceilings	--[a]	--[a]	--[a]
Roofs	1,200	81,000	--[b]
Exposure Rate (μR/h)	5	10	6
Radon (pCi/L)	<0.04	0.5	0.3

[a]No measurements taken.

[b]Scanned; no direct measurements taken. Therefore, an average value could not be calculated.

Source: BNI 1990a.

TABLE 2-20

BUILDING 116B SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	82	13
Beta-gamma	14	176	110
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	27	265	110
Walls	46	485	150
Ceilings	43	2,203	560
Roofs	17	2,630	910
Beta-gamma			
Floors	599	10,234	3,600
Walls	393	4,928	1,400
Ceilings	851	73,721	13,000
Roofs	2,600	6,930	--[a]
Exposure Rate (μR/h)	6	20	9

[a]Scanned; no direct measurements taken. Therefore, an average value could not be calculated.

Source: BNI 1990a.

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TABLE 2-21

BUILDING 117 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	382	12
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	7	4,596	160
Walls	5	1,323	120
Ceilings	7	6,447	320
Roofs	33	6,100	1,200
Beta-gamma			
Floors	43	117,347	2,800
Walls	91	20,548	1,500
Ceilings	361	98,798	3,900
Roofs	1,370	35,800	--[a]
Exposure Rate (μR/h)	5	29	6
Radon (pCi/L)	0.1	1.0	0.55

[a]Scanned; no direct measurements taken. Therefore, an average value could not be calculated.

Source: BNI 1990a.

TABLE 2-22

BUILDING 700 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	11	1.7
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	6	482	37
Walls	7	110	36
Ceilings	6	454	55
Roofs	116	1,582	880
Beta-gamma			
Floors	387	254,775	9,100
Walls	133	34,688	2,100
Ceilings	328	62,483	2,500
Roofs	4,931	6,986	5,900
Exposure Rate (μR/h)	5	13	6
Radon (pCi/L)	<0.04	<0.04	<0.04

Source: BNI 1990a.

guidelines, and contamination on the roofs of these structures exceeds guidelines for both alpha and beta-gamma radioactivity. Beta-gamma contamination on floors exceeds DOE guidelines in all four buildings. No removable contamination was found in any of the buildings. Survey results for these buildings are summarized in Tables 2-23 through 2-26 (BNI 1990a). The ORNL survey showed that only beta-gamma dose rates at spots on floors and walls exceed the DOE guidelines for uranium in Building 704. The survey of Building 705 showed that measured nonremovable alpha and/or beta-gamma radiation levels exceed DOE guidelines for uranium at numerous points on the floors, walls, and ceilings. Building 706 has one area where beta-gamma dose rates exceed DOE guidelines, as does Building 707. Average radon concentrations range from 0.5 to 1.0 pCi/L, and maximum concentrations range from 0.7 to 1.2 pCi/L (ORNL 1981).

- Building 708 Most surfaces in Building 708 contain levels of radioactivity below DOE guidelines. The primary area showing beta-gamma contamination is the roof. No removable contamination exceeding guidelines was detected. A summary of the results is provided in Table 2-27 (BNI 1990a). The 1977 ORNL survey showed that none of the measurements taken in this building exceed the DOE guidelines for natural uranium. Beta-gamma dose rates average 0.09 mrad/h on the gravel surface roof. Average radon concentrations range from 0.6 to 1.0 pCi/L, and maximum concentrations range from 1.0 to 1.2 pCi/L (ORNL 1981).

- Building 81 No surface in Building 81 yields results exceeding guidelines, and no removable radioactivity exceeding DOE guidelines was found. Results are summarized in Table 2-28.

- Building 82 No residual radioactivity exceeding DOE guidelines exists on the roof or on the interior surfaces. No removable contamination exceeding DOE guidelines was detected. Table 2-29 provides a summary of the results.

Roof surveys also were conducted in Plant 1. The roof surfaces of Buildings Q, T, V, and W within Plant 1 show no measurements exceeding DOE guidelines. Other roofs surveyed in Plant 1 have some areas that slightly exceed DOE guidelines. In general, the contamination is low level and was found in isolated areas. Three roofs in Plant 2 were surveyed; Buildings 53, 56, and 501 within

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TABLE 2-23

BUILDING 704 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	2	25	10
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	46	470	140
Walls	6	558	120
Ceilings	6	190	49
Roofs	8	5,026	1,400
Beta-gamma			
Floors	6,839	42,322	18,000
Walls	7	14,999	1,400
Ceilings	8	4,510	1,400
Roofs	915	25,623	--[a]
Exposure Rate (μR/h)	6	8	6
Radon (pCi/L)	0.2	0.4	0.3

[a]Scanned; no direct measurements taken. Therefore, an average value could not be calculated.

Source: BNI 1990a.

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TABLE 2-24

BUILDING 705 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	235	31
Beta-gamma	81	207	130
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	3	16,298	370
Walls	3	16,298	280
Ceilings	7	10,002	420
Roofs	101	4,850	2,200
Beta-gamma			
Floors	129	529,932	17,000
Walls	49	217,494	4,200
Ceilings	100	35,833	7,600
Roofs	15,600	97,900	--[a]
Exposure Rate (μR/h)	3	10	5
Radon (pCi/L)	<0.04	0.25	0.16

[a]Scanned; no direct measurements taken. Therefore, an average value could not be calculated.

Source: BNI 1990a.

TABLE 2-25

BUILDING 706 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	8	26	17
Beta-gamma	2	186	100
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	--[a]	--[a]	--[a]
Walls	28	706	220
Ceilings	31	2,098	380
Roofs	659	2,290	1,300
Beta-gamma			
Floors	215	150,672	26,000
Walls	200	6,968	1,000
Ceilings	40	26,230	5,400
Roofs	1,344	7,616	--[b]
Exposure Rate (μR/h)	4	6	5
Radon (pCi/L)	<0.04	0.12	0.05

[a]No measurements taken.

[b]Scanned; no direct measurements taken. Therefore, an average value could not be calculated.

Source: BNI 1990a.

TABLE 2-26

BUILDING 707 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	8	4
Beta-gamma	24	127	88
Nonremovable Contamination (dpm/100 cm^2)			
<u>Alpha</u>			
Floors	20	186	72
Walls	6	688	140
Ceilings	23	808	350
Roofs	1,154	2,125	1,600
<u>Beta-gamma</u>			
Floors	817	12,857	5,000
Walls	25	6,989	2,600
Ceilings	657	5,917	2,500
Roofs	3,136	7,616	--[a]
Exposure Rate (μR/h)	4	6	5
Radon (pCi/L)	<0.04	0.4	0.2

[a]Scanned; no direct measurements taken. Therefore, an average value could not be calculated.

<u>Source</u>: BNI 1990a.

TABLE 2-27

BUILDING 708 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	1	9	2.3
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	--[a]	--[a]	--[a]
Walls	7	514	82
Ceilings	7	71	39
Roofs	157	3,667	1,800
Beta-gamma			
Floors	129	11,825	2,200
Walls	35	5,556	930
Ceilings	575	1,726	920
Roofs	4,931	6,986	5,900
Exposure Rate (μR/h)	5	21	7
Radon (pCi/L)	<0.04	0.4	0.04

[a]No measurements taken.

Source: BNI 1990a.

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TABLE 2-28

BUILDING 81 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	2	7	4
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	6	39	21
Walls	7	52	26
Ceilings	7	39	25
Roofs	70	573	320
Beta-gamma			
Floors	43	43	43
Walls	105	740	430
Ceilings	14	378	270
Roofs	443	2,877	1,000
Exposure Rate (μR/h)	2	6	4
Radon (pCi/L)	0.1	0.3	0.2

Source: BNI 1990a.

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TABLE 2-29

BUILDING 82 SURVEY RESULTS

Parameter	Min.	Max.	Average
Removable Contamination (dpm/100 cm^2)			
Alpha	2	5	2.2
Nonremovable Contamination (dpm/100 cm^2)			
Alpha			
Floors	6	52	27
Walls	7	730	35
Ceilings	--[a]	--[a]	--[a]
Roofs	7	1,364	570
Beta-gamma			
Floors	43	2,107	92
Walls	51	2,835	840
Ceilings	--[a]	--[a]	--[a]
Roofs	866	2,165	1,400
Exposure Rate (μR/h)	6	10	6
Radon (pCi/L)	0.1	0.5	0.3

[a]No measurements taken.

Source: BNI 1990a.

Plant 2 have some beta-gamma radioactivity exceeding uranium guidelines. Results of these additional roof surveys are provided in Table 2-30.

Soil survey. BNI conducted a soil investigation at SLDS and the adjacent city property. Results of the survey indicate the presence of subsurface contamination from the surface to a maximum depth of 12.8 m (42 ft). A total of 218 boreholes were drilled and sampled to determine the presence of radioactive contamination; 110 of these were also sampled for chemical constituents and 9 were converted to monitoring wells. Borehole locations and areas of contamination are shown in Figure 2-21; boreholes were drilled in both exterior and interior locations. Table 2-31 shows the averages and ranges of radionuclide concentrations found in soil around each plant and at the city property adjacent to Plant 7E (BNI 1990a). The total estimated volume of contaminated soil at SLDS and adjacent contaminated properties is 220,200 m^3 (288,000 yd^3). The following paragraphs summarize the locations and extent of radioactive subsurface soil contamination at each plant. Subsection 2.4.3 provides a summary of the chemical conditions at the property.

For purposes of discussion, a uranium-238 guideline of 50 pCi/g is assumed. The actual guideline will be established during the development of ARARs for the St. Louis site. A value of 50 pCi/g is believed to be conservatively low based on dose analyses, the application of ALARA, and the current use of the property. (Note: The borehole identifiers used in the following figures explain the types of samples collected from the boreholes. For example, R denotes a borehole sampled for radiological analysis only, whereas C denotes a borehole sampled for both radiological and chemical analyses.)

- Plant 1 Twenty-three boreholes were drilled, and soil samples were collected and analyzed; analytical results for seven of these boreholes exceed DOE cleanup guidelines for soil. Most elevated radioactivity in soil was found near Building K1E, and radium-226 is the primary soil contaminant (see Figure 2-22). Contamination at Plant 1 extends to a depth greater than 3 m (10 ft).

- Plant 2 Twenty-seven boreholes were drilled, and soil samples were collected and analyzed; samples from 13 exceed DOE cleanup guidelines. Most of the radioactivity exceeding guidelines was found near or beneath Buildings 51, 51A, 52, and 52A. Uranium-238 and thorium-230 are the primary soil contaminants (see Figure 2-23). Contamination at Plant 2 extends to a depth greater than 7 m (23 ft).

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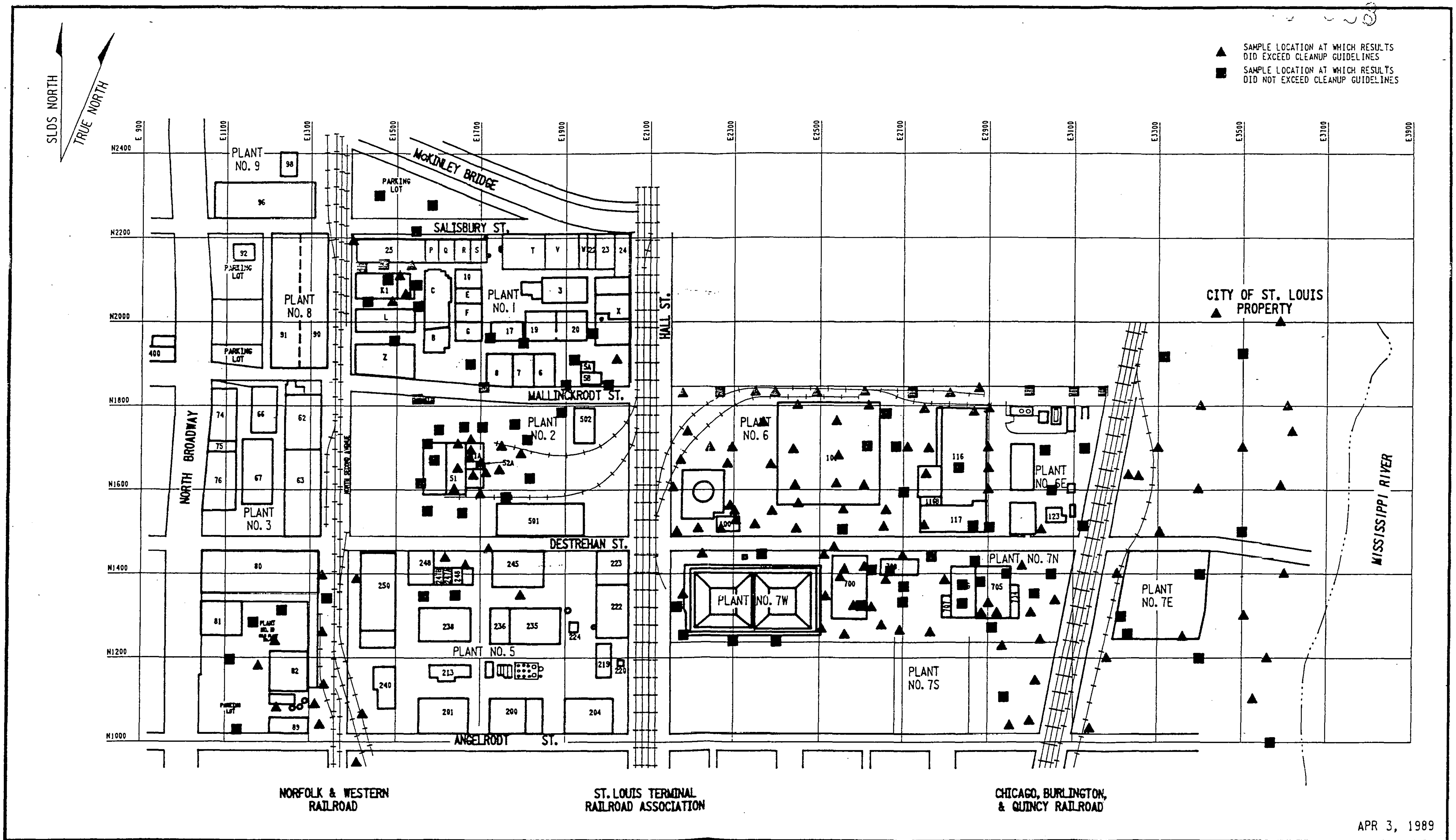
TABLE 2-30

ADDITIONAL ROOF SURVEYS FOR NONREMOVABLE CONTAMINATION

Building	Alpha			Beta-Gamma		
	Min.	Max.	Avg.	Min.	Max.	Avg.
X	29	1,443	287	633	6,030	2,090
501	29	107	66	717	1,813	1,111
R	29	649	163	548	3,163	1,538
P	52	963	304	930	4,640	2,231
Q	33	169	86	670	760	715
C	23	246	92	670	1,640	1,246
B	33	207	79	590	1,100	760
L	27	996	182	168	13,409	2,077
Z	27	453	143	506	1,855	979
53	112	270	194	574	840	707
56	33	506	222	574	1,105	840
F	27	395	153	633	4,512	1,656
G	27	550	174	1,139	2,488	1,776
10	27	279	108	717	2,488	1,167
T,V,W[a]	13	130	38	594	2,110	759

[a]A single roof covers three buildings.



116F022.DGN BORE

FIGURE 2-21 LOCATIONS OF BOREHOLES AT SLDS

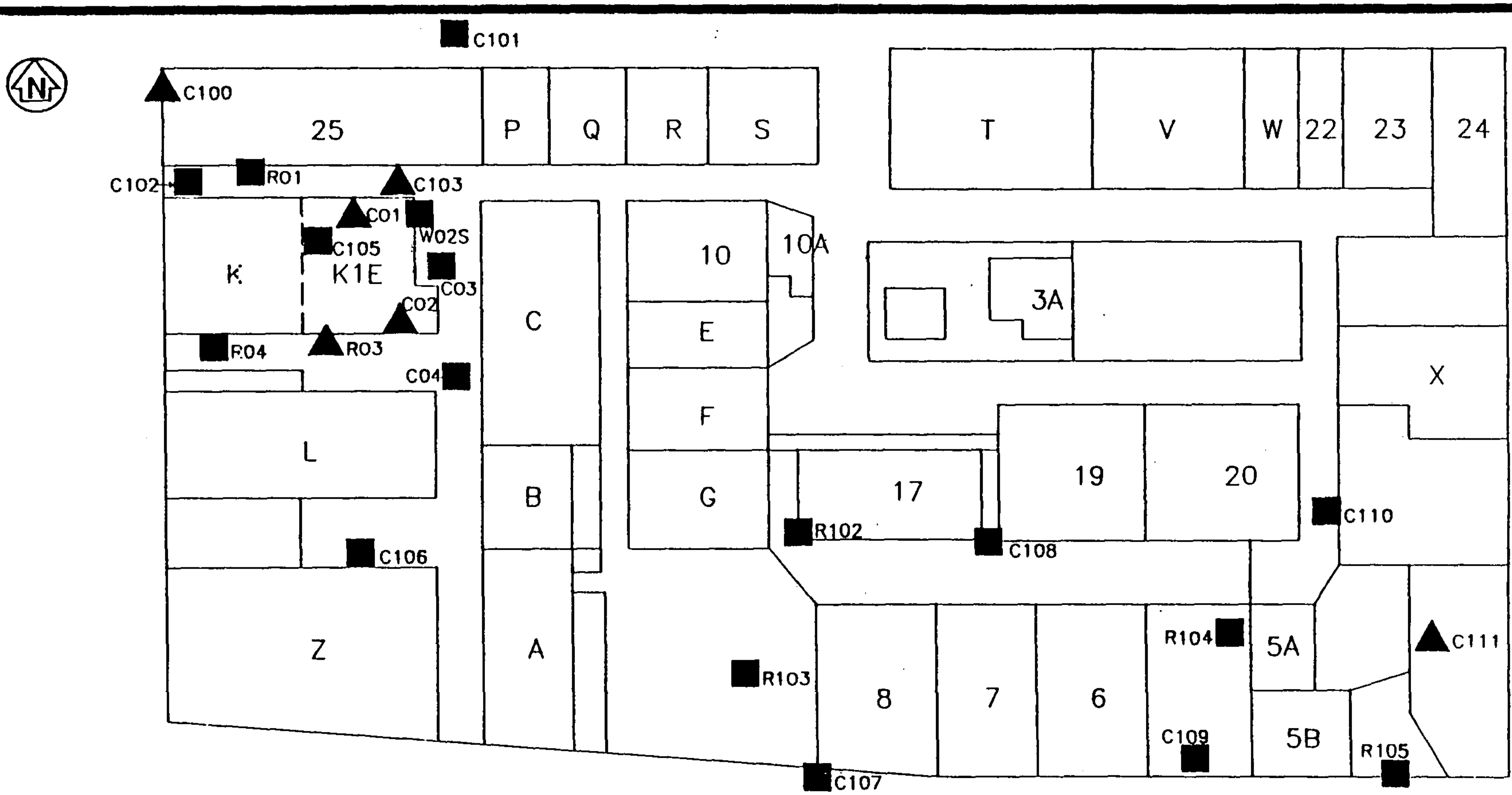
TABLE 2-31

ANALYTICAL RESULTS FOR SOIL AT SLDS

	Parameter (pCi/g)							
	U-238		Ra-226		Th-232		Th-230	
Location	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Plant 1	3	310	0.7	5,400	0.5	14	0.3	330
Plant 2	3	33,000	0.4	500	0.5	9	0.4	14,000
Plant 5	4	170	1	290	0.7	130	0.5	1,000
Plant 6	1.3	15,000	0.5	2,800	0.4	440	0.4	3,000
Plant 7	2	310	0.4	490	0.4	210	0.4	670
Plant 10[a]	2	1,100	0.5	300	0.5	56	0.3	2,100
City Property and Plant 7E	2	20,000	0.9	1,300	1.0	46	1.3	590

[a]Two small rock-like materials were found near the eastern side of Plant 10 yielding maximum concentrations of uranium-238 (95,000 pCi/g), radium-226 (2,100 pCi/g), thorium-232 (700 pCi/g), and thorium-230 (98,000 pCi/g). These are isolated materials and are not indicative of the area.

Source: BNI 1990a.



▲ ABOVE CLEANUP GUIDELINES

■ BELOW CLEANUP GUIDELINES

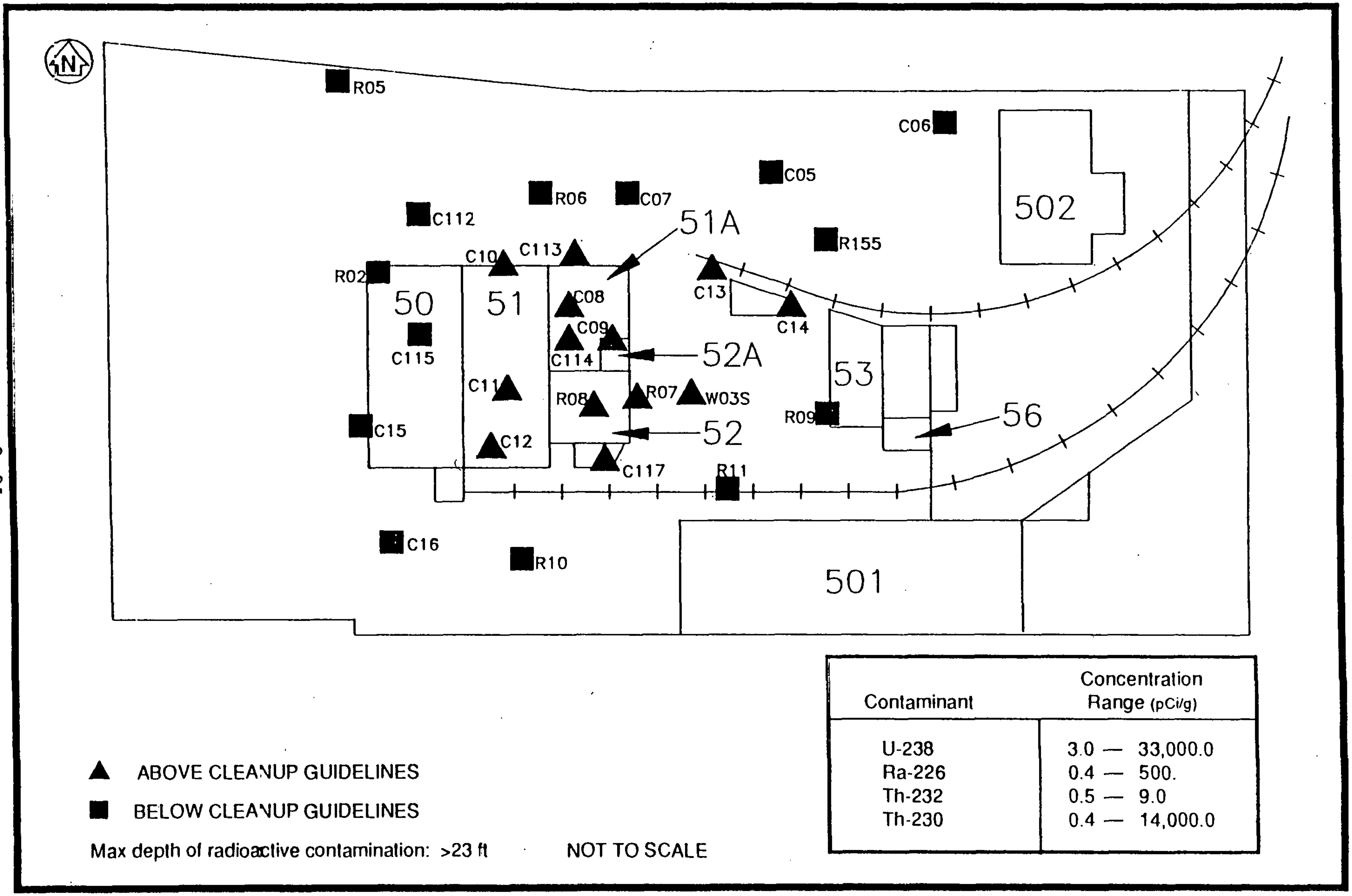
Max depth of radioactive contamination: >10 ft

NOT TO SCALE

Contaminant	Concentration Range (pCi/g)
U-238	3.0 — 310.0
Ra-226	0.7 — 5,400.0
Th-232	0.5 — 14.0
Th-230	0.3 — 330.0

FIGURE 2-22 RADIOLOGICAL ANALYSIS RESULTS FOR SOIL AT PLANT 1

4.14-1097 1
B2OSSOIL1:V1



Contaminant	Concentration Range (pCi/g)
U-238	3.0 — 33,000.0
Ra-226	0.4 — 500.
Th-232	0.5 — 9.0
Th-230	0.4 — 14,000.0

FIGURE 2-23 RADIOLOGICAL ANALYSIS RESULTS FOR SOIL AT PLANT 2

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4 4-1097.2
B2DSSOIL2:V1

- Plant 5 Of the eight boreholes drilled, seven showed radioactivity exceeding guidelines; thorium-230 is the primary contaminant (see Figure 2-24). The maximum depth of contamination at Plant 5 is 3 m (10 ft).

- Plants 6 and 6E Sixty-four boreholes were drilled at Plants 6 and 6E, and 53 of the soil samples collected and analyzed exceed cleanup guidelines. In general, soil at Plant 6 exceeds guidelines across the entire area, and Plant 6E shows little residual radioactivity. Uranium-238 is the primary contaminant, and concentrations of radium-226 and thorium-230 exceed guidelines in some spots (see Figure 2-25). The maximum depth of contamination at Plant 6 is 6 m (20 ft).

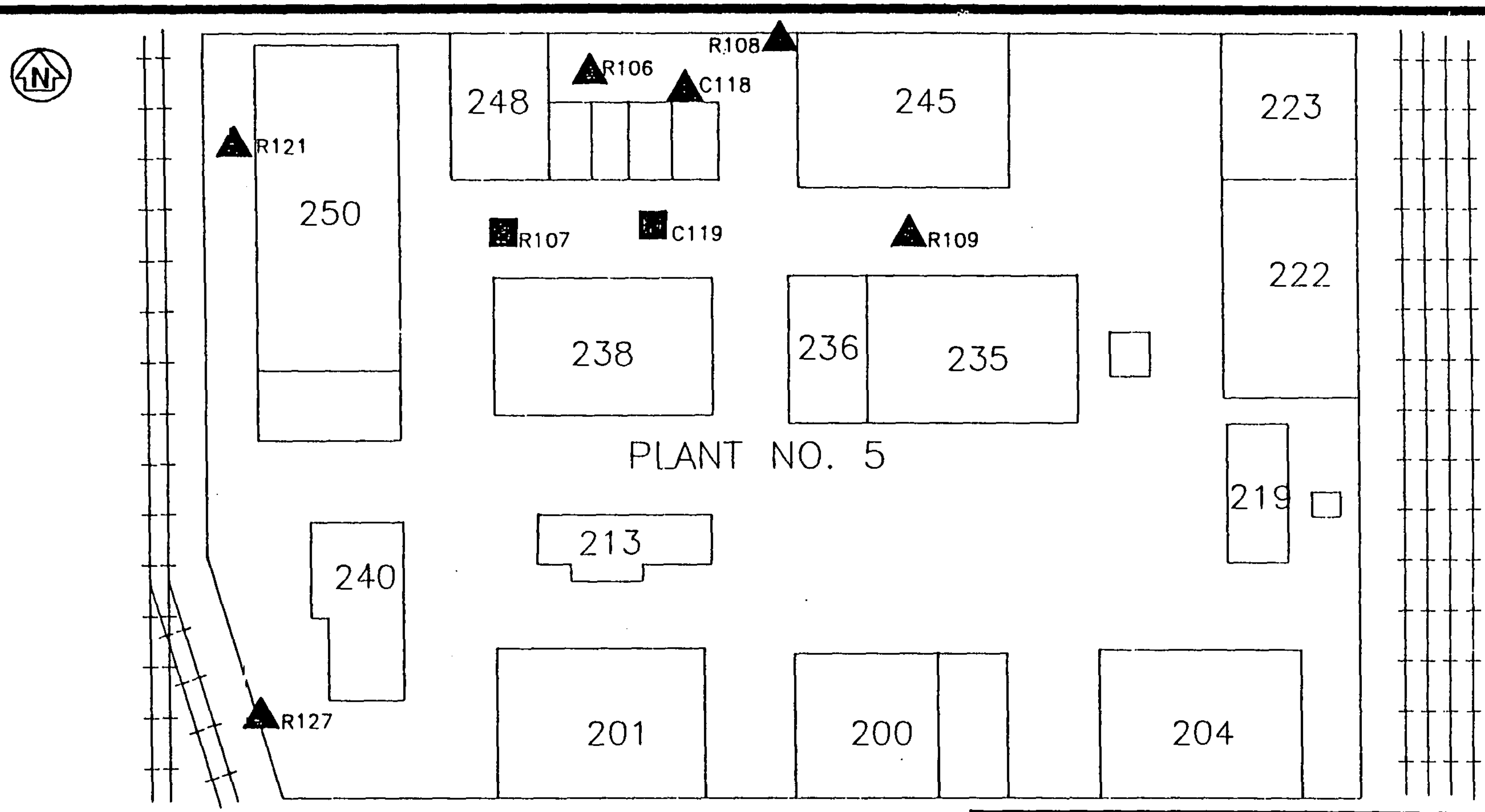
- Plant 7 Of the 45 boreholes drilled at Plant 7, analytical results for soil from 32 showed uranium-238, radium-226, thorium-232, and thorium-230 in concentrations exceeding cleanup guidelines (see Figure 2-26). Radioactivity is distributed across the entire plant area; contamination extends to a depth greater than 6 m (20 ft).

- Plant 10 Thirteen boreholes were drilled at Plant 10; analytical results for soil from nine showed radioactivity exceeding cleanup guidelines. The contamination is distributed across the entire plant area, and uranium-238 and thorium-230 are the primary contaminants (see Figure 2-27). The maximum depth of contamination at Plant 10 is 2.1 m (7 ft).

- City property Twenty-one boreholes were drilled in this area, located west of the Mississippi River and east of the Chicago, Burlington, and Quincy Railroad; analytical results for soil from 16 showed radioactivity exceeding DOE cleanup guidelines. Uranium-238, radium-226, and thorium-230 seem to be spread across the entire area (see Figure 2-28). The maximum depth of contamination at the city property is 12.8 m (42 ft).

- Plant 7E Of the five boreholes drilled at Plant 7E, analytical results for soil from two showed radioactivity near the surface in excess of guidelines. The boreholes were drilled around the perimeter of the property because the entire area is covered with a stockpile of coal. Radium-226 and thorium-230 are the primary contaminants (see Figure 2-28). The maximum depth of contamination at Plant 7E is 0.3 m (1 ft).

Figure 2-29 shows areas of radioactive contamination at SLDS.



▲ ABOVE CLEANUP GUIDELINES

■ BELOW CLEANUP GUIDELINES

Max depth of radioactive contamination: 10 ft

NOT TO SCALE

Contaminant	Concentration Range (pCi/g)
U-238	4.0 — 170.0
Ra-226	1.0 — 290.0
Th-232	0.7 — 130.0
Th-230	0.5 — 1,000.0

FIGURE 2-24 RADIOLOGICAL ANALYSIS RESULTS FOR SOIL AT PLANT 5

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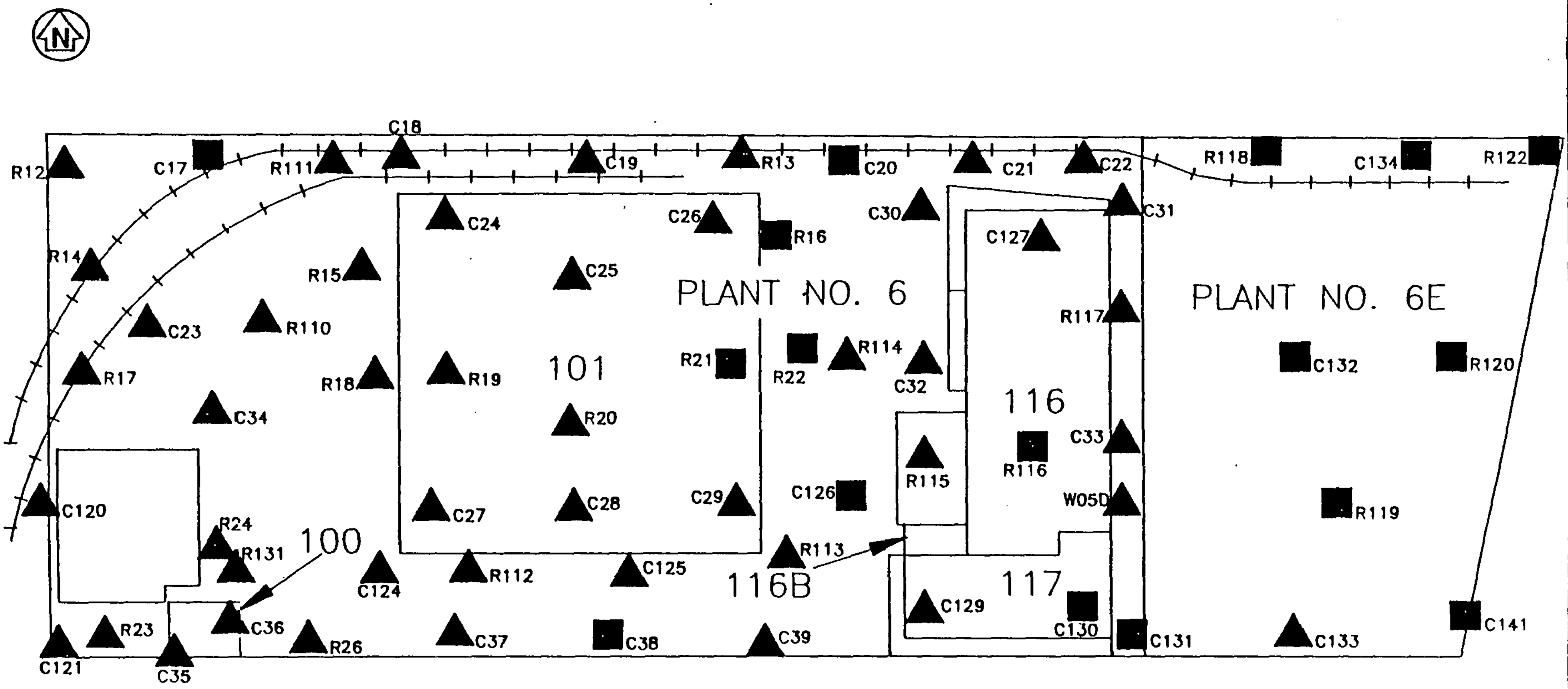
4.14-1097.3
B2 DSSOILS:V1



▲ ABOVE CLEANUP GUIDELINES

■ BELOW CLEANUP GUIDELINES

Max depth of radioactive contamination: 20 ft

NOT TO SCALE

Contaminant	Concentration Range (pCi/g)
U-238	1.3 — 15,000.0
Ra-226	0.5 — 2,800.0
Th-232	0.4 — 440.0
Th-230	0.4 — 3,000.0

FIGURE 2-25 RADIOLOGICAL ANALYSIS RESULTS FOR SOIL AT PLANTS 6 AND 6E

4.14-1097.4
B2:DSSOIL6:V1

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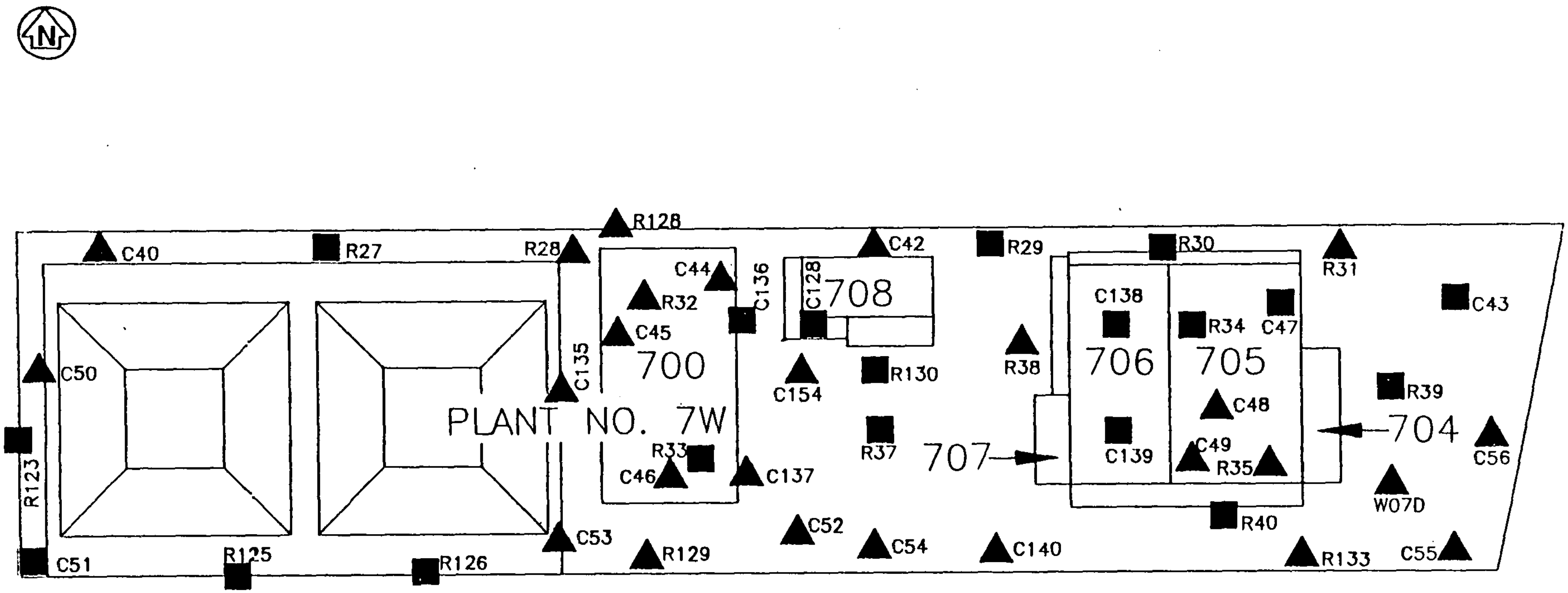


▲ ABOVE CLEANUP GUIDELINES

■ BELOW CLEANUP GUIDELINES

Max depth of radioactive contamination: 20 ft

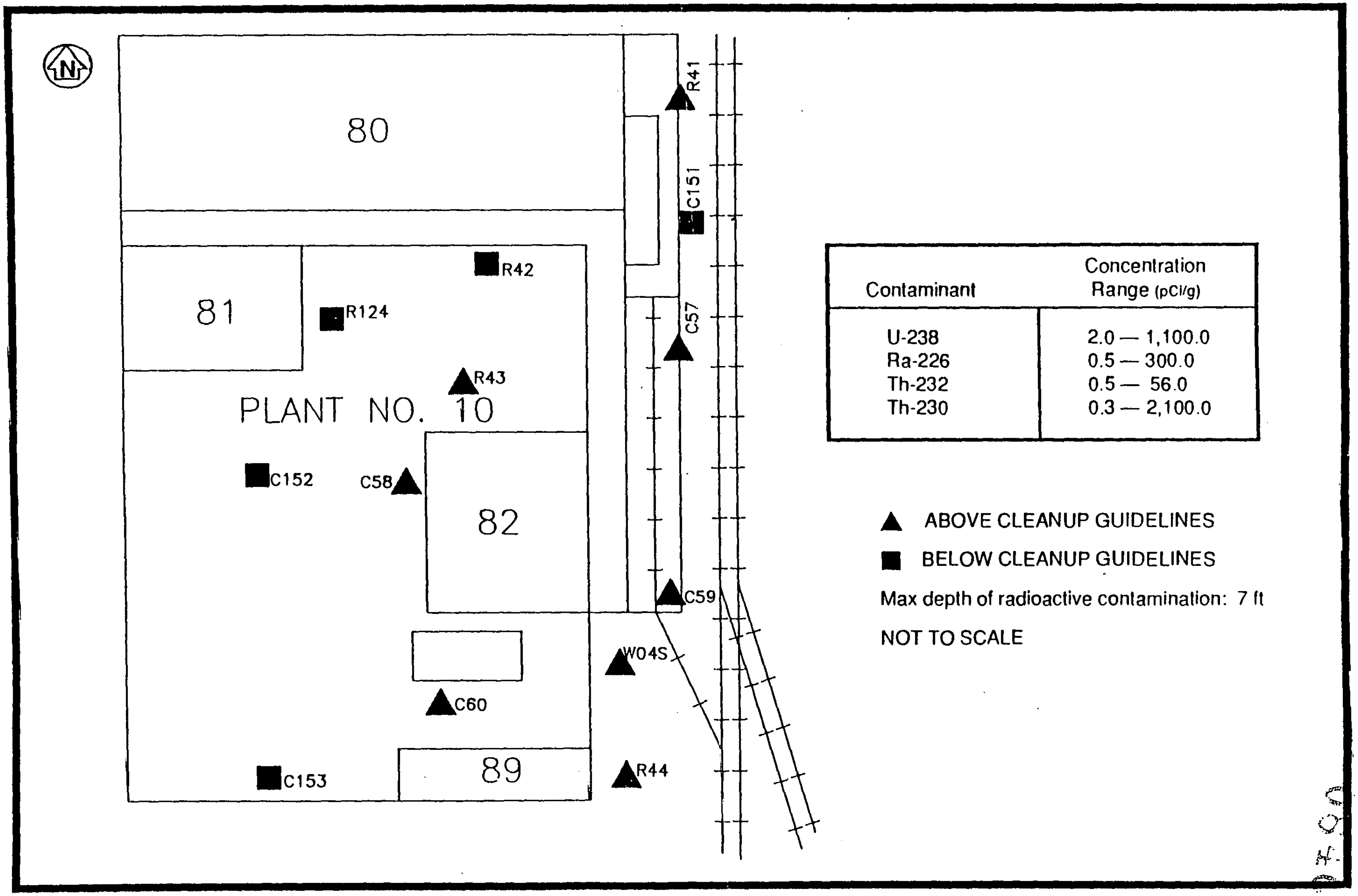
NOT TO SCALE

Contaminant	Concentration Range (pCi/g)
U-238	2.0 — 310.0
Ra-226	0.4 — 490.0
Th-232	0.4 — 210.0
Th-230	0.4 — 670.0

FIGURE 2-26 RADIOLOGICAL ANALYSIS RESULTS FOR SOIL AT PLANT 7

4.14-1097.5
B2:DSSOIL7:V1

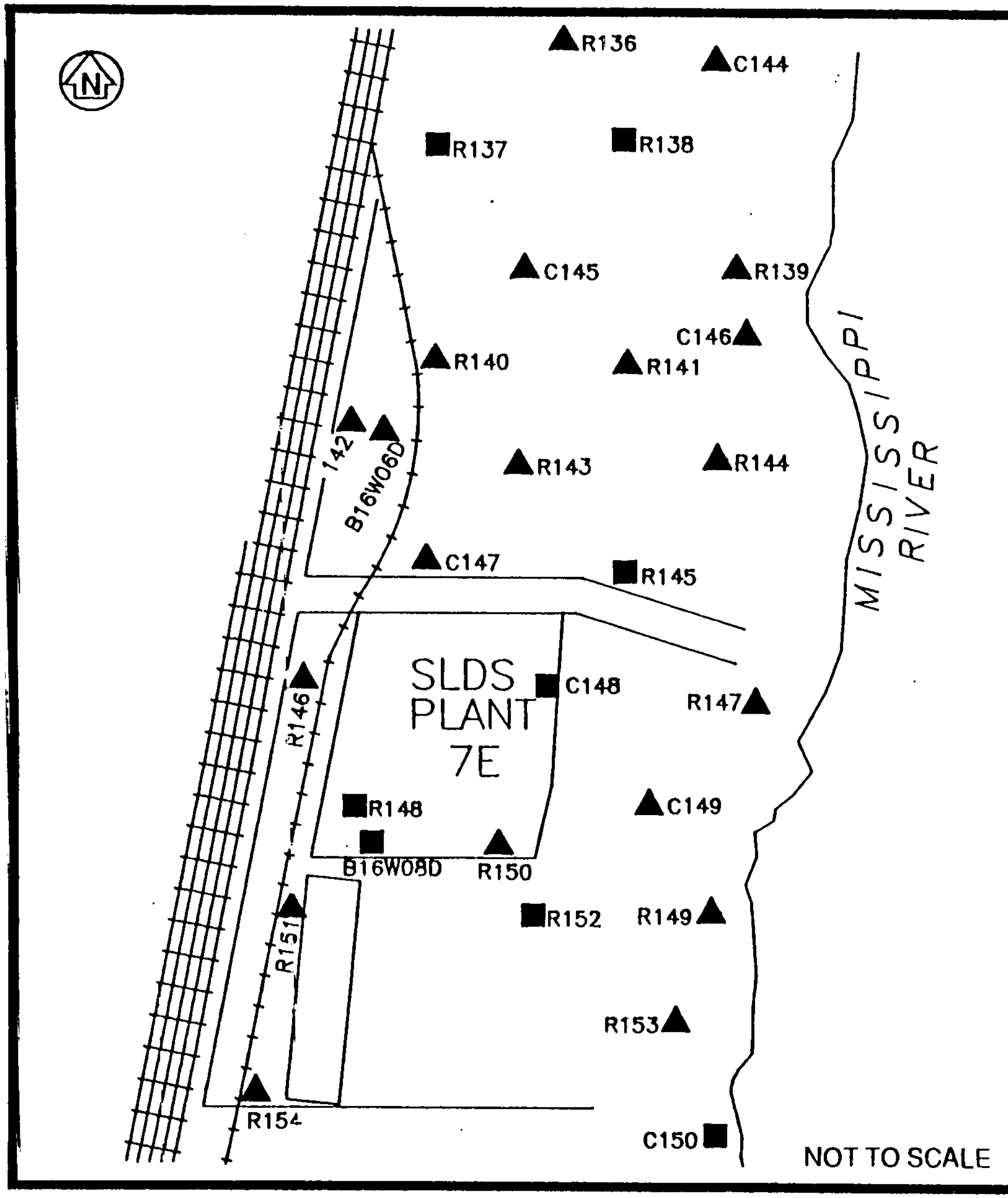
084628



Contaminant	Concentration Range (pCi/g)
U-238	2.0 — 1,100.0
Ra-226	0.5 — 300.0
Th-232	0.5 — 56.0
Th-230	0.3 — 2,100.0

FIGURE 2-27 RADIOLOGICAL ANALYSIS RESULTS FOR SOIL AT PLANT 10

4,14-1097.6
B2:DSSOIL10:V1



Contaminant	Concentration Range (pCi/g)
U-238	2.0 — 20,000.0
Ra-226	0.9 — 1,300.0
Th-232	1.0 — 46.0
Th-230	1.3 — 590.0

▲ ABOVE CLEANUP GUIDELINES

■ BELOW CLEANUP GUIDELINES

Maximum depth of radioactive contamination at the city property: 42 ft

Maximum depth of radioactive contamination at Plant 7E: 1 ft

FIGURE 2-28 RADIOLOGICAL ANALYSIS RESULTS FOR SOIL AT THE CITY PROPERTY AND PLANT 7E

4.14-1097.7

084628

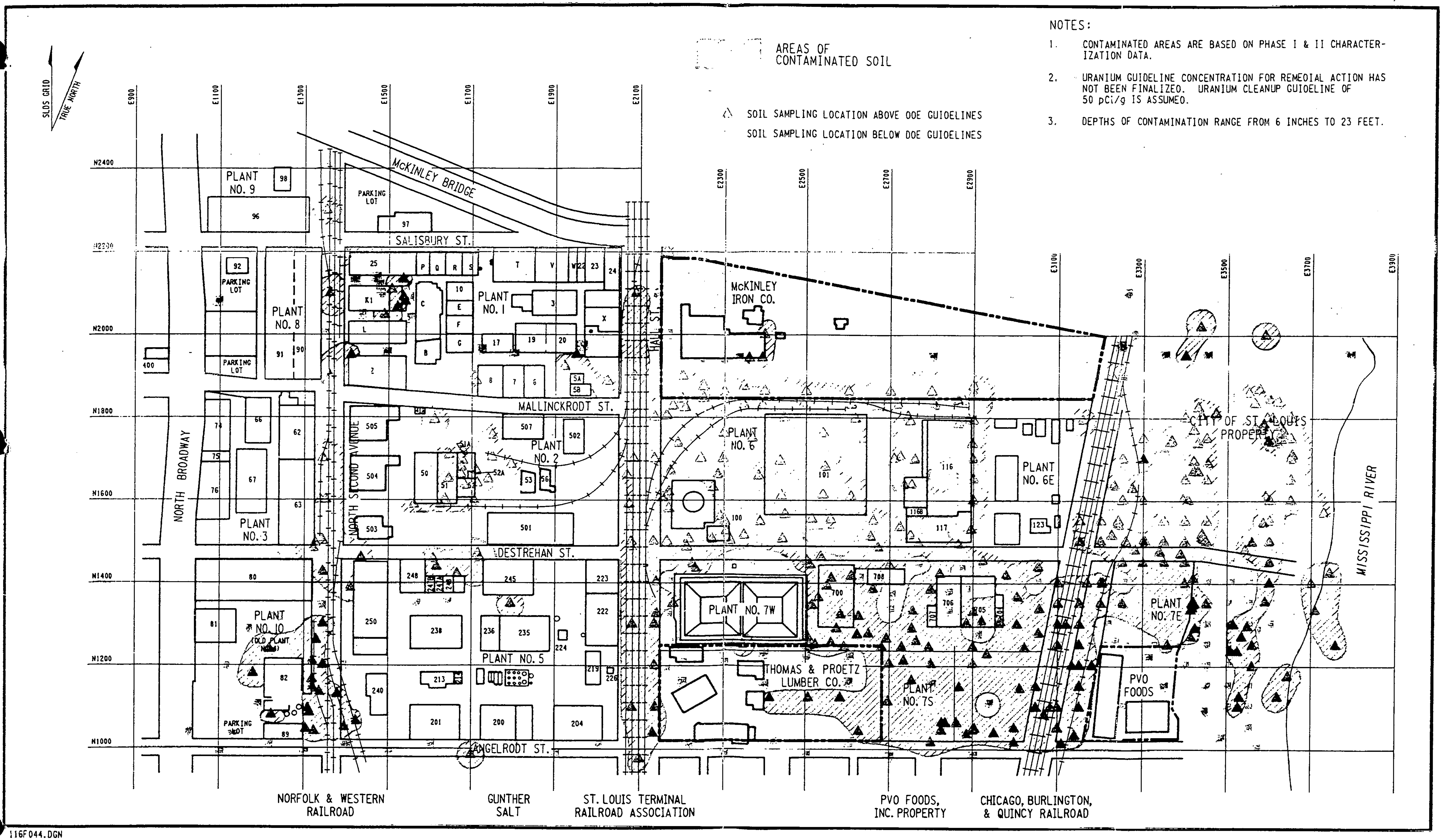


FIGURE 2-29 AREAS OF RADIOACTIVE CONTAMINATION AT SLDS

Drains and sumps. Eighty-four manholes at SLDS (Figure 2-30) were surveyed to determine whether residual radioactivity exists in the drainage pathways; sludge or sidewall samples were collected and analyzed from 50 of the manholes. One sample was collected from each manhole where available. Analytical results are given in Table 2-32. Thirty-five of the manholes showed residual radioactivity exceeding DOE uranium guidelines for surface soil contamination. When final building surveys are performed shortly before remedial action begins, the extent of contamination in each drainage pathway will be determined. This approach was selected because of ongoing operations at the property (BNI 1990a). These operations may render data collected several years before remedial action useless for the purpose of cleanup.

Groundwater investigations. Nine groundwater monitoring wells were installed to evaluate groundwater quality and to help determine groundwater flow directions (Figure 2-31). Well 9 was installed after the others and was only used to evaluate groundwater flow direction. Groundwater was sampled quarterly from July 1988 to April 1989; characterization data indicates that concentrations of uranium-238, radium-226, and thorium-230 range from less than 3×10^{-9} (which is the lowest level of detection) to 1.93×10^{-7}, 3×10^{-10} to 3.2×10^{-9}, and less than 1×10^{-10} to 3.7×10^{-9} μCi/ml, respectively. Table 2-33 shows minimum, maximum, and average values of radionuclides in groundwater at SLDS. Well B16W02S exhibits a maximum total uranium concentration of 193×10^{-9} μCi/ml. Well B16W01S contains maximum concentrations of radium-226 and thorium-230 of 3.2×10^{-9} and 3.7×10^{-9} μCi/ml, respectively. EPA has proposed an amendment to the Uranium Mill Tailings Radiation Control Act (40 CFR 192) to add 30×10^{-9} μCi/ml (30 pCi/L) as a guideline for concentrations of uranium in groundwater, which could result in a potential ARAR for the St. Louis site.

SLDS vicinity properties

The SLDS vicinity properties include the Norfolk and Western Railroad property; the Chicago, Burlington, and Quincy Railroad property; the Thomas and Proetz Lumber Company property; the PVO Foods, Inc., property; the McKinley Iron Company property; and the St. Louis Terminal Railroad Association property. Survey activities at these properties included walkover gamma radiation scans, soil sampling, and gamma radiation logging. Residual radioactivity was found in soil at concentrations exceeding guidelines on five of the six properties. Analytical results for soil collected and analyzed from the six vicinity properties reveal elevated (exceeding DOE remedial action guidelines) concentrations of uranium-238, radium-226, thorium-232, and thorium-230 in

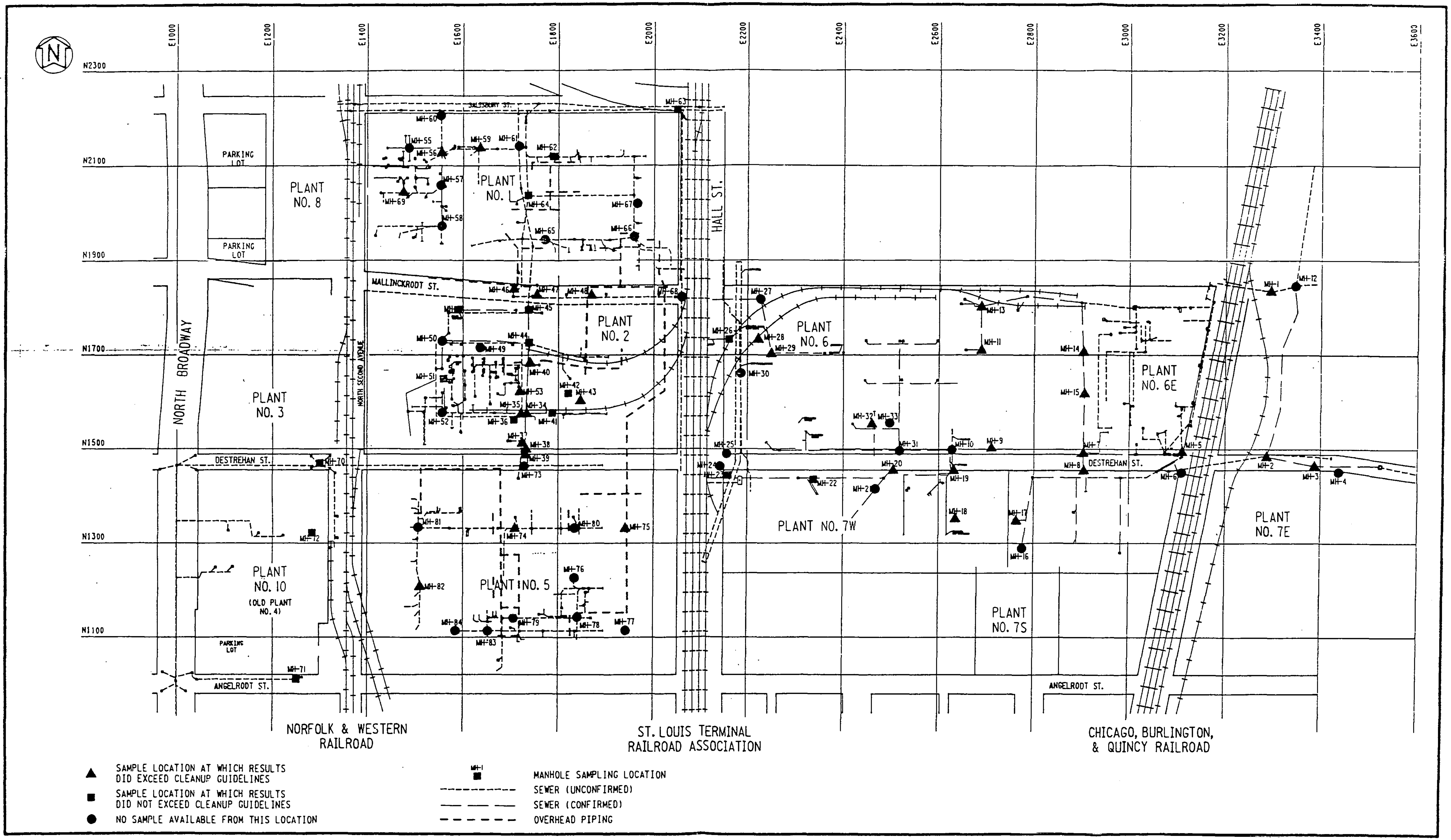


FIGURE 2-30 LOCATIONS OF MANHOLES SURVEYED AT SLDS

116F002.DGN MANHOL

TABLE 2-32

RADIONUCLIDE CONCENTRATIONS IN SAMPLES

COLLECTED FROM MANHOLES AT SLDS

Location	Concentration (pCi/g)			
	Uranium-238	Radium-226	Thorium-232	Thorium-230
MANHOLE-1	<10.0	2.0	2.0	3.9
MANHOLE-2	<30.0	4.0	<6.0	6.0
MANHOLE-3	<19.0	2.0	4.0	2.0
MANHOLE-5	24.0	6.0	6.0	50.0
MANHOLE-7	42.0	31.0	27.0	20.0
MANHOLE-8	<35.0	13.0	<3.0	2,600.0
MANHOLE-9	<12.0	17.0	15.0	71.0
MANHOLE-11	<31.0	41.0	110.0	37.0
MANHOLE-13	91.0	41.0	44.0	24.0
MANHOLE-14	270.0	130.0	91.0	150.0
MANHOLE-15	160.0	76.0	74.0	92.0
MANHOLE-17	21.0	8.0	16.0	4.0
MANHOLE-18	7.0	4.1	5.0	15.0
MANHOLE-19	<32.0	22.0	11.0	520.0
MANHOLE-20	<14.0	5.0	3.0	39.0
MANHOLE-22	<8.0	<1.0	2.0	2.7
MANHOLE-23	<4.0	1.1	1.3	1.1
MANHOLE-26	<4.0	2.8	<1.0	1.1
MANHOLE-28	22.0	11.0	3.0	73.0
MANHOLE-29	18.0	10.0	8.0	43.0
MANHOLE-32	9.0	3.2	2.0	5.9
MANHOLE-34	<14.0	3.0	2.0	2.6
MANHOLE-35	<10.0	3.0	3.0	4.6
MANHOLE-36	<7.0	1.6	2.0	1.1
MANHOLE-37	<6.0	2.3	2.0	4.2
MANHOLE-38	<11.0	8.0	4.0	21.0
MANHOLE-39	<8.0	1.3	<1.0	9.7
MANHOLE-40	<53.0	7.0	<5.0	5.7
MANHOLE-41	<2.0	2.2	0.9	3.6
MANHOLE-42	<5.0	2.8	2.2	1.8
MANHOLE-43	<4.0	2.0	3.0	3.2
MANHOLE-44	<3.0	<1.0	1.0	3.1
MANHOLE-45	<4.0	1.8	1.4	1.3
MANHOLE-46	<26.0	10.0	30.0	10.0
MANHOLE-47	<8.0	3.1	4.0	3.5
MANHOLE-48	<7.0	2.4	1.9	3.9
MANHOLE-51	<2.0	0.8	<1.0	1.9
MANHOLE-53	19.0	5.3	2.5	12.0
MANHOLE-56	<17.0	11.0	<9.0	3.7
MANHOLE-59	30.0	7.0	<5.0	16.0

TABLE 2-32

(continued)

Location	Concentration (pCi/g)			
	Uranium-238	Radium-226	Thorium-232	Thorium-230
MANHOLE-62	<6.0	<1.0	2.0	<0.6
MANHOLE-63	<3.0	1.0	<2.0	0.8
MANHOLE-64	7.0	<2.0	<1.0	0.9
MANHOLE-69	7.0	2.3	<1.0	4.7
MANHOLE-70	<4.0	1.4	1.6	2.9
MANHOLE-71	<4.0	1.3	0.7	2.9
MANHOLE-72	<6.0	1.5	<4.0	1.2
MANHOLE-74	<7.0	4.4	1.0	2.4
MANHOLE-75	<5.0	8.0	2.0	<0.5
MANHOLE-82	190.0	930.0	640.0	510.0

Source: BNI 1990a.

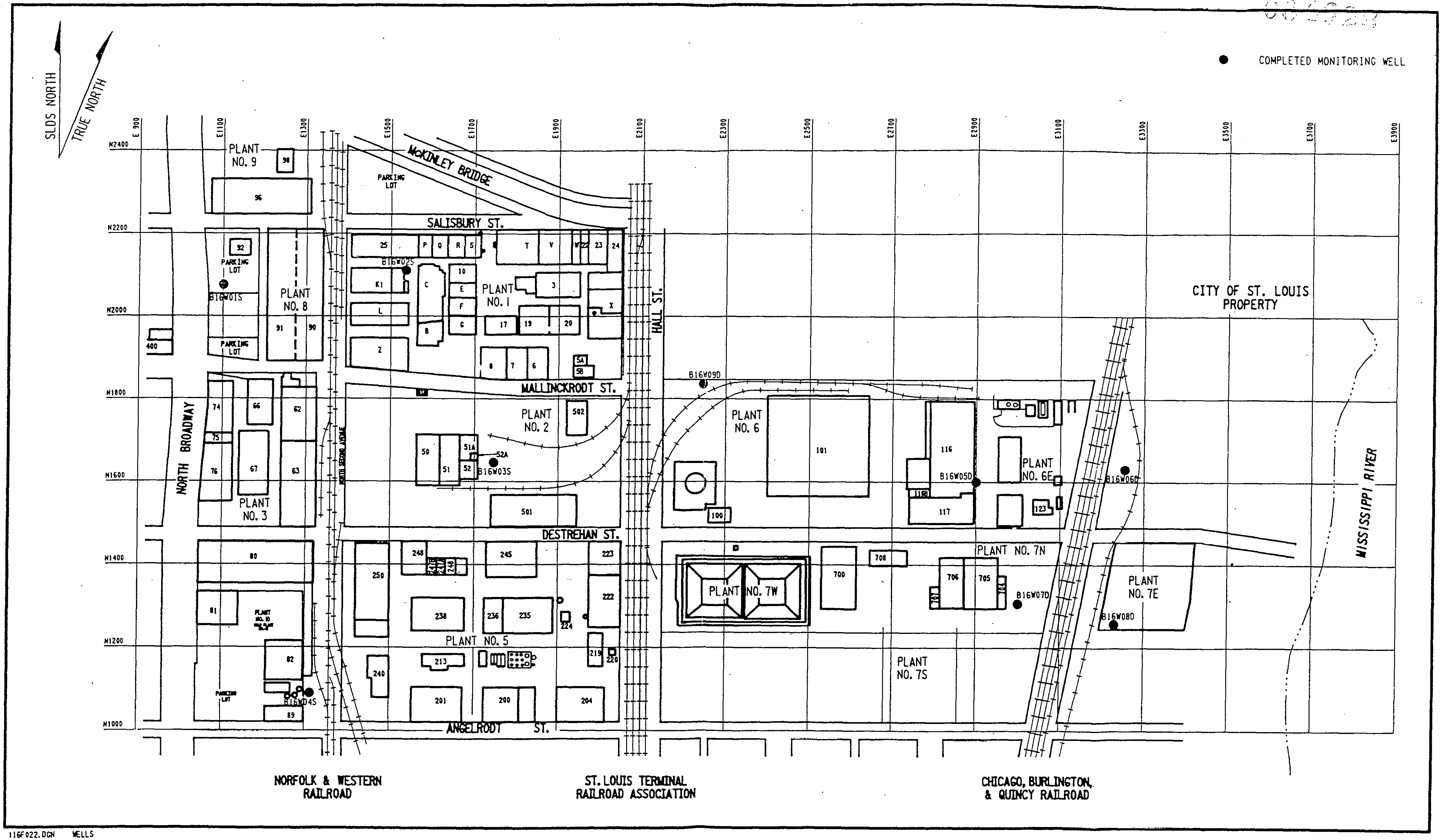


FIGURE 2-31 LOCATIONS OF GROUNDWATER MONITORING WELLS AT SLDS

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TABLE 2-33

CONCENTRATIONS OF TOTAL URANIUM, RADIUM-226, AND THORIUM-230 IN GROUNDWATER AT SLDS

Sampling Location[a]	Number of Samples	Concentration (pCi/L)[b,c] Minimum	Maximum	Average
Total Uranium				
B16W01S	4	<3	5	4
B16W02S	4	107	193	162
B16W03S	4	<3	<3	<3
B16W04S	4	<3	<3	<3
B16W05D	4	<3	3	<3
B16W06D	4	<3	3	<3
B16W07D	4	<3	<3	<3
B16W08D	4	<3	<3	<3
Radium-226				
B16W01S	4	0.7	3.2	2.3
B16W02S	4	0.3	2.7	1.2
B16W03S	4	0.3	0.6	0.5
B16W04S	4	0.3	1.3	0.8
B16W05D	4	0.9	1.1	1.0
B16W06D	4	0.5	1.8	1.3
B16W07D	4	0.3	0.9	0.6
B16W08D	4	0.3	0.8	0.6
Thorium-230				
B16W01S	4	0.3	3.7	1.9
B16W02S	4	<0.1	2.7	0.9
B16W03S	4	0.2	0.6	0.3
B16W04S	4	<0.1	0.8	0.4
B16W05D	4	<0.1	0.2	0.1
B16W06D	4	<0.1	0.2	0.2
B16W07D	4	<0.2	0.3	0.3
B16W08D	4	<0.1	<0.3	<0.2

[a]Sampling locations are shown in Figure 2-31.

[b]Where no more than one value is less than the limit of sensitivity of the analytical method, values are considered equal to the limit of sensitivity, and the average value is reported without the "less than" notation.

[c]1 pCi/L = 1 x 10^{-9} μCi/ml.

Source: BNI 1990a.

surface soil on all the properties, with the exception of PVO Foods. One subsurface soil sample collected from the Thomas and Proetz property exceeds the DOE guideline concentration for radium-226. For all six vicinity properties surveyed, concentrations of uranium-238 range from less than 2 to 1,100 pCi/g. Radium-226 concentrations range from 0.5 to 300 pCi/g. Concentrations of thorium-232 and thorium-230 range from 0.8 to 160 and 0.9 to 2,100 pCi/g, respectively.

St. Louis Airport Site

Soil survey. ORNL performed radiological investigations at SLAPS and the surrounding area from 1976 through 1978. These investigations revealed elevated concentrations of uranium-238 and radium-226 in soil along and in the drainage ditches to the north and south of McDonnell Boulevard, probably from surface runoff from SLAPS (ORNL 1979).

In 1986, BNI conducted a radiological characterization of SLAPS to identify the radionuclides on the property in concentrations exceeding DOE guidelines and to determine the depths and areal limits of radioactive contamination. The subsurface investigation was conducted by drilling boreholes at most 33-m (100-ft) grid intersections; 102 boreholes were drilled. Wherever possible, continuous sampling was performed from the surface to undisturbed (natural) soil as identified by the field geologists. Surface soil samples were collected at 21 biased locations to help quantify conditions at the property perimeter and in the drainage ditches. These biased surface samples were analyzed for gamma-emitting radionuclides only.

This 1986 characterization indicated radioactive contamination at SLAPS extending to depths as great as 5.5 m (18 ft), with most contamination between 1.2 and 2.4 m (4 and 8 ft) (Figure 2-32). The volume of contaminated soil at SLAPS is 191,000 m^3 (250,000 yd^3). Soil sample analyses identified elevated levels of radium-226, uranium-238, thorium-232, and thorium-230 (BNI 1987a). These results are provided in Table 2-34.

External gamma radiation levels were measured as part of the quarterly sampling conducted for the environmental monitoring program. Levels at the property boundary have not changed notably since monitoring began in 1984. Annual averages are shown in Table 2-35.

Surface water and sediment survey. Additional information about radiological conditions at SLAPS has been obtained through the DOE environmental monitoring program conducted by BNI since 1984. The monitoring program has included quarterly collection of Coldwater Creek sediment

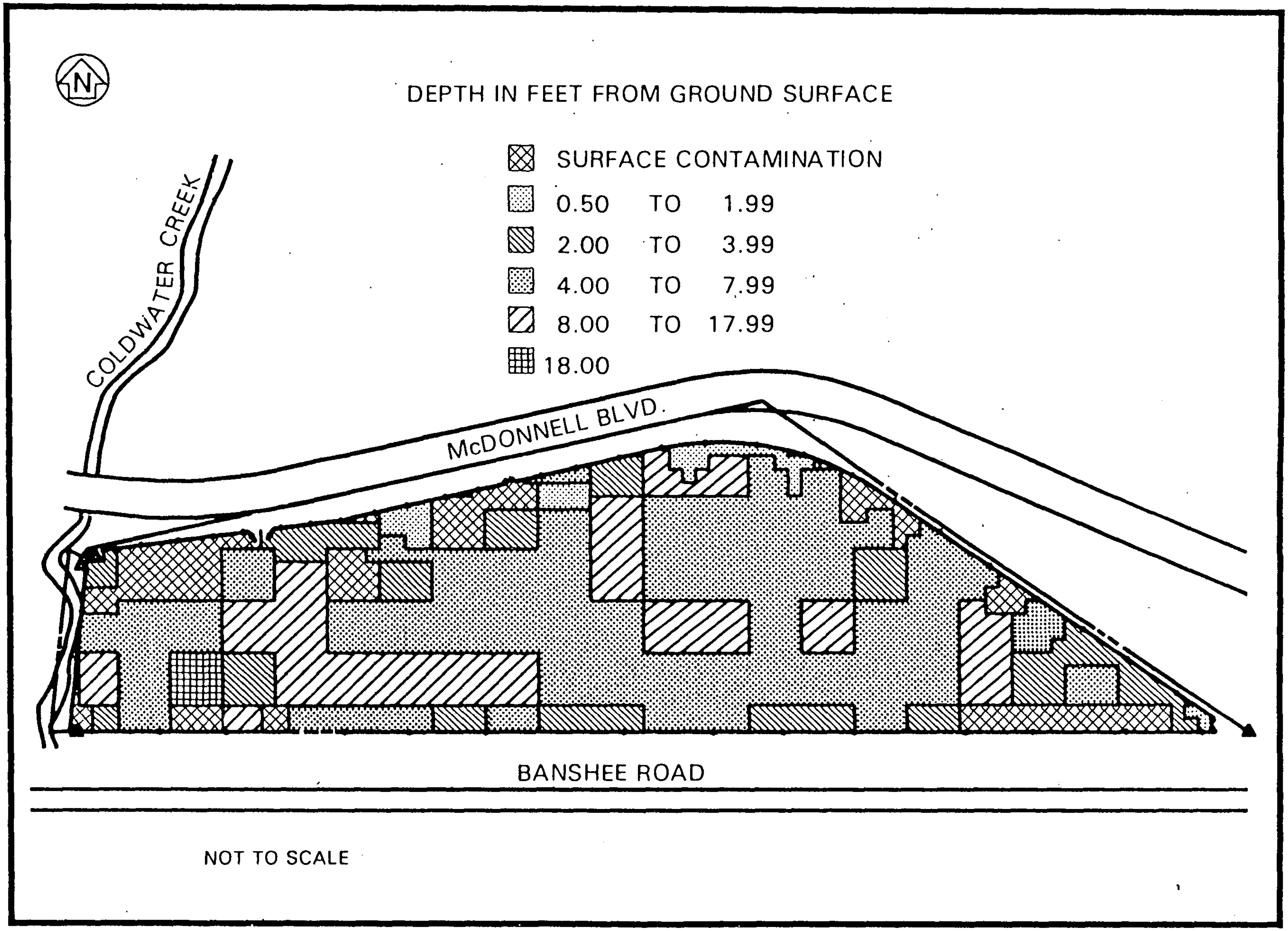

FIGURE 2-32 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT SLAPS

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TABLE 2-34

ANALYTICAL RESULTS FOR SOIL AT SLAPS

Concentration (pCi/g)							
U-238		Ra-226		Th-232		Th-230[b]	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
<3.0	1,600	<0.3	5,620	<0.5	63.0	0.6	2,600

[a]Results for surface and subsurface soil from all depths were included.

[b]It is probable that the maximum thorium-230 concentration on the property is much greater than indicated by analytical results because only those samples with no associated gamma-emitting radionuclides were analyzed for thorium-230.

Source: BNI 1987a.

TABLE 2-35

ANNUAL AVERAGE EXTERNAL GAMMA RADIATION

LEVELS AT SLAPS, 1984-1989

Sampling Location[a]	Radiation Level (mR/yr)[b]					
	1984	1985	1986	1987	1988	1989
1	59[c]	46	14	34	38	41
2	2157[c]	2087	1363	1557	1967	1938
3	115[c]	116	67	87	87	86
4	51[c]	57	21	38	29	57
5[d]	--	3	81	67	34	29
6	28[c]	41	10	35	35	32
7[d,e]	--	93	43	58	113	89
8[d]	--	12	17	25	29	34
9[f]	--	--	--	110	119	132
<u>Background</u>						
16[g]	--	99	97	77	73	61
17[h]	--	--	--	--	--	62[j]
18[i]	--	--	--	--	--	45[j]

[a]Sampling locations are shown in Figure 2-33.

[b]Measured background has been subtracted from the readings taken at the nine sampling locations shown in Figure 2-33.

[c]Sampling location installed in late 1984; data are for fourth quarter only.

[d]Sampling location established in early 1985.

[e]Station 7 is a quality control for station 3.

[f]Station 9 was established in April 1987.

[g]Located in Florissant, Mo., 24 km (15 mi) northeast of SLAPS.

[h]Located at McDonnell Blvd., 0.8 km (0.5 mi) east of SLAPS; installed in April 1988.

[i]Located at St. Charles County Airport, approximately 32 km (20 mi) southwest of SLAPS; installed in April 1988.

[j]Because of the measurement system operating parameters, data from these new locations were used for measurements in the last three quarters only.

<u>Source</u>: BNI 1985a,b; 1986a; 1987d; 1988a; 1989a; 1990c.

samples upstream and downstream of SLAPS (Figure 2-33). Results of sediment analyses from 1984 through 1989 are presented in Table 2-36; the measured values have been fairly consistent since 1984. These values are within the range of typical soil concentrations, which for uranium-238 is about 1 pCi/g.

The monitoring program has also included quarterly collection of surface water samples from four locations, including the nearest drinking water intake downstream of the property, the Chain of Rocks Water Treatment Plant on the Mississippi River (see Figure 2-33). Sampling points were established both upstream and downstream of the property to evaluate background conditions and to determine the effect of runoff from the property on surface water. Results are presented in Table 2-37; concentrations of total uranium have remained stable since 1984.

Groundwater investigations. A well canvass was conducted in March 1989 to identify and investigate wells within a 4.8-km (3-mi) radius of SLAPS and HISS. The appropriate state and local agencies were contacted first, followed by door-to-door interviews within the designated area. Interviews were supplemented by review of permit records (permitting of water wells has been required since January 1987). The canvass identified eight wells within the area, none of which is used as a source of drinking water. Four of the wells have been used for irrigation; one is capped and no longer used, and the other three are low-yield wells. One industrial well, drilled in 1988, supplies water for cleaning septic tanks. One domestic well was capped in 1962, and another has not been used since 1968. A hand-dug well dating back to the 1820s has not been used for the last 10 years. Figure 2-34 shows the locations of the wells identified in the 1989 canvass.

Groundwater samples have also been collected quarterly from 16 on-site monitoring wells (Figure 2-33); Table 2-38 presents the results of groundwater analyses from 1984 to 1989. The locations of the background monitoring wells are shown in Figure 2-35. The wells are located adjacent to old ball fields along Byassee Drive. The surrounding area is industrialized with no residential properties within the immediate vicinity. In several shallow wells, the measured values of uranium concentrations are considerably higher than those occurring naturally in groundwater and the proposed Uranium Mill Tailings Radiation Control Act [a potential ARAR (40 CFR 192)] guideline, probably because the shallow wells are in an area of known subsurface contamination. However, all measured values have been relatively consistent over the years and between wells, which could suggest that no horizontal migration of radionuclides in groundwater is occurring.

Air investigations. Radon-222 levels are measured quarterly as part of the environmental monitoring program. Since 1984, radon levels have fluctuated some in all locations but one;

2-110

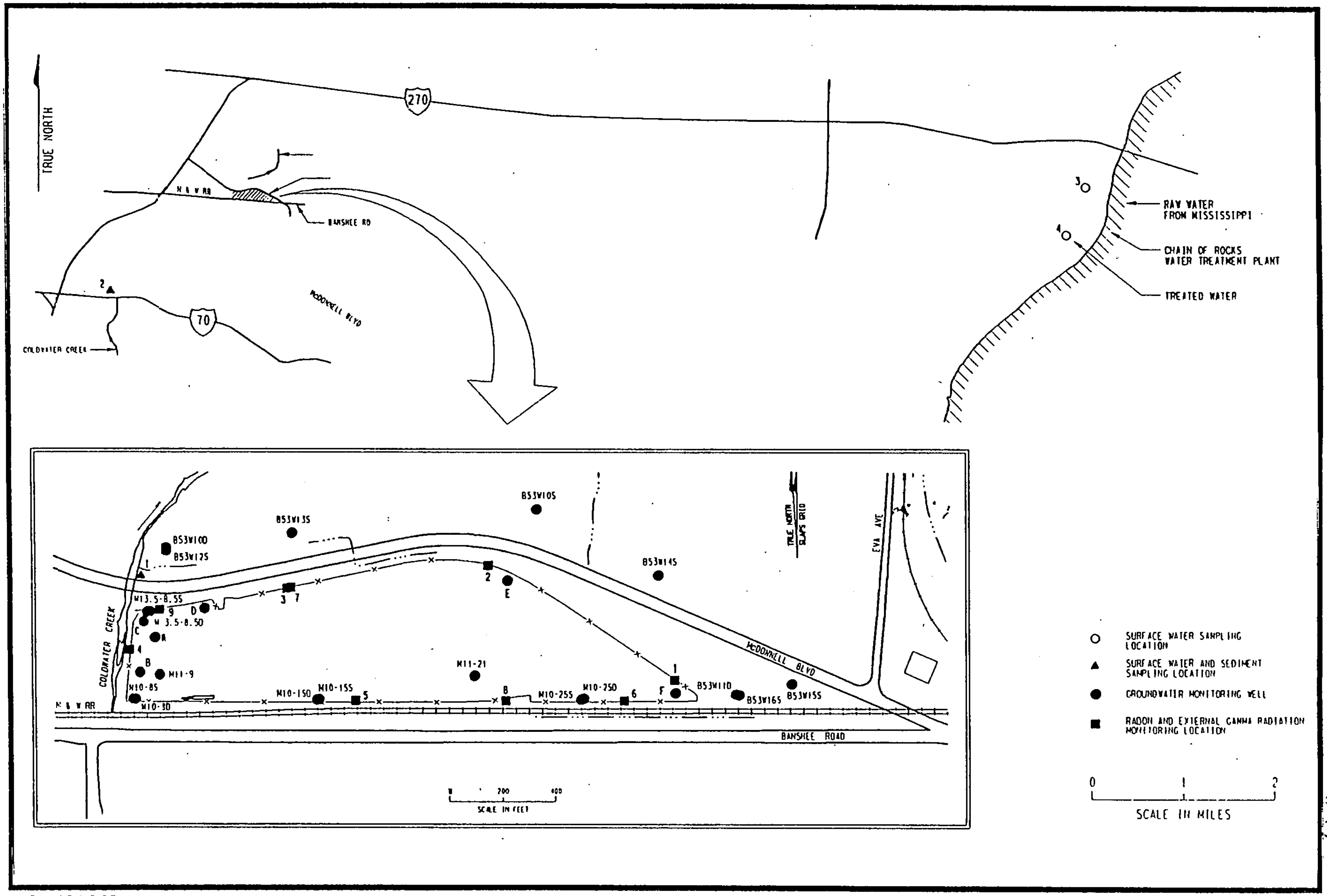

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FIGURE 2-33 LOCATIONS OF ENVIRONMENTAL MONITORING STATIONS AT SLAPS

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TABLE 2-36

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM, RADIUM-226, AND THORIUM-230 IN SEDIMENT IN THE VICINITY OF SLAPS, 1984-1989

Sampling Location[a]	Concentration [pCi/g (dry)] 1984	1985	1986	1987[b]	1988	1989
Radium-226						
1	0.1	1.9	1.2	1.4	1.0	1.2
2	0.3	2.6	1.1	1.0	1.5	1.2
Thorium-230						
1	15	43.6[c]	1.0	1.3	5.4	2.9
2	1.2	0.7	1.2	1.4	1.3	0.8
Uranium-234						
1	1.6	3.7	0.8	0.6	1.2	1.2
2	0.6	0.6	0.9	0.8	0.9	0.9
Uranium-235						
1	0.07	0.2	0.05	<0.05	<0.1	0.1
2	0.04	0.05	0.06	0.06	<0.1	<0.1
Uranium-238						
1	1.5	3.7	1.2	0.6	1.3	1.2
2	0.6	0.5	1.6	0.7	0.7	0.9
Total Uranium[d]						
1	3.2	7.6	2.0	1.3	2.6	2.5
2	1.2	1.1	2.6	1.6	1.7	1.9

[a]Sampling locations are shown in Figure 2-33. Location 1 is downstream and location 2 is upstream of SLAPS.

[b]Third-quarter samples were lost in shipment.

[c]The maximum value obtained for the first quarter sample, 170.0 pCi/g, is inconsistent with other measured values. Special follow-up sampling on 7/10/85 and 8/28/85 showed 1.5 and 5.6 pCi/g, respectively.

[d]Total uranium concentration for each location is determined by summing the measured concentrations of each uranium isotope for the respective location.

Source: BNI 1985a,b; 1986a; 1987d; 1988a; 1989a; 1990c.

TABLE 2-37

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM, RADIUM-226, AND THORIUM-230 IN SURFACE WATER IN THE VICINITY OF SLAPS, 1984-1989

Sampling Location[a]	Concentration (pCi/L)					
	1984	1985	1986	1987	1988	1989
Total Uranium						
1	14.0	3.4	4.3	4.2	4.0	4.6
2[b]	4.0	<3.0	<3.0	<3.0	4.0	<3.4
3	--[c]	<3.0	<3.0	<4.0	4.0	4.3
4	--[c]	<3.0	3.5	<4.0	3.0	4.1
Radium-226						
1	0.2	0.2	0.2	0.4	0.3	0.3
2[b]	0.1	0.1	0.3	0.3	0.5	0.3
3	--[c]	0.2	0.2	0.3	0.3	0.4
4	--[c]	0.1	0.2	0.3	0.2	0.3
Thorium-230						
1	0.1	0.4	<0.2	0.4	0.3	0.3
2[b]	0.36	<0.4	<0.2	0.2	0.1	0.1
3	--[c]	<0.5	0.3	0.3	0.3	<0.1
4	--[c]	<0.4	<0.2	<0.2	<0.1	0.2

[a]Sampling locations are shown in Figure 2-33.

[b]Location is upstream from the property and acts as background. Background values have not been subtracted.

[c]Sampling locations 3 and 4 were added in 1985.

Source: BNI 1985a,b; 1986a; 1987d; 1988a; 1989a; 1990c.

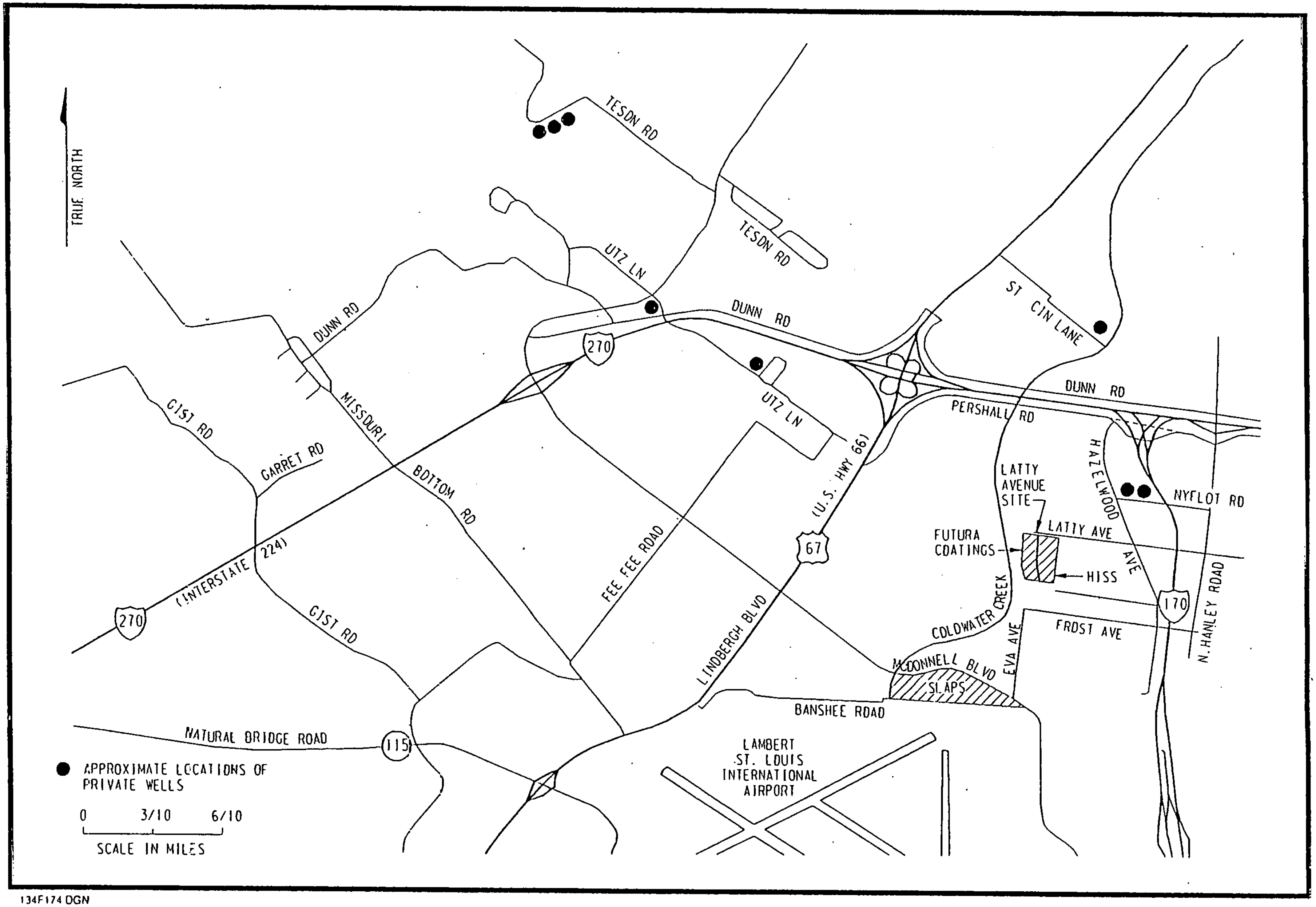

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FIGURE 2-34 LOCATIONS OF PRIVATE WELLS IN THE SLAPS VICINITY

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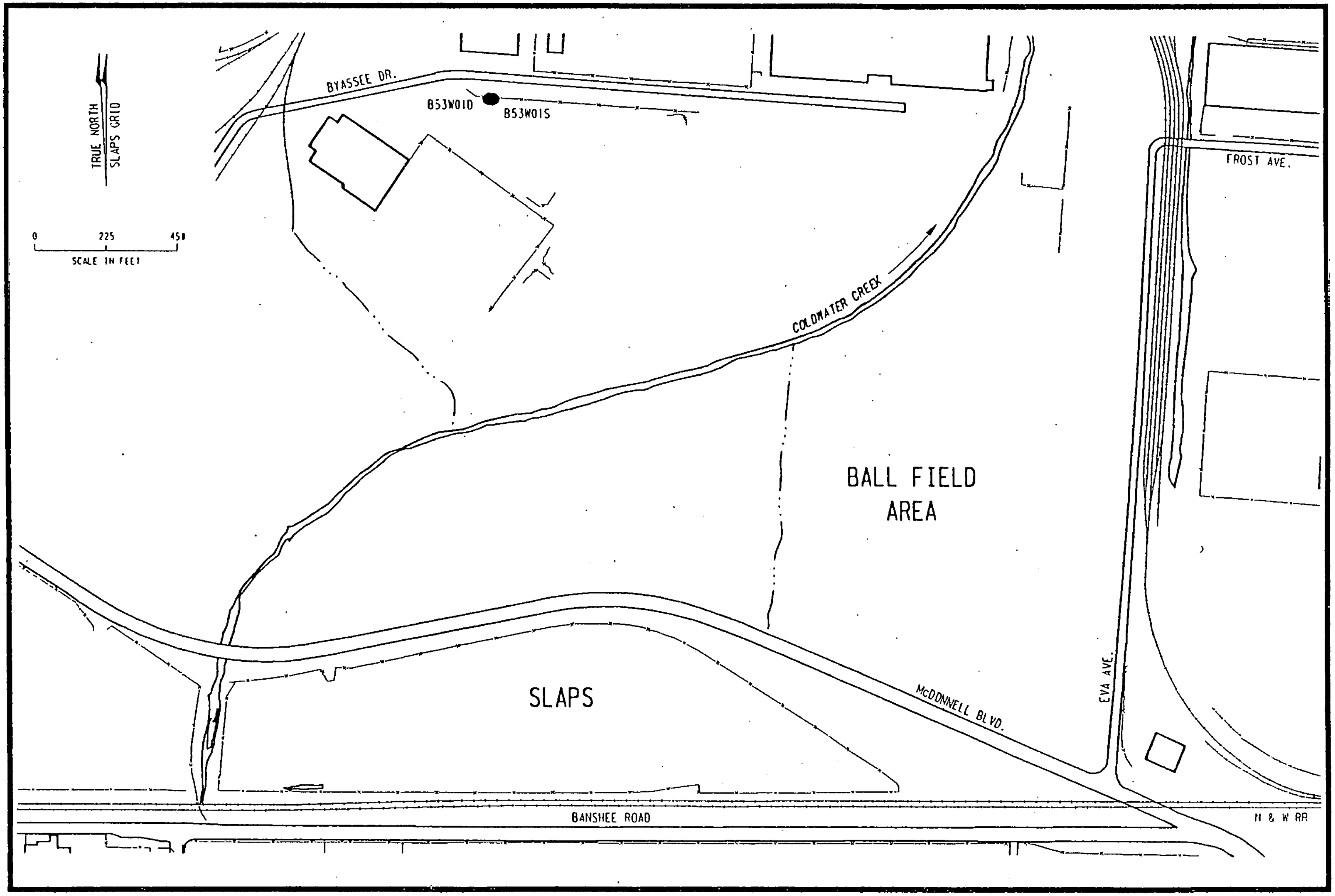

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FIGURE 2-35 BACKGROUND GROUNDWATER SAMPLING LOCATIONS FOR SLAPS

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TABLE 2-38

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM, RADIUM-226, AND THORIUM-230 IN GROUNDWATER AT SLAPS, 1984-1989

Sampling Location[a,b]	Concentration (pCi/L) 1984	1985	1986	1987	1988	1989
Total Uranium						
Well A	1287	2375	1184	1139	1700	2065
Well B	5700	4735	6570	5829	5590	5281
Well C	40	36	16	13	18	20
Well D	233	474	802	637	475	773
Well E	129	114	540	576	197	819
Well F[c]	141	177	146	106	265	266
Well M10-25S	--	--	--	25	39	33
Well M10-25D	--	--	--	4	4	3
Well M11-21	--	--	--	45	73	96
Well M10-15S	--	--	--	11	9	11
Well M10-15D	--	--	--	9	5	<3
Well M10-8S	--	--	--	32	19	21
Well M10-8D	--	--	--	5	4	5
Well M11-9	--	--	--	4578	4620	4807
Well M13.5-8.5S	--	--	--	4	4	3
Well M13.5-8.5D	--	--	--	<3	<3	<3
Background[d]						
Well B53W01S	--	--	--	--	3	<3
Well B53W01D	--	--	--	--	4	<3
Radium-226						
Well A	0.3	0.2	0.3	0.3	0.4	0.4
Well B	0.3	0.3	0.4	0.3	0.6	0.6
Well C	0.3	0.2	0.3	0.4	0.5	0.5
Well D	0.2	0.1	0.3	0.1	0.3	0.5
Well E	0.6	0.2	0.5	0.3	0.6	0.6
Well F[c]	0.2	0.1	0.2	0.3	0.6	0.4
Well M10-25S	--	--	--	0.2	0.6	0.5
Well M10-25D	--	--	0.2	0.4	0.7	0.7
Well M11-21	--	--	--	0.5	0.7	0.7
Well M10-15S	--	--	--	0.3	0.8	0.4
Well M10-15D	--	--	--	0.4	0.9	0.9
Well M10-8S	--	--	--	0.4	0.5	0.4

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TABLE 2-38

(continued)

Sampling Location[a,b]	Concentration (pCi/L) 1984	1985	1986	1987	1988	1989
Radium-226 (continued)						
Well M10-8D	--	--	--	0.3	0.6	0.6
Well M11-9	--	--	--	0.5	0.8	0.5
Well M13.5-8.5S	--	--	--	0.5	0.8	0.5
Well M13.5-8.5S	--	--	--	0.5	0.6	0.6
Background[d]						
Well B53W01S	--	--	--	--	0.6	0.7
Well B53W01D	--	--	--	--	1.1	1.0
Thorium-230						
Well A	9.5	2.3	<0.4	0.8	2.8	2.9
Well B	0.3	0.3	1.2	1.4	2.0	1.1
Well C	0.2	0.2	0.2	0.9	0.3	0.1
Well D	0.9	1.3	0.3	0.9	0.9	1.4
Well E	0.3	1.0	0.4	0.9	4.8	1.7
Well F[c]	0.4	1.1	0.2	1.7	2.0	0.8
Well M10-25	--	--	--	0.2	0.4	0.1
Well M10-25D	--	--	--	<0.8	0.5	0.8
Well M11-21	--	--	--	15.2	52.0	11.0
Well M10-15S	--	--	--	1.8	5.3	1.3
Well M10-15D	--	--	--	0.4	1.3	1.1
Well M10-8S	--	--	--	0.2	0.5	0.3
Well M10-8D	--	--	--	<0.1	0.3	0.3
Well M11-9	--	--	--	0.3	1.0	0.8
Well M13.5-8.5S	--	--	--	0.4	0.7	0.2
Well M13.5-8.5D	--	--	--	<0.1	0.7	0.6
Background[d]						
Well B53W01S	--	--	--	--	0.2	0.3
Well B53W01D	--	--	--	--	0.2	0.4

[a]Sampling locations are shown in Figure 2-33, and background locations are located at Byassee Road, approximately 2.4 km (1.5 mi) southwest of the Latty Avenue Properties.
[b]The "M" wells were added to the environmental monitoring program in April 1987.
[c]Upgradient well.
[d]Wells established for background in July 1988.

Source: BNI 1985a,b; 1986a; 1987d; 1988a; 1989a; 1990c.

however, they have remained below the DOE guideline of 3.0 pCi/L for uncontrolled sites (DOE 1990a). In several instances, however, the Missouri radon limit of 1 pCi/L [19 Code of State Regulations (CSR) 20] has been exceeded. Radon concentrations along the northern boundary of the property are heavily influenced by soil moisture and the presence or absence of standing water in the ditch abutting the fenceline. Standing water could account for lower radon-222 levels during some years, and dry conditions could cause higher readings at other times. Annual averages are shown in Table 2-39.

SLAPS vicinity properties

The SLAPS vicinity properties include Banshee Road; ditches to the north and south of SLAPS; a portion of the property south of SLAPS owned by the St. Louis Airport Authority; the City of St. Louis property to the north of SLAPS, known as the ball field area; the haul roads and vicinity properties; Coldwater Creek and vicinity properties; and the Norfolk and Western railroad properties. The locations of these properties are shown in Figures 2-36, 2-37, and 2-38. Radiological characterization of these properties was necessary to define the magnitude and boundaries of contamination and evaluate disposal alternatives.

Banshee Road. Forty-eight boreholes were drilled through Banshee Road, which forms the southern boundary of SLAPS, during the radiological characterization. Downhole gamma logging was performed in 47 of these boreholes to determine the general depth of contamination from gamma-emitting radionuclides. Gamma logging was conducted by lowering an unshielded NaI(Tl) detector into the hole and recording the count rate as a function of depth. No significant variations in count rates were observed as gamma logging progressed in the boreholes. Downhole gamma logging data were used for selection and analysis of soil samples to determine radionuclide concentrations. Analytical results for soil revealed two small areas with elevated concentrations of thorium-230 to a depth of 0.3 m (1 ft) (Figure 2-39). Concentrations of uranium-238, radium-226, thorium-232, and thorium-230 range from 1 to 46, 0.8 to 7, 0.6 to 7, and 0.4 to 34 pCi/g, respectively (BNI 1990b).

Ditches to the north and south of SLAPS. In 1982, BNI performed a radiological survey of the drainage ditches and portions of Coldwater Creek to establish the vertical and horizontal limits of uranium-238 and radium-226 contamination (BNI 1983). In 1986, a radiological investigation of the SLAPS ditches was conducted to determine the depths and areal limits of radioactive

TABLE 2-39

ANNUAL AVERAGE CONCENTRATIONS OF RADON-222

AT SLAPS, 1984-1989

Sampling Location[a]	Concentration (pCi/L)[b]					
	1984	1985	1986	1987	1988	1989
1	0.1	0.5	0.4	1.6	1.1	0.5
2	0.5	1.2	3.5	3.6	1.2	2.0
3	0.3	0.8	0.8	0.7	1.0	0.8
4	0.6	0.4	0.9	0.8	1.0	0.7
5[c]	--	0.8	0.6	2.1	2.1	1.0
6	0.4	0.5	0.6	0.5	0.8	0.6
7[c]	--	0.5	0.7	0.8	0.7	0.9
8[c]	--	1.0	0.7	1.3	1.8	1.8
9[d]	--	--	--	3.1	1.0	0.6
Background						
16[e]	--	0.5	0.3	0.4	0.4	0.5
17[f]	--	--	--	--	0.4	0.5
18[g]	--	--	--	--	0.5	0.6

[a]Sampling locations are shown in Figure 2-33.

[b]Background level has not been subtracted.

[c]Detector installed in 1985.

[d]Detector installed in April 1987.

[e]Background detector installed in 1985 in Florissant, Mo., approximately 24 km (15 mi) northeast of SLAPS.

[f]Background detector installed in April 1988 at McDonnell Blvd., approximately 0.8 km (0.5 mi) east of SLAPS.

[g]Background detector installed in April 1988 in St. Charles County, approximately 32 km (20 mi) southwest of SLAPS.

Source: BNI 1985a,b; 1986a; 1987d; 1988a; 1989a; 1990c.

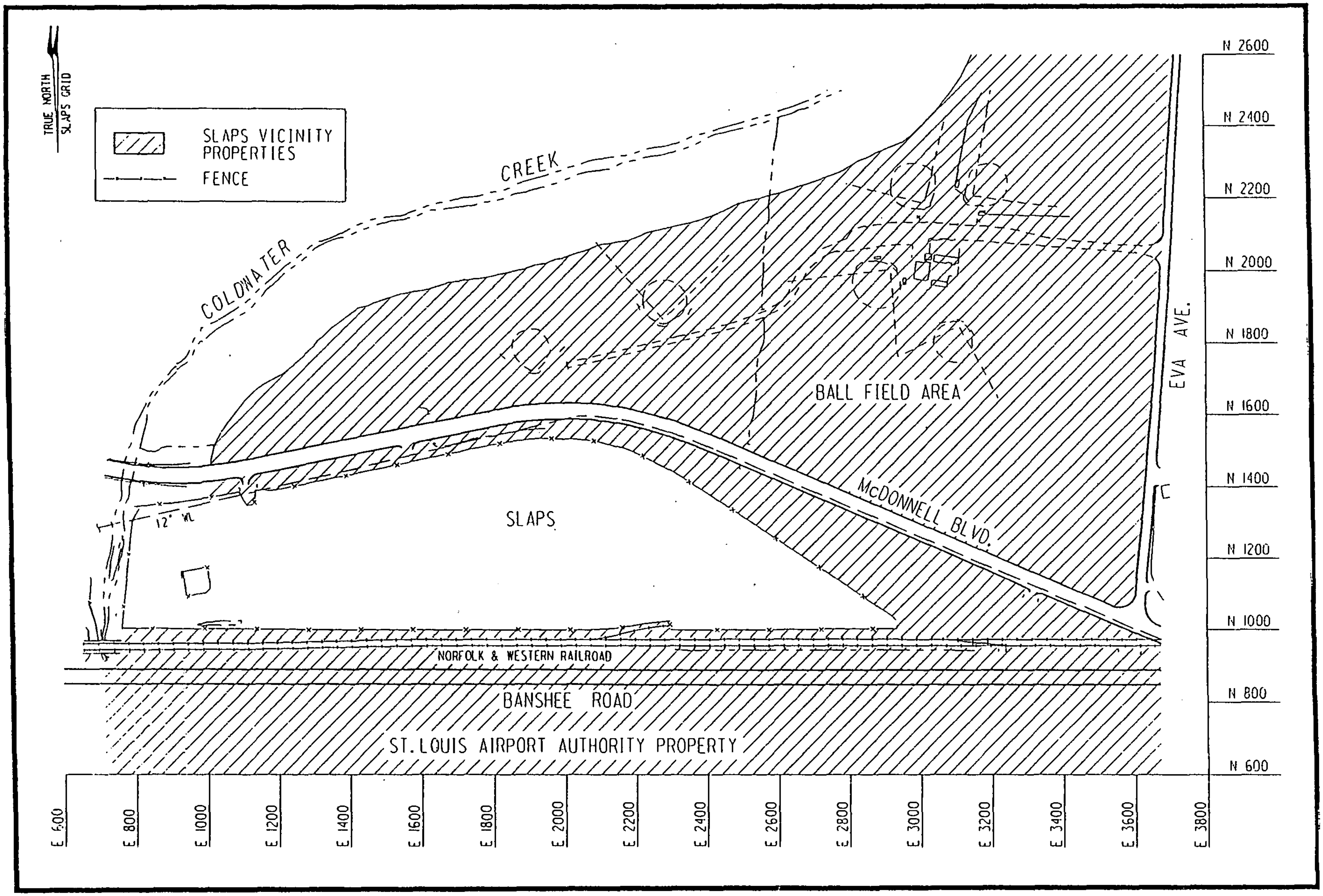

FIGURE 2-36 LOCATIONS OF SLAPS AND VICINITY PROPERTIES

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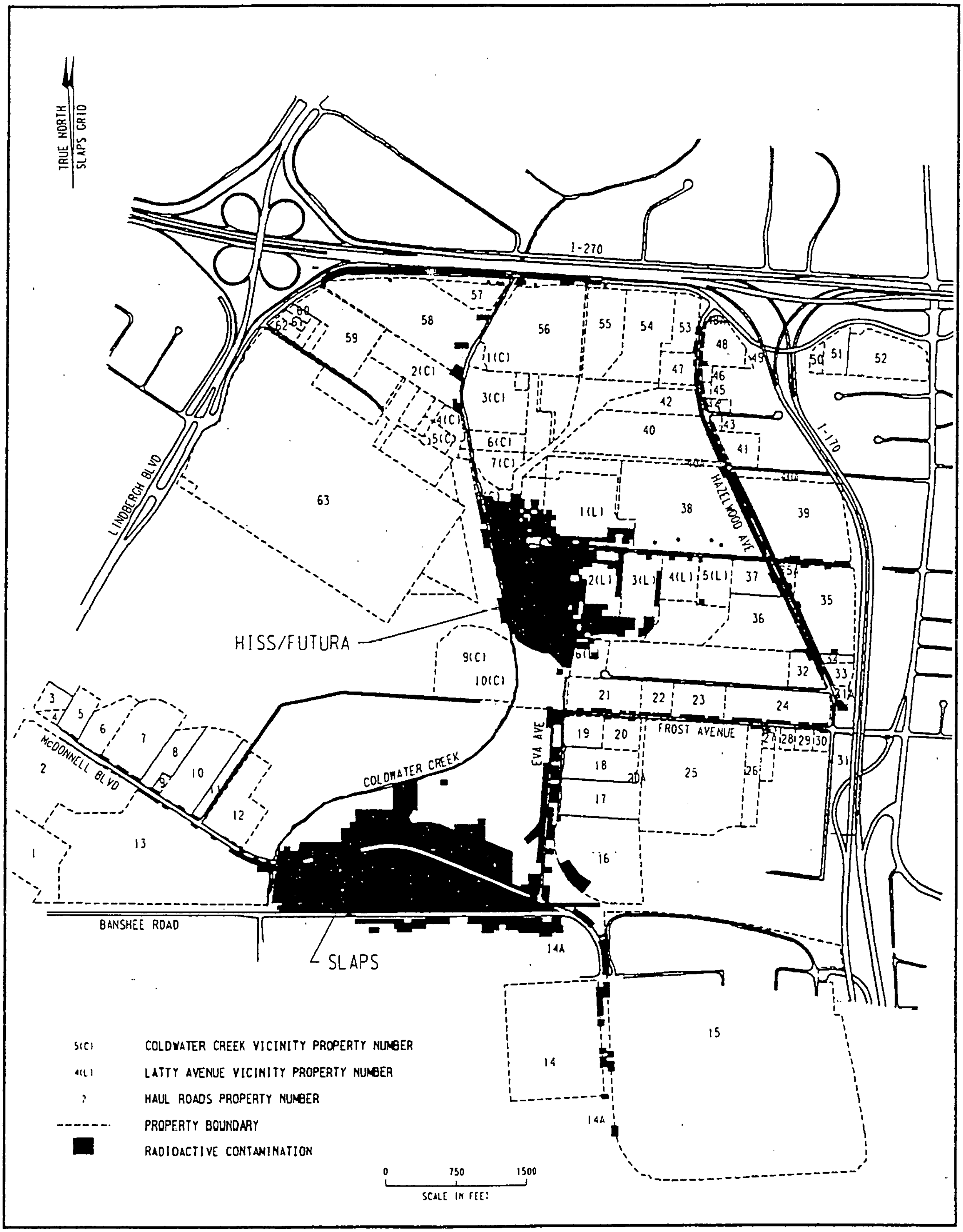

FIGURE 2-37 LOCATIONS OF THE HAUL ROADS AND ASSOCIATED VICINITY PROPERTIES

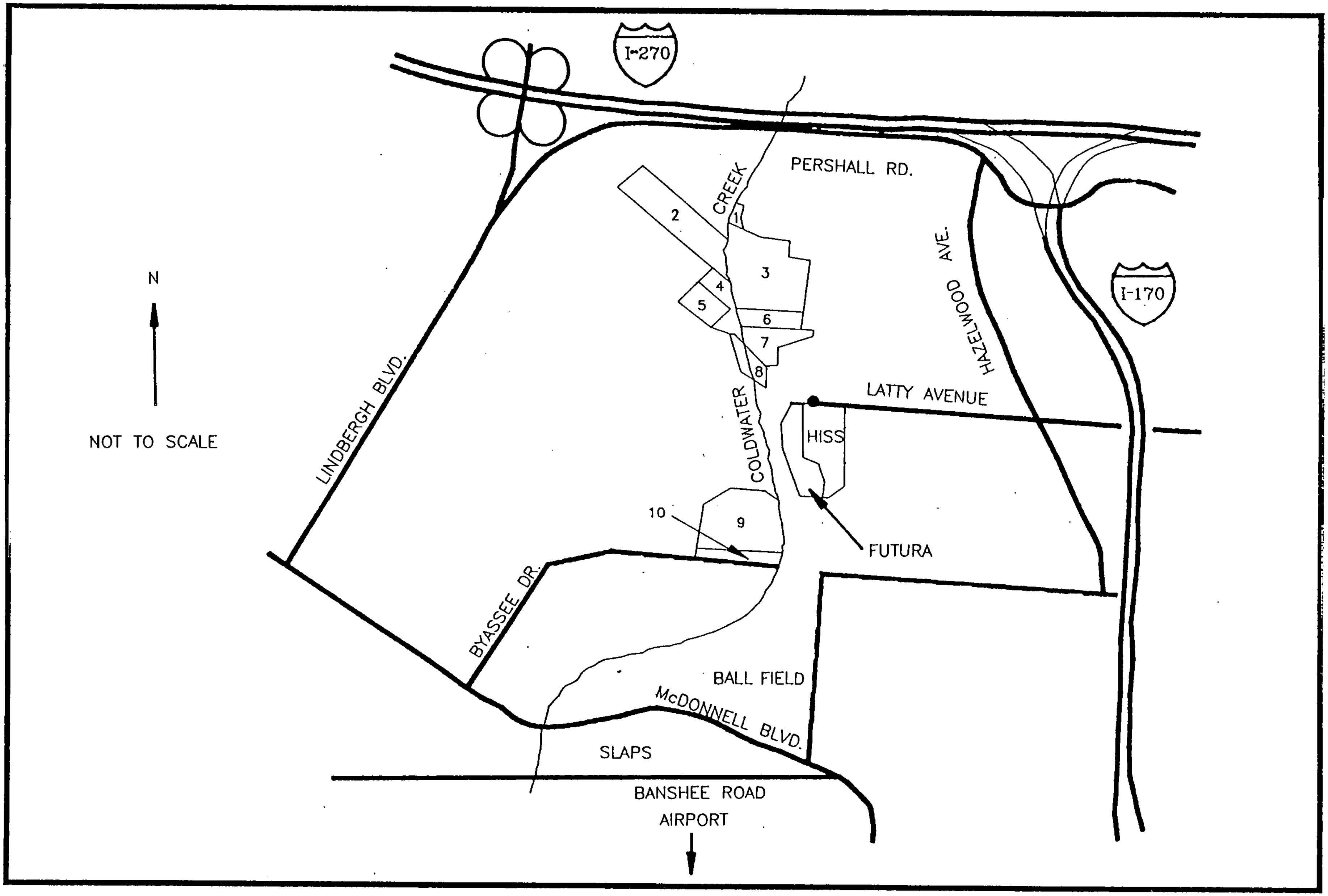

FIGURE 2-38 LOCATIONS OF THE COLDWATER CREEK VICINITY PROPERTIES

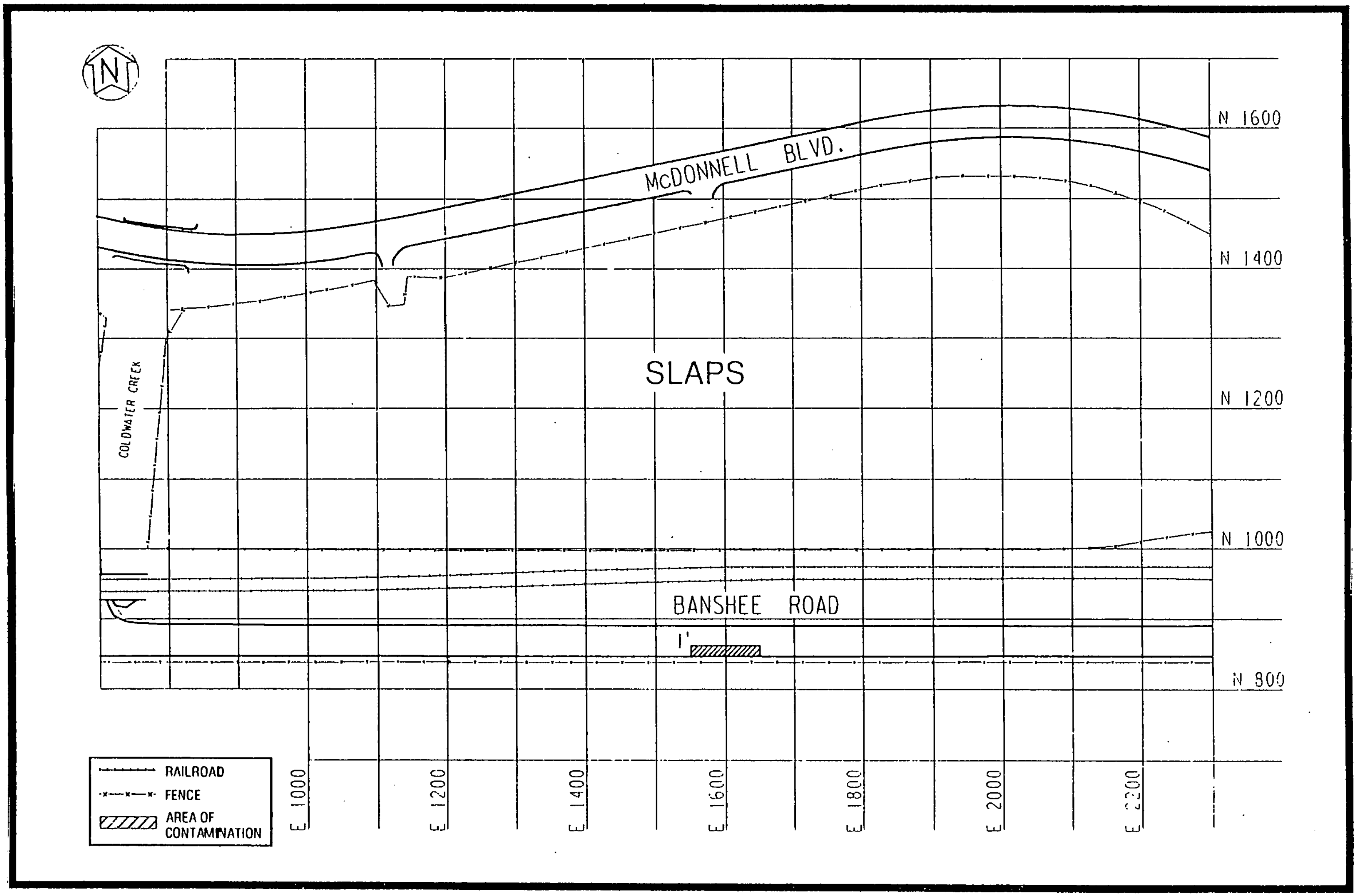

FIGURE 2-39 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT BANSHEE ROAD

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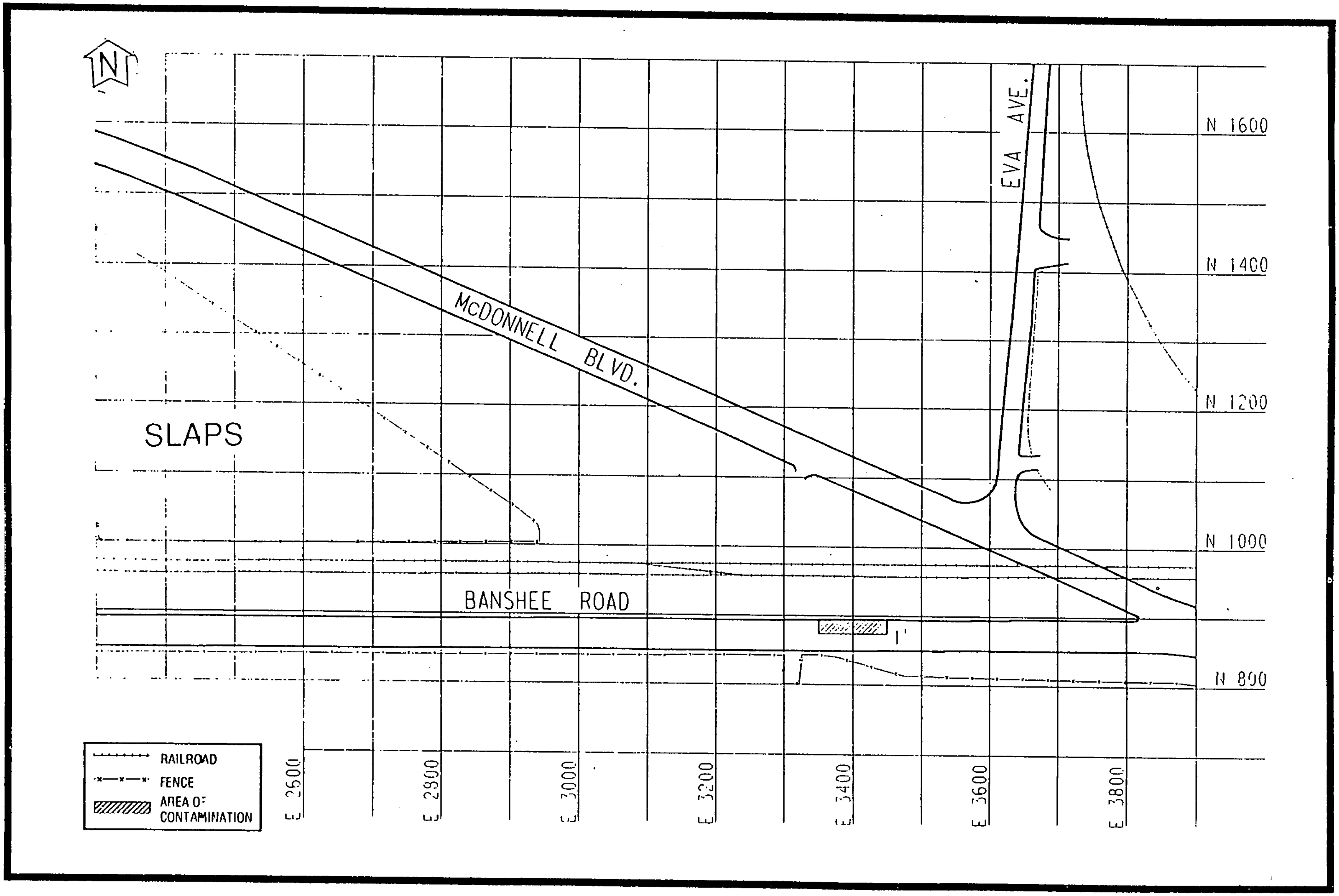

FIGURE 2-39 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT BANSHEE ROAD (CONT.)

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contamination. Near-surface gamma radiation measurements were taken at the SLAPS ditches to identify areas with radionuclide concentrations exceeding DOE guidelines. Eighty-six subsurface and 125 surface locations were sampled at the property. Downhole gamma logging was performed in the augered holes and boreholes to determine the general depth of gamma-emitting radionuclides. Significant variations in count rates at ten locations were observed as gamma logging progressed at the SLAPS ditches, indicating contamination from gamma-emitting radionuclides. Analytical results for soil revealed areas with elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. Essentially all the ditch area north and south of SLAPS is contaminated; contamination ranges in depth from 0 to 4.3 m (0 to 14 ft) (see Figure 2-40). The 4.3-m (14-ft) depth of contamination occurred at one location. Thorium-230 was identified as the major contaminant. Concentration ranges of uranium-238, radium-226, thorium-232, and thorium-230 are less than 1 to 94, 0.7 to 130, 0.7 to 6, and 0.9 to 15,000 pCi/g, respectively (BNI 1990b).

St. Louis Airport Authority property. A portion of the property owned by the St. Louis Airport Authority was surveyed to determine the areal and vertical extent of radioactive contamination to the south of SLAPS. Seventy surface and 65 subsurface locations were characterized for radioactive contamination. Near-surface gamma radiation measurements were taken, and downhole gamma logging was performed in the boreholes. No significant variations in count rates were observed as gamma logging progressed. Soil samples were collected and analyzed for radioactive constituents; analytical results indicate that radioactive contamination on the airport property south of SLAPS extends to a depth of 1.2 m (4 ft) at two locations. Several areas on the airport property exhibit radioactive contamination. In general, the contamination on this property is shallow [0.6 m (2 ft)] and extends the length of SLAPS. Analytical results for soil revealed areas with elevated concentrations of thorium-230 in surface samples. All uranium-238 concentrations are less than 11 pCi/g. Concentrations of radium-226, thorium-232, and thorium-230 range from 0.8 to 3.3, 0.8 to 5, and less than 0.7 to 58 pCi/g, respectively. Figure 2-41 shows areas and depths of contamination at the Airport Authority property (BNI 1990b).

Ball field area. This property north of SLAPS is leased to the City of Berkeley by the City of St. Louis. Near-surface gamma radiation measurements were taken and downhole gamma logging was performed in the augered holes. No significant variations in count rates were observed as gamma logging progressed in the augered holes. Approximately 680 soil samples were collected from the ball field area; analytical results revealed areas with elevated concentrations of radium-226 in surface samples and thorium-230 in surface and subsurface samples. Based on soil sampling results

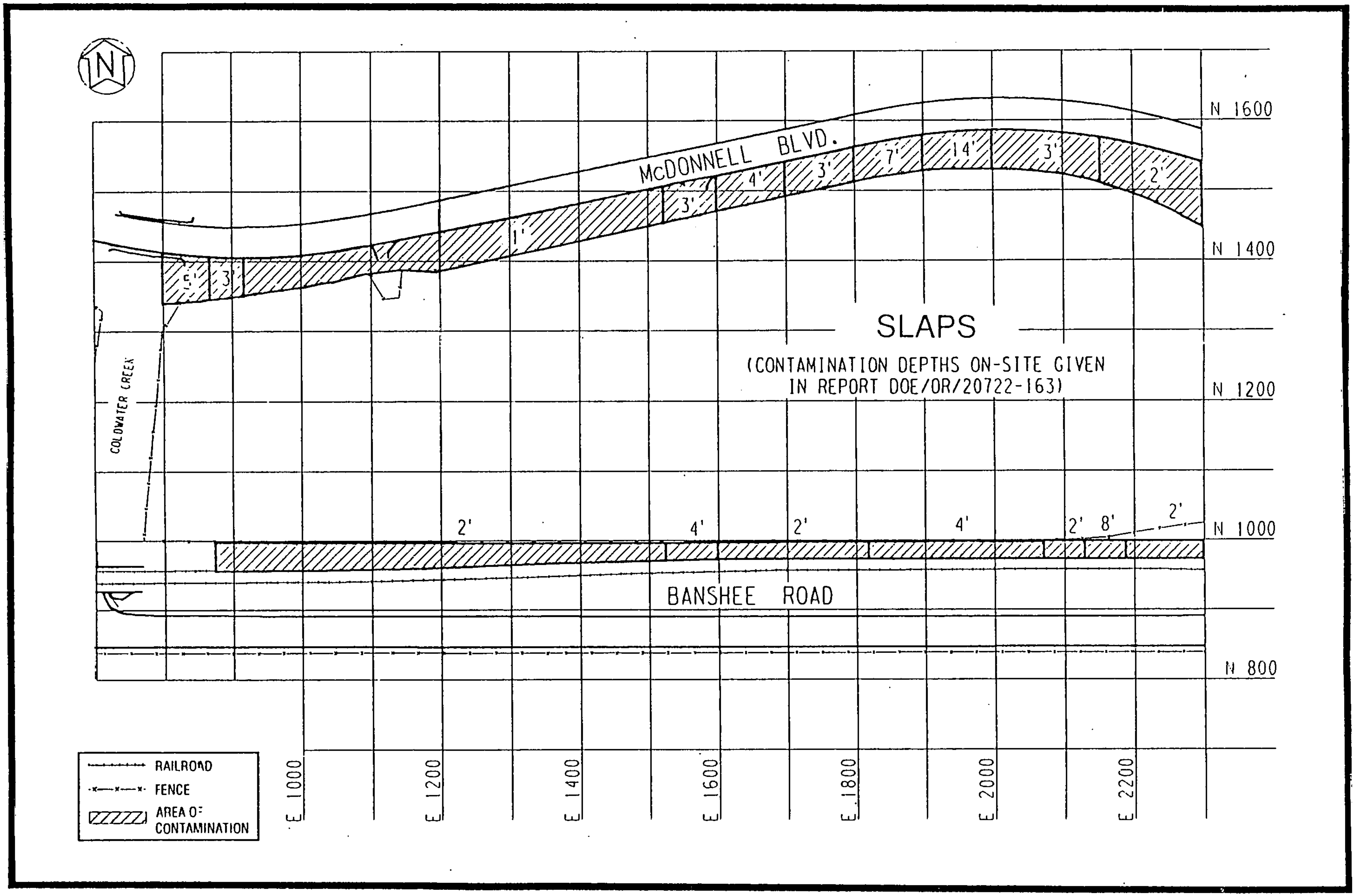

FIGURE 2-40 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE DITCHES TO THE NORTH AND SOUTH OF SLAPS

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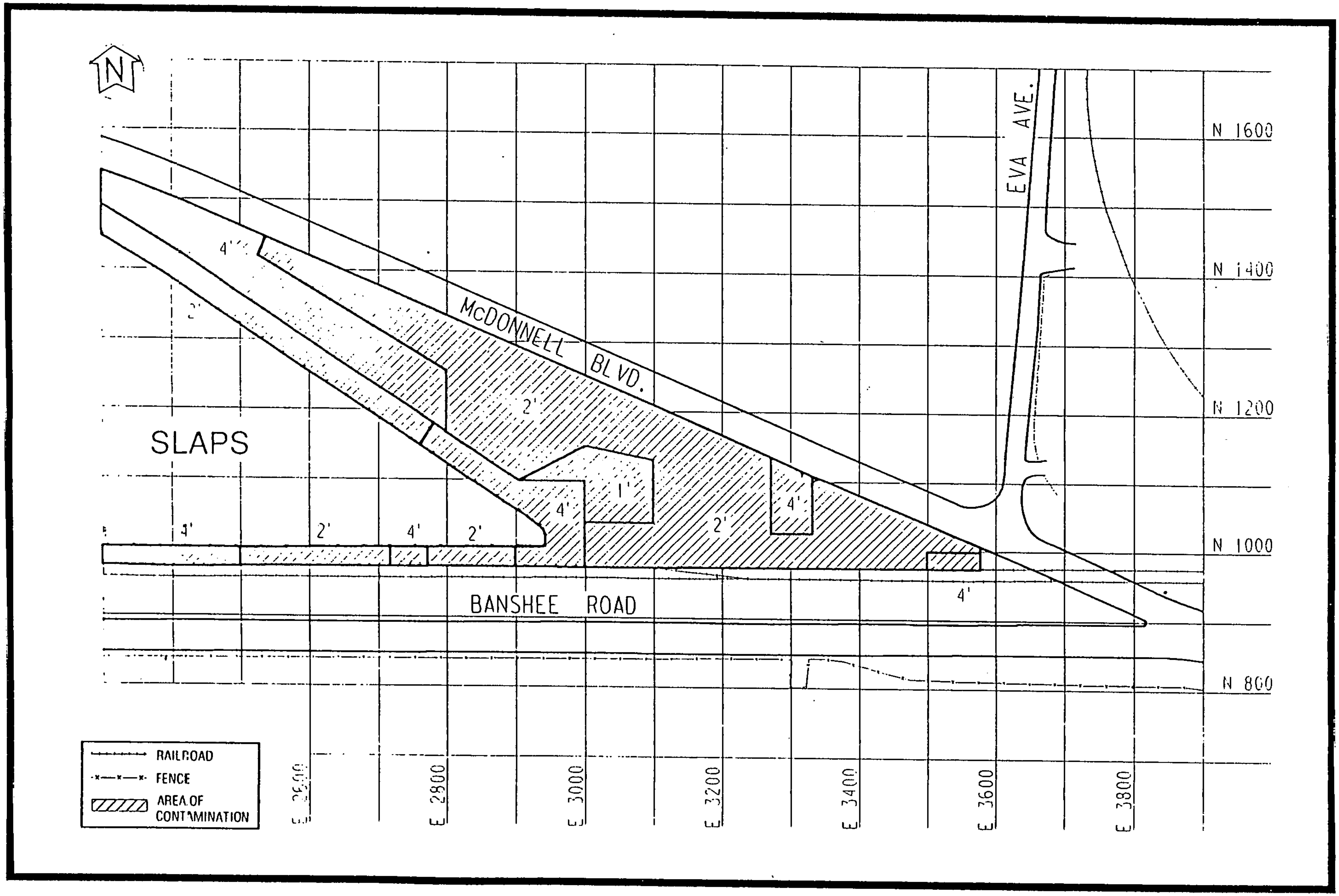

FIGURE 2-40 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE DITCHES TO THE NORTH AND SOUTH OF SLAPS (CONT.)

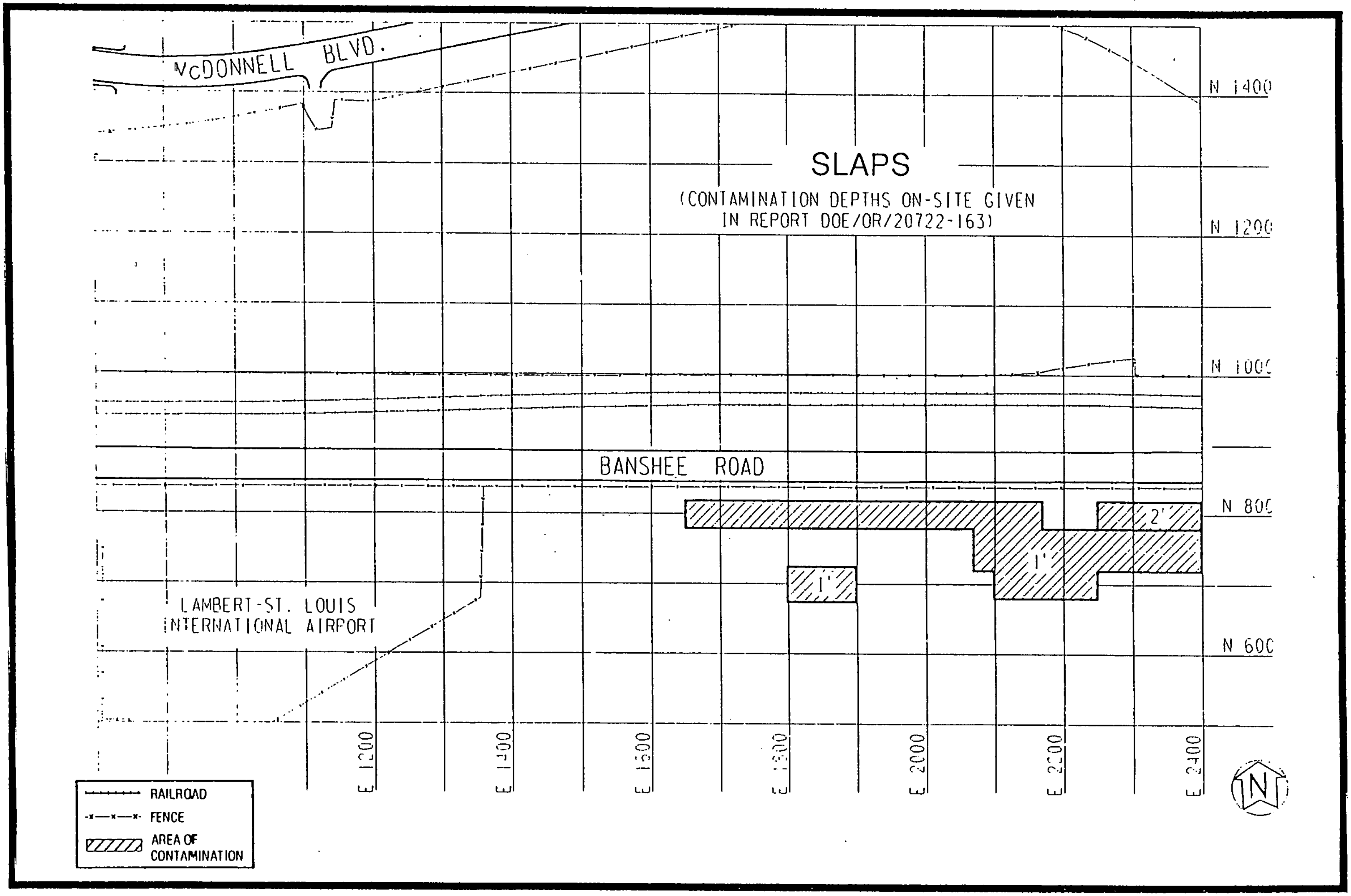

FIGURE 2-41 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE ST. LOUIS AIRPORT AUTHORITY PROPERTY

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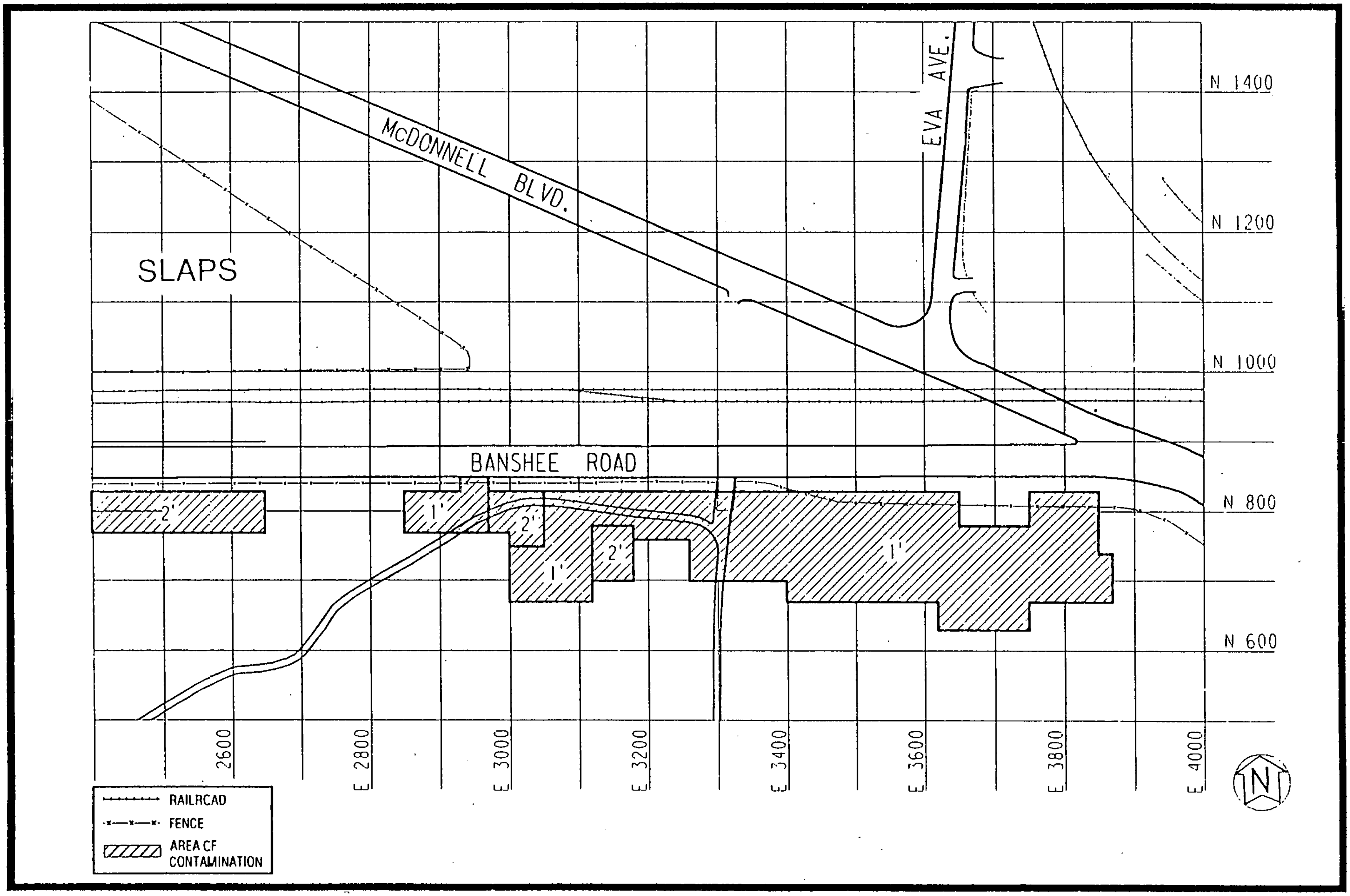

FIGURE 2-41 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE ST. LOUIS AIRPORT AUTHORITY PROPERTY (CONT.)

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for the ball field, radioactive contamination averages 0.3 m (1 ft) in depth over the first 45.7 to 61 m (150 to 200 ft) along the northern edge of McDonnell Boulevard (Figure 2-42). Thorium-230 was identified as the primary contaminant. The infield areas of the ball fields showed no contamination. Concentrations of uranium-238, radium-226, thorium-232, and thorium-230 range from less than 3 to 42, less than 5 to 190, 0.6 to 5, and less than 0.1 to 200 pCi/g, respectively (BNI 1990b).

Haul roads and associated vicinity properties. In December 1984, ORNL conducted a mobile gamma scanning survey of potential transportation routes to and from the Latty Avenue Properties and West Lake Landfill (ORNL 1985). Preliminary surveys conducted along these roads showed no radionuclide concentrations in excess of DOE guidelines for surface soil. In addition, ORNL conducted a mobile gamma scan on the haul roads between SLAPS and the Latty Avenue Properties. Anomalies were detected on McDonnell Boulevard, Hazelwood Avenue, and Pershall Road. BNI conducted additional sampling along these roads and Latty Avenue, Eva Avenue, and Frost Avenue to detect the presence of radionuclides exceeding DOE guidelines; analytical results showed thorium-230 to be the major contaminant (BNI 1990b). Radiological characterization included collecting soil samples from the shoulders of the haul roads and approximately 45.7 m (150 ft) onto adjacent properties bordering these roads. Samples from underneath the pavement were collected from Pershall Road, McDonnell Boulevard, and Latty Avenue. In addition to discrete samples, composite samples were collected and considered contaminated if activity for any radionuclide was greater than 2 pCi/g. Soil samples were composited as an initial step to determine whether the shoulders of the haul roads were contaminated. A summary of the characterization results is given in Table 2-40. Because only properties adjacent to Eva Avenue and Frost Avenue (not the roads themselves) were characterized, they are not included in Table 2-32. In general, radioactive contamination is present in some areas under Latty Avenue, McDonnell Boulevard, and Pershall Road and along both sides of Hazelwood Avenue, Pershall Road, and Eva Avenue. Contamination is primarily on the northern side of Frost Avenue. Figure 2-43 shows areas of contamination at the haul roads. Summary results for the haul roads include the following:

- Latty Avenue: Of 954 samples analyzed, no results showed concentrations of uranium-238 greater than 50 pCi/g; 1 sample showed radium-226 greater than 5 pCi/g; no result for thorium-232 was greater than 5 pCi/g; and of the 1,006 samples analyzed for thorium-230, concentrations in 82 were greater than 5 pCi/g (BNI 1990b).

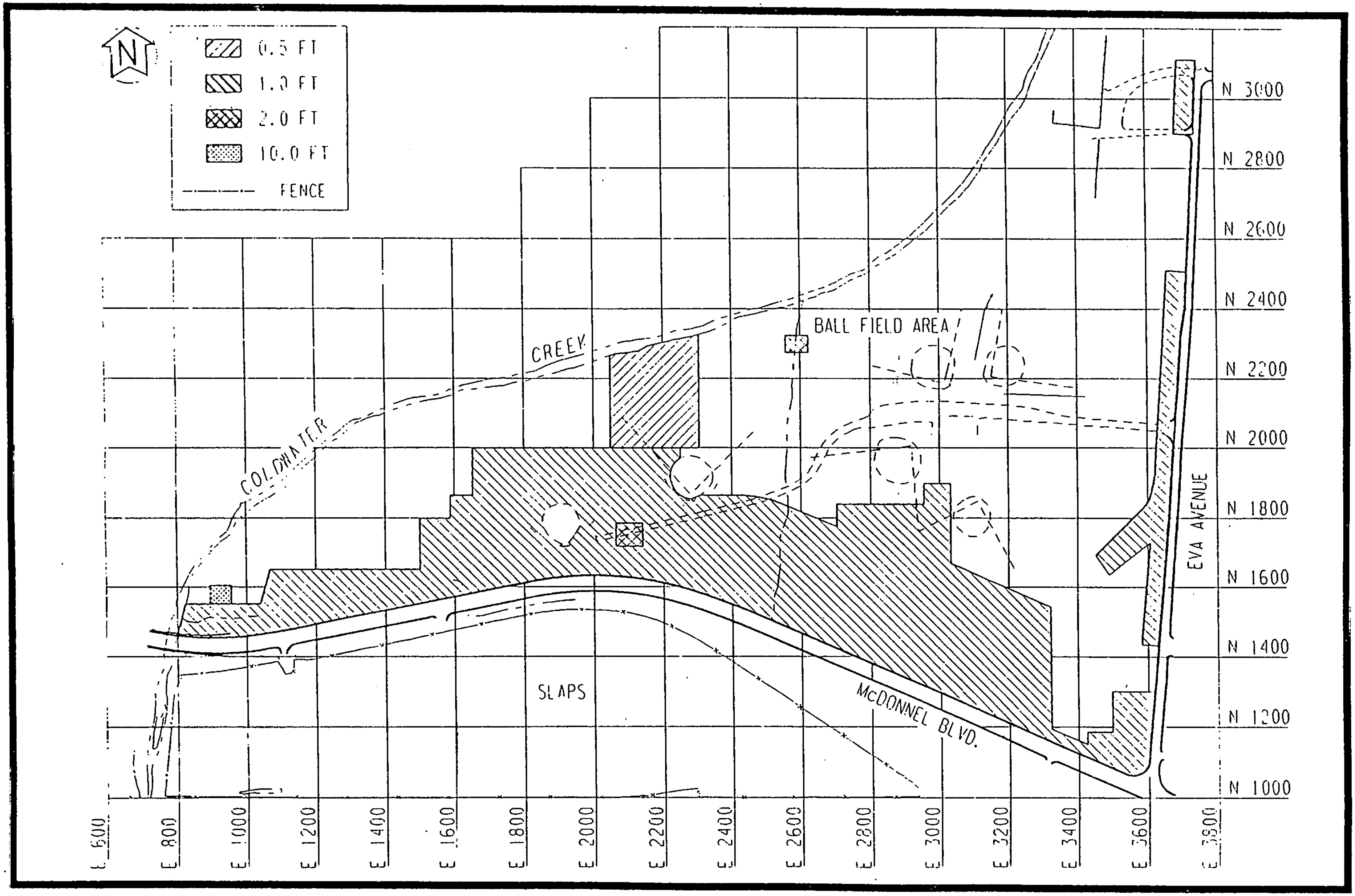

FIGURE 2-42 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE BALL FIELD AREA

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TABLE 2-40

ANALYTICAL RESULTS FOR SOIL ON THE HAUL ROADS

Location	Concentration (pCi/g) U-238	Ra-226	Th-232	Th-230
Latty Avenue[a]	<3 - 48.2	0.6 - 39.9	0.4 - 9.5	<0.2 - 1413
McDonnell Boulevard[b]	<2 - 59	0.7 - 64	<0.7 - 9	0.7 - 2900
Hazelwood Avenue[c]	<4 - 72	0.6 - 42	0.8 - 9	0.9 - 4810
Pershall Road[d]	<3 - 73	0.4 - 92	0.7 - <9	0.6 - 4900

[a]Results showed areas with elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. In most instances, contamination is confined to surface soil [0 to 0.3 m (0 to 1 ft)].

[b]Results revealed areas with elevated concentrations of radium-226, thorium-232, and thorium-230 in composite samples. Elevated concentrations of thorium-230 were found in subsurface samples down to a depth of 4.5 m (15 ft).

[c]Contamination exists along both sides of Hazelwood Avenue to an average depth of 0.3 m (1 ft) from the intersection with Frost Avenue to Pershall Road.

[d]Results showed elevated concentrations of radium-226, thorium-232, and thorium-230 in composite surface samples. Elevated concentrations of thorium-230 were detected in subsurface samples.

Source: BNI 1990b.

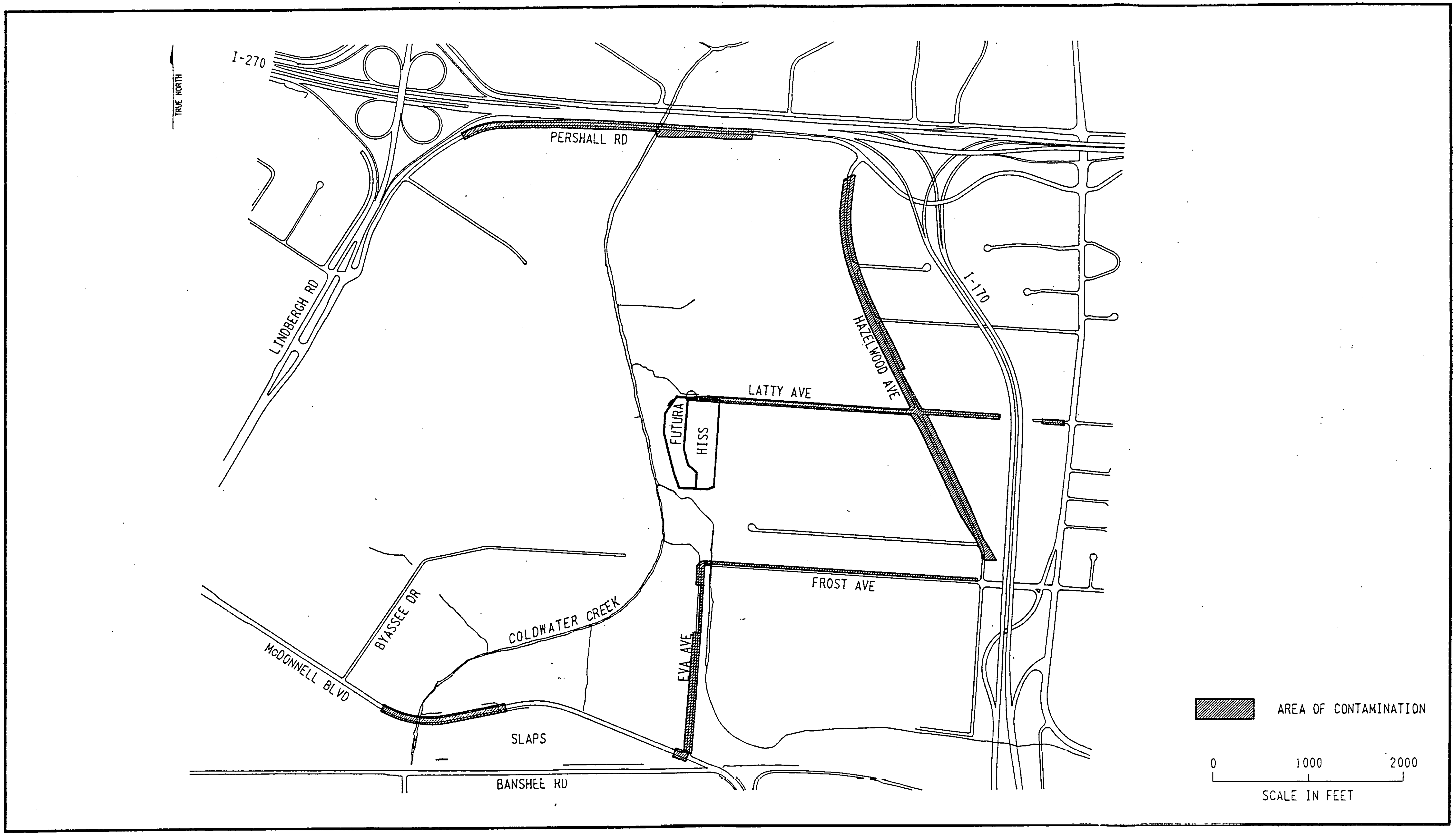

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FIGURE 2-43 GENERAL AREAS OF CONTAMINATION AT THE HAUL ROADS

- McDonnell Boulevard: Of 354 samples analyzed, only 5 showed uranium-238 concentrations greater than 50 pCi/g; only 25 (including composites) showed radium-226 concentrations greater than 5 pCi/g; only 6 had thorium-232 concentrations greater than 5 pCi/g; and 118 (including composites) showed thorium-230 concentrations greater than 5 pCi/g (BNI 1990b).

- Pershall Road: Of 900 samples analyzed, only 6 had concentrations of uranium-238 greater than 50 pCi/g; 95 contained radium-226 concentrations greater than 5 pCi/g and 15 were greater than 15 pCi/g; 12 showed concentrations of thorium-232 greater than 5 pCi/g; and 261 had concentrations of thorium-230 greater than 5 pCi/g (BNI 1990b).

- Hazelwood Avenue: Of 122 samples analyzed, 2 had concentrations of uranium-238 greater than 50 pCi/g; 18 showed concentrations of radium-226 greater 5 pCi/g and 4 were greater than 15 pCi/g; and only 1 exceeded 5 pCi/g for thorium-232 and 59 exceeded 5 pCi/g for thorium-230 (BNI 1990b).

Neither walkover gamma scans were performed nor near-surface gamma radiation measurements were taken at the 67 haul roads vicinity properties because thorium-230, an alpha radiation emitter previously identified as the major contaminant, cannot be detected with field instruments. Soil samples taken from Properties 12, 35, 37, 38, 39, 57, and 58 were analyzed for uranium-238, radium-226, and thorium-232 in addition to the thorium-230 analysis done for all of the haul roads vicinity properties. From these seven properties, none of 475 samples showed uranium-238 greater than 50 pCi/g, only 4 showed radium-226 concentrations greater than 5 pCi/g, and none showed thorium-232 concentrations greater than 5 pCi/g (BNI 1990b). For this reason, only thorium-230 analyses were conducted on the other vicinity properties. For confirmation, during remedial action, soil samples will be collected from all the vicinity properties exhibiting above-guideline thorium-230 concentrations and will be analyzed for gamma-emitting radionuclides.

Soil samples were collected in 0.3-m (1-ft) increments to a depth of 1 m (3 ft) at 15-m (50-ft) grid intersections at the haul roads' edges, 15 m (50 ft) onto the vicinity properties, and at 30.5-m (100-ft) grid intersections 45.7 m (150 ft) onto the properties from the edge of the road (Figure 2-44). Areas and concentrations of thorium-230 contamination are shown in Table 2-41.

Properties 1 through 14A border McDonnell Boulevard. Contamination is generally confined to areas immediately adjacent to the boulevard and is generally shallow. Only Properties 12, 13, and

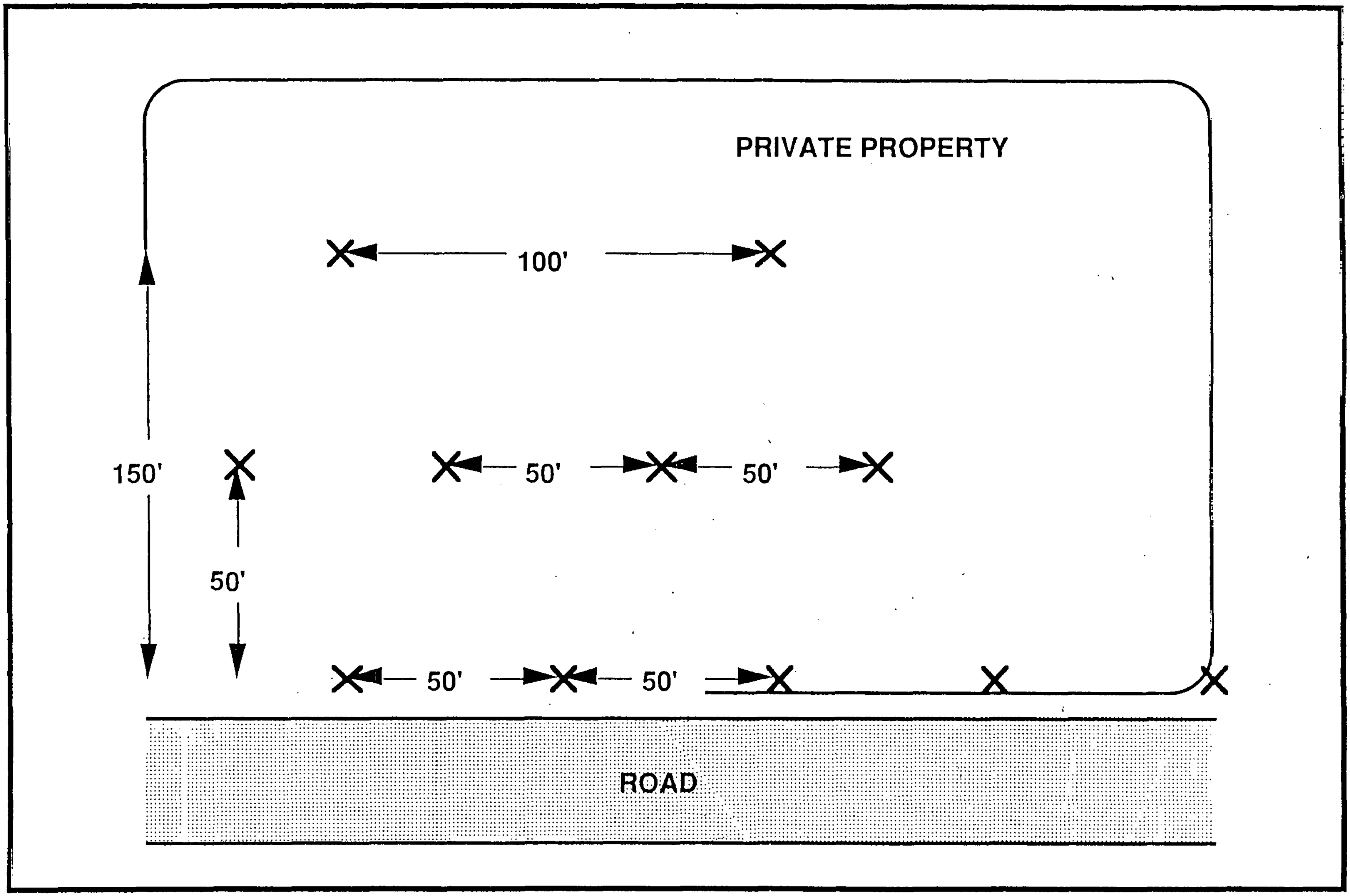

FIGURE 2-44 GRID INTERSECTION AND SOIL SAMPLING DIAGRAM FOR THE HAUL ROADS VICINITY PROPERTIES

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TABLE 2-41

LOCATIONS AND CONCENTRATIONS OF THORIUM-230

AT THE HAUL ROADS VICINITY PROPERTIES

Page 1 of 3

Property No.	Concentration Range (pCi/g)
1[a]	-- --
2[b]	<0.6 - 3.5
3	<0.6 - 2.4
4	1.4 - 3.9
5	1.1 - 14
6	<1.1 - 2.8
7	0.6 - 32
8	1.2 - 2.2
9	<0.5 - 12.0
10	1.2 - 7.2
11	<0.8 - 18
12	<1 - 570[c]
13	<0.7 - 370
14	<0.9 - 33
14A	<0.4 - 36
15	<0.6 - 460
16[d]	1.5 - 6.6
17	<0.9 - 1.4
18	No analysis done
19	<0.7 - 11
20[e]	0.7 - 8.4
20A	0.6 - 2.6
21	<0.5 - 230
22	<0.6 - 110
23	<0.8 - 710
24	<0.4 - 710
25	1 - 4.8
26	1.4 - 6.9
27	1.4 - 8.1
28	1.5 - 4.6
29	0.7 - 3.2
30	1 - 8.8
31	1.2 - 2.1
31A[f]	<1 - 41
32	<0.3 - 540
33	1.1 - 170
34	1.3 - 140
35	0.8 - 1014[c]
37	<0.8 - 600[c]
38	0.5 - 1200[c]
39	<0.8 - 200[c]

TABLE 2-41

(continued)

Property No.	Concentration Range (pCi/g)
40	<0.5 - 110
41	0.8 - 53
42	1.4 - 63
43	0.8 - 22
44	1.1 - 91
45	1 - 21
46	<0.8 - 7
47	0.9 - 110
48	0.7 - 34
48A	1.4 - 1.9
49[g]	0.8 - 1.5
50	1 - 1.4
51	1 - 1.7
52	1 - 4.3
53	0.8 - 21
54	0.7 - 1.7
55	1.3 - 2.3
56	0.7 - 1100
57	1.3 - 19[c]
58	<0.9 - 8.5[c]
59	1.3 - 2.2
60	<0.9 - 1.5
61	0.8 - 1.7
62	1 - 3.4
63	1 - 10
63A	0.6 - 200

[a]Soil samples from Property 1 were not analyzed because of the absence of contamination from McDonnell Boulevard to the property.

[b]Properties 2 through 15 border McDonnell Boulevard. Contamination is generally confined to locations immediately adjacent to the boulevard and is generally shallow [<0.7 m (<2 ft)].

[c]Concentrations of uranium-238, radium-226, and thorium-232 are below DOE guidelines. The actual concentrations of radionuclides other than thorium-230 are given in the characterization report (BNI 1990b).

[d]Properties 16 through 19 are all near Eva Avenue.

TABLE 2-41

(continued)

Page 3 of 3

[e]Properties 20 through 31 are located along Frost Avenue; characterization shows that areas and levels of contamination are greater on the northern side of Frost Avenue. In general, contamination is shallow.

[f]Properties 31A through 48A border Hazelwood Avenue. Contamination is generally confined to locations immediately adjacent to the road and is shallow [<0.7 m (<2 ft)].

[g]Properties 49 through 63A border Pershall Road. Contamination is generally confined to areas immediately adjacent to the road and is shallow and extremely spotty.

Source: Bechtel 1990b.

15 show elevated concentrations (exceeding DOE remedial action guidelines) of thorium-230 (less than 0.5 to 570 pCi/g). Property 12 also shows elevated radium-226 concentrations.

Properties 16, 17, and 19 near Eva Avenue have low levels of thorium-230 contamination. One isolated area of contamination, extending to a depth of 1.5 m (5 ft), exists near the intersection of McDonnell Boulevard and Eva Avenue.

Properties 20 through 31 are located along Frost Avenue. Areas of contamination are more numerous on the northern side of the avenue; specifically, Properties 21 through 24 show maximum thorium-230 concentrations from 110 to 710 pCi/g. In general, contamination is shallow [0 to 0.3 m (0 to 1 ft)]. Properties bordering Hazelwood Avenue show shallow [less than 0.7 m (less than 2 ft)] contamination. However, Properties 32 through 48 have maximum thorium-230 concentrations ranging from 53 to 1,200 pCi/g. Properties 49 through 63A show spotty contamination that is shallow and immediately adjacent to the road.

In summary, radioactive contamination is present in some areas underneath Latty Avenue, McDonnell Boulevard, and Pershall Road, and on both sides of Hazelwood Avenue, Pershall Road, and Eva Avenue. Contamination is primarily located on the northern side of Frost Avenue (BNI 1990b).

Coldwater Creek and vicinity properties. Surface soil and sediment samples [from 0 to 15 cm (0 to 6 in.)] from the sides (at the edge of the water) and center of Coldwater Creek, beginning at SLAPS and continuing downstream to HISS, were collected at 30.5-m (100-ft) intervals and analyzed in 1986. The data from these analyses indicate spotty contamination over the entire distance. Analytical results for sediment reveal areas with elevated concentrations of thorium-230 ranging from 0.5 to 110 pCi/g. Uranium-238, radium-226, and thorium-232 concentrations are low and range from 0.2 to 4.8, 0.3 to 3.1, and less than 0.1 to 1.5 pCi/g, respectively.

Results from the 1987 Coldwater Creek characterization indicate areas with elevated radium-226 and thorium-230 concentrations; radium-226 concentrations range from 0.6 to 71 pCi/g, and thorium-230 concentrations range from 0.8 to 5,100 pCi/g. Uranium-238 and thorium-232 concentrations range from less than 2 to 78 and 0.7 to 5 pCi/g, respectively. All samples were collected from the center of the creek (where accessible), 30.5 m (100 ft), and 61 m (200 ft) to the east and west of the centerline of the creek at 30.5-m (100-ft) intervals from the southwestern corner of SLAPS to Pershall Road; the samples were collected from bank sediments and private properties in the floodway. Samples were collected at the 0 to 15 cm (0 to 6 in) depth and the 15 to 30 cm (6 to 12 in) depth. Contamination along the edges and centerline of Coldwater Creek is shown in Figure 2-45; this figure was compiled from data from the 1986 and 1987 characterization and illustrates areas that exceed the DOE surface soil guideline of 5 pCi/g for thorium-230.

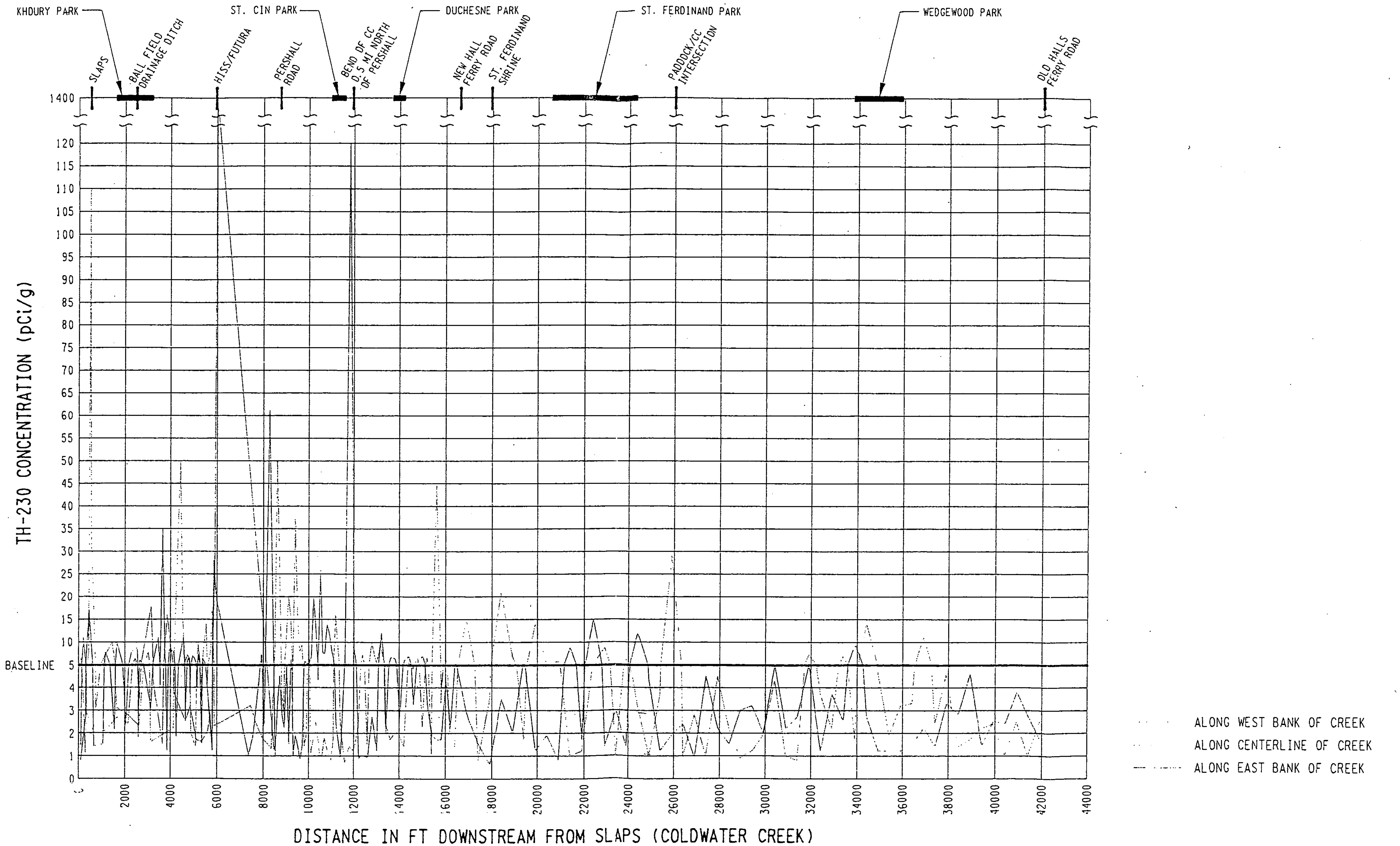

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FIGURE 2-45 THORIUM-230 CONCENTRATIONS ALONG COLDWATER CREEK

In 1989, additional Coldwater Creek characterization included collection and analysis of soil samples from the banks at the edge of the creek for a distance of 2.4 km (1.5 mi) north of Pershall Road. Soil samples were collected from both sides of the creek at 30.5-m (100-ft) intervals for the first 0.8 km (0.5 mi) and at 61-m (200-ft) intervals for 1.6 km (1 mi) thereafter. Sixty-four of 175 samples exhibited radionuclide concentrations exceeding DOE remedial action guidelines. Also in 1989, a 7.7-km (4.8-mi) stretch of Coldwater Creek was surveyed for the Corps of Engineers beginning at the termination point of the 2.4-km (1.5-mi) study. Soil samples were collected at 152.4-m (500-ft) intervals and analyzed; results reveal areas with above-guidelines concentrations of thorium-230 in surface samples.

Additional sediment sampling has been conducted in Coldwater Creek as part of the ongoing environmental programs at HISS and SLAPS. (Results are discussed in the sediment subsections for HISS and SLAPS.) The primary radioactive contaminant at Coldwater Creek is thorium-230; contamination along the creek is spotty and is confined to surface soil and sediment. Areas of contamination are more numerous between SLAPS and Pershall Road, adjacent to SLAPS and HISS. There is a correlation between the creek's configuration and the areas of contamination: the inside banks of the creek at the bends appear to be the areas containing above-guideline concentrations of thorium-230, indicating settling of contaminated sediment.

The locations of the vicinity properties adjacent to Coldwater Creek are shown in Figure 2-38. Results of the most recent characterization activities on these properties are given in Table 2-42 (BNI 1990b). Properties 1, 2, 3, 5, 8, and 9 exhibit thorium-230 concentrations in excess of DOE remedial action guidelines, primarily in the first foot of soil.

Railroad properties. Table 2-43 gives the 1986-1989 characterization results for the Norfolk and Western Railroad properties. Near-surface gamma radiation measurements were not taken on the railroad properties adjacent to Hazelwood Avenue, Eva Avenue, Coldwater Creek, or Hanley Road because thorium-230 had already been identified as the primary contaminant. Analytical results for soil collected from these properties revealed radioactive contamination on portions of all the railroad properties with the exception of the one adjacent to Hanley Road and Hazelwood Avenue, north of Latty Avenue. The areas and depths of radioactive contamination on the railroad properties are shown in Figures 2-46 through 2-49.

Hazelwood Interim Storage Site

In 1981, Oak Ridge Associated Universities (ORAU) characterized the storage pile at HISS and performed a radiological survey of the northern and eastern boundaries of the property.

TABLE 2-42

CHARACTERIZATION RESULTS FOR

COLDWATER CREEK VICINITY PROPERTIES

Property Number[b]	Concentration Range (pCi/g)[a]			
	U-238	Ra-226	Th-232	Th-230
1	3 - 14	0.8 - 2.7	0.7 - 5	1.4 - 38
2	5 - 20	0.7 - 3	0.9 - 4	<1 - 7.7
3	2 - 16	0.3 - 4	0.8 - 4	<0.8 - 79
4	3 - 11	0.6 - 1.8	0.9 - 3	<0.6 - 5.1
5	2 - 16	0.9 - 3	0.9 - 4	<0.7 - 61
6	6 - 13	1.2 - 1.7	<0.4 - 3	1.1 - 5.2
7	4 - 6	0.9 - 2.2	<0.3 - 3	0.9 - 3.7
8	3 - 11	0.4 - 2.8	<1 - 4	1.3 - 23
9	5 - 10	<0.5 - 2.3	<1 - 3	1 - 6.5
10	7 - 11	1.6 - 1.8	1.7 - 3	1.5 - 5.7

[a]Background values have not been subtracted.

[b]Property locations are shown in Figure 2-38.

Source: BNI 1990b.

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TABLE 2-43

CHARACTERIZATION RESULTS FOR THE NORFOLK AND WESTERN RAILROAD PROPERTIES ADJACENT TO LATTY AVENUE VICINITY PROPERTIES

Railroad property adjacent to:	Parameter (pCi/g)			
	U-238	Ra-226	Th-230	Th-232
9200 Latty Avenue[a,b]	<4 - 390	0.6 - 1,100	0.7 - 26,000	0.6 - 7
Hanley Road[c,d]	<7	1.6 - 2.2	0.8 - 6	2.0 - 2.5
South of SLAPS[b,c]	<3 - 27	0.6 - 8	1.5 - 170	0.6 - 5
Coldwater Creek[c,e]	<23	0.7 - 15	1.3 - 1,300	0.8 - 4
Hazelwood Avenue/ South of Latty Avenue[c,f]	--	--	1.2 - 210	--
Hazelwood Avenue/ North of Latty Avenue[f,g]	--	--	1.9 - 3.8	--
Eva Avenue[f,h]	--	--	<0.8 - 85	--

[a]Significant variations in count rates were observed as gamma logging progressed, indicating possible contamination from gamma-emitting radionuclides.

[b]Soil analysis revealed areas with elevated concentrations of radium-226 in surface samples and of thorium-230 in surface and subsurface samples.

[c]No significant variations in count rates were observed as gamma logging progressed.

[d]Soil analysis revealed no areas exhibiting radionuclide concentrations above guidelines.

[e]Analytical results for surface soils revealed areas with elevated concentrations of radium-226 and thorium-230.

[f]Downhole gamma logging was not performed because thorium-230 had previously been identified as the major contaminant.

[g]Only thorium-230 analysis was done; six surface samples were found without contamination.

[h]Only thorium-230 analysis was done; 23 of 72 samples analyzed exhibited elevated levels.

Source: BNI 1990b.

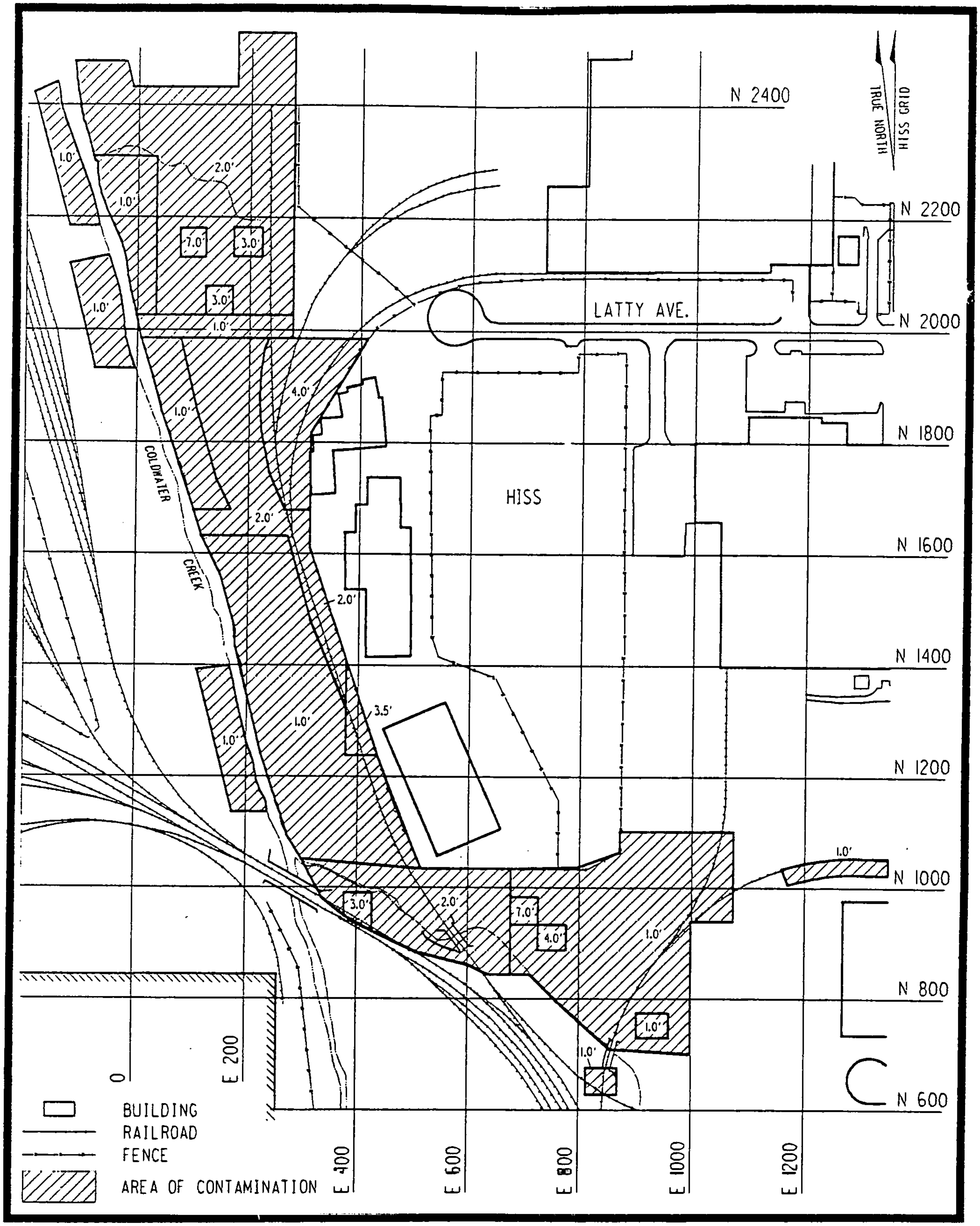

FIGURE 2-46 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO 9200 LATTY AVENUE

S34WMS20.DGN FIG 7

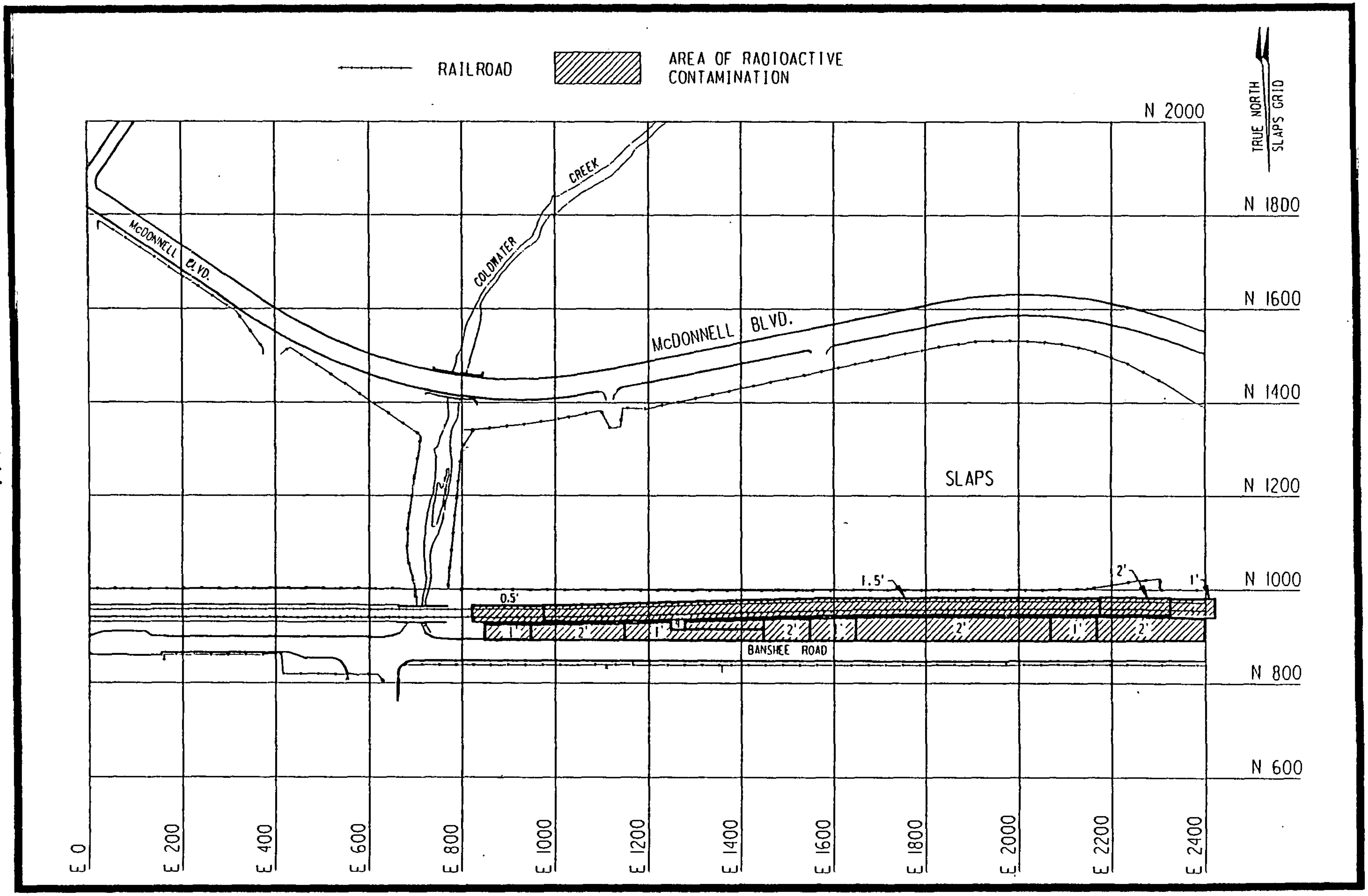

FIGURE 2-47 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS

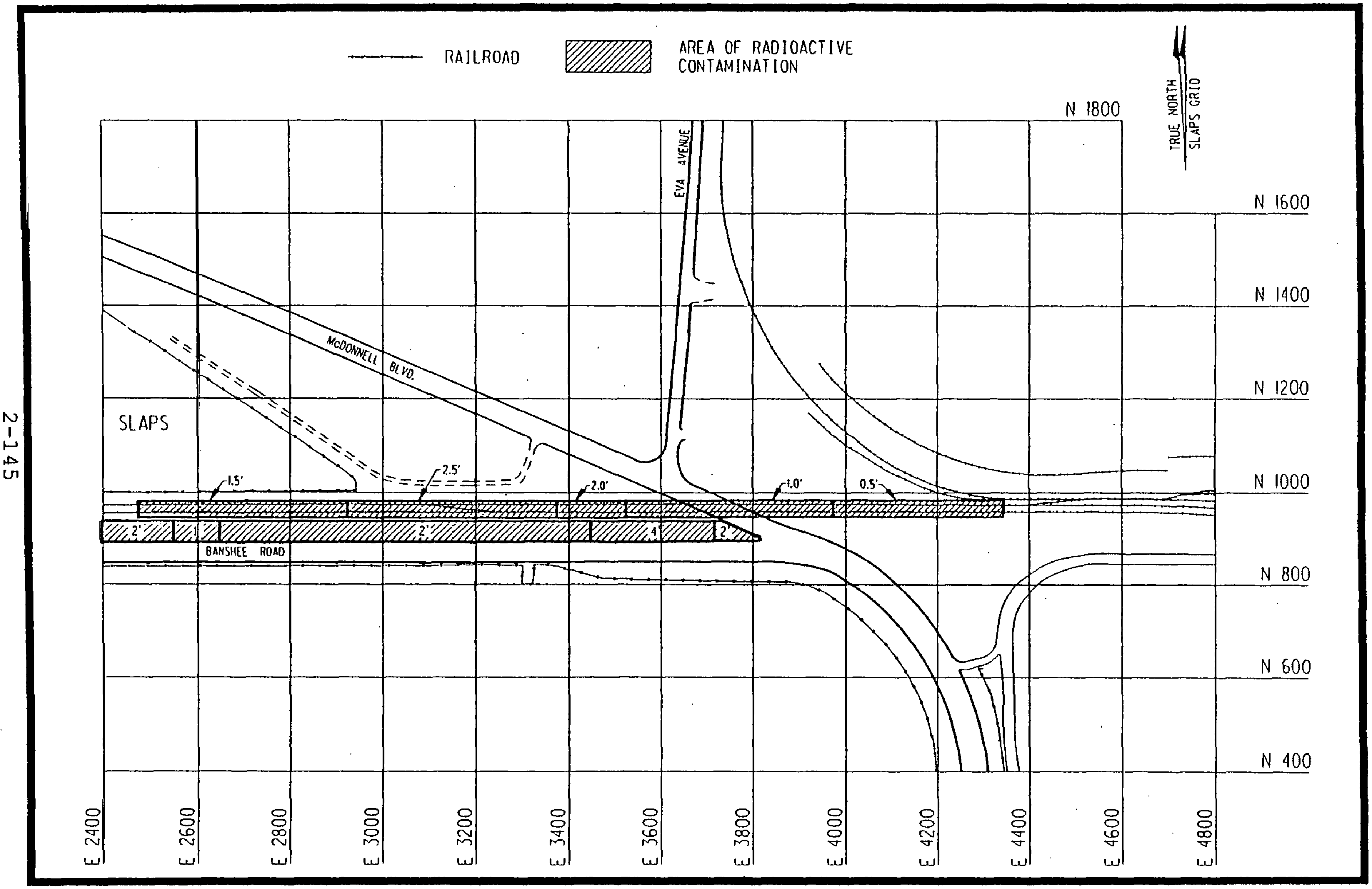

FIGURE 2-47 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS (CONT.)

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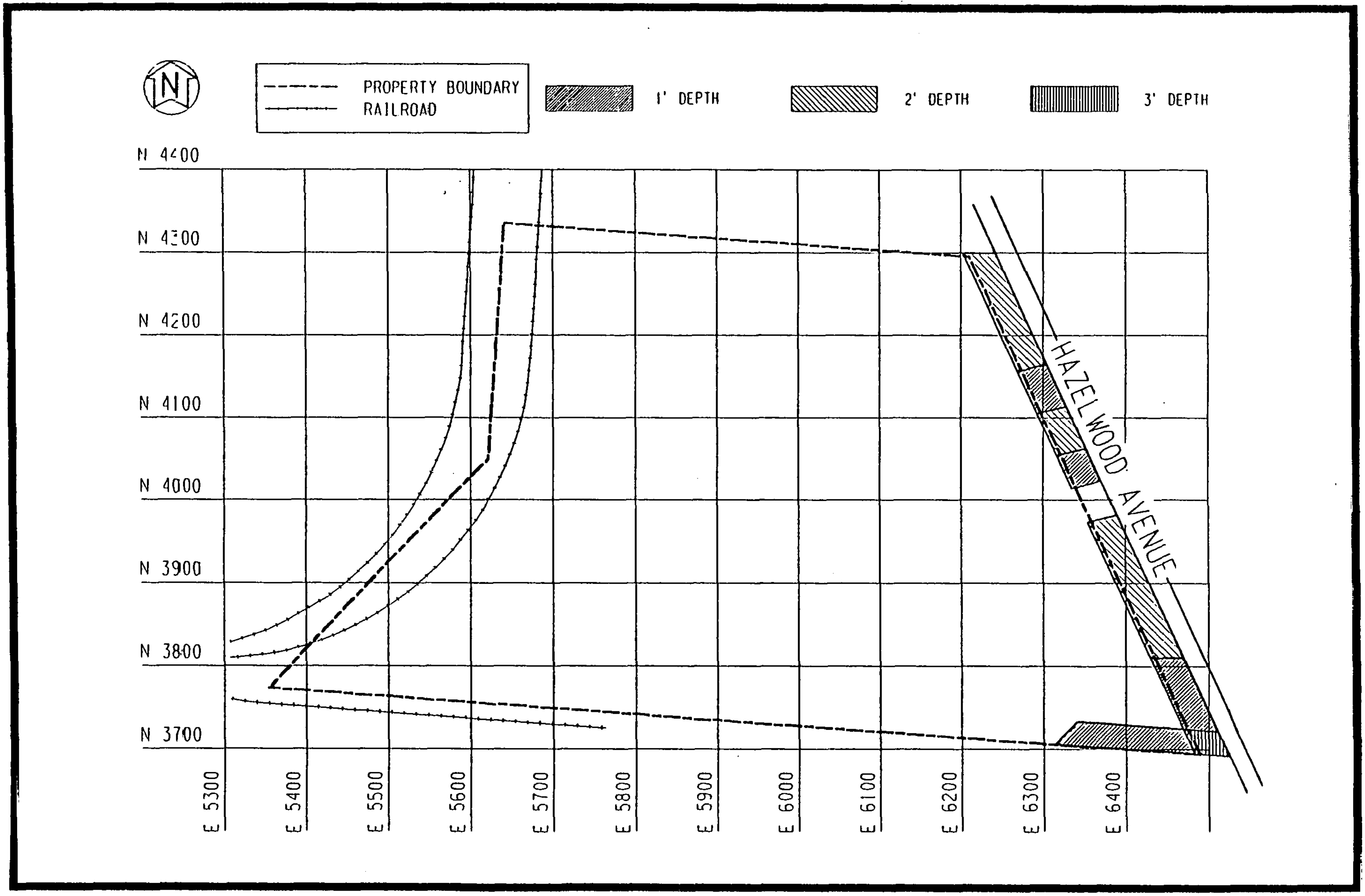

FIGURE 2-48 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HAZELWOOD AVENUE AND SOUTH OF LATTY AVENUE

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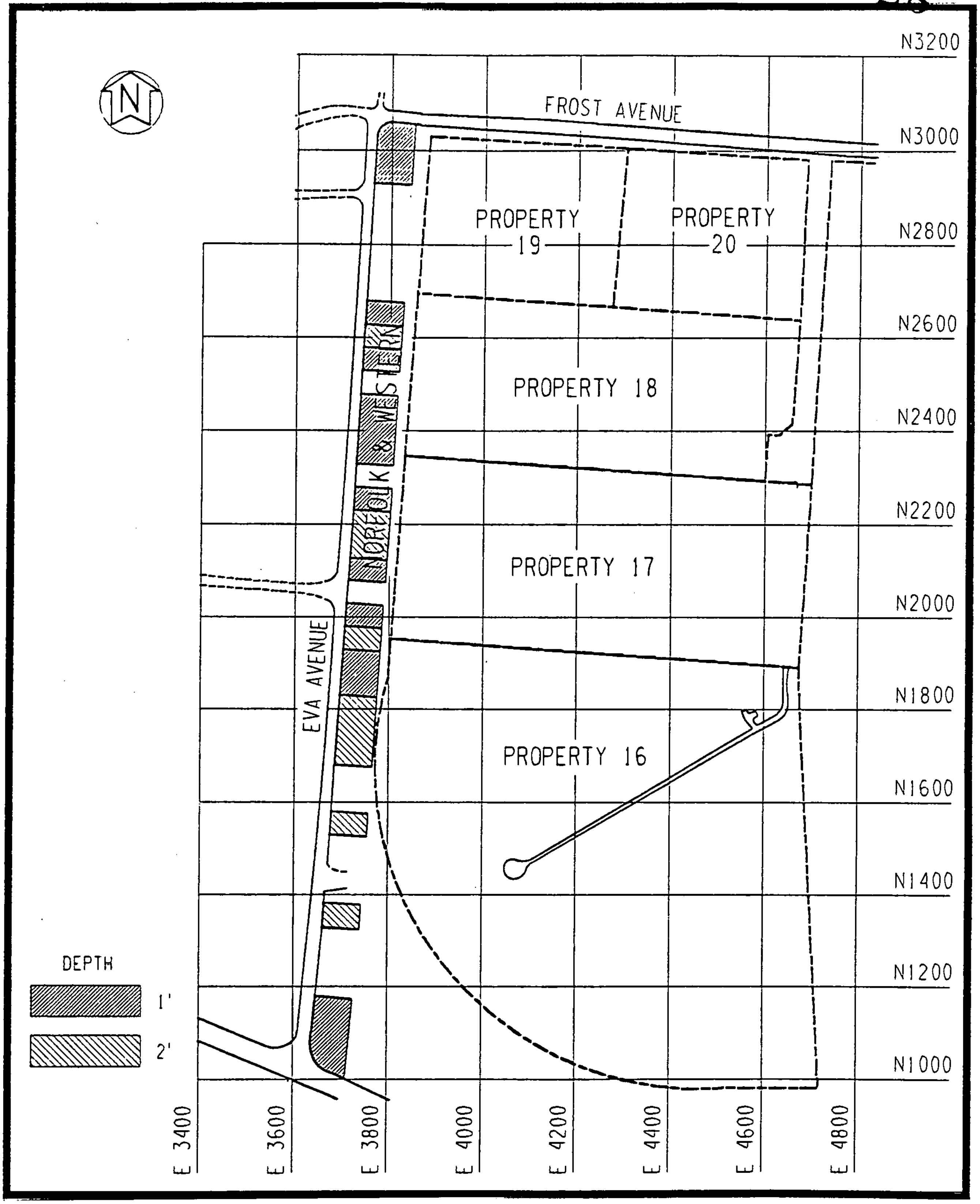

FIGURE 2-49 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO EVA AVENUE

134F091.DGN DEPTH

Elevated concentrations of members of the naturally occurring uranium, thorium, and actinium decay series were found in the storage pile. Levels of contamination (principally thorium-230) similar to those on the property were also found on both boundaries (ORAU 1981).

Soil survey. During fall 1986, a radiological survey was conducted by BNI and Thermo Analytical/Eberline (TMA/E) at HISS. Thirty-six boreholes were drilled; soil samples were collected and analyzed for uranium-238, radium-226, thorium-232, and (in selected samples) thorium-230. Table 2-44 summarizes the results of this survey. Experience in the St. Louis area has shown that when the radium-226 concentration is elevated, it is reasonable to assume that the concentration of thorium-230 exceeds the DOE guideline of 15 pCi/g. Based on this rationale, as well as on the downhole gamma logs, samples were selected for thorium-230 analyses. Typically, this meant that samples were selected from regions of the borehole where gamma logging results showed a decrease in the count rate, indicating a drop in radium-226 concentration. Radiological characterization results revealed that a majority of the ground surface is contaminated at levels exceeding DOE guidelines. Contamination was found to a depth of 1.8 m (6 ft); the average depth is approximately 1 m (3 ft). Areas and depths of contamination at HISS are shown in Figure 2-50 (BNI 1987b). The volume of contaminated soil at HISS, including the material in stockpiles, is 53,520 m^3 (70,000 yd^3).

Additional information about radiological conditions at HISS has been obtained through the DOE environmental monitoring program conducted by BNI since 1984. The monitoring includes quarterly sampling of external gamma radiation levels; annual averages are listed in Table 2-45. External gamma radiation levels have declined sharply since 1984 at all but two monitoring locations; this overall decline reflects remedial actions at the property (BNI 1989c).

Surface water and sediment survey. The environmental monitoring program includes quarterly collection of sediment samples from surface water sampling locations where sediment is present (Table 2-46). All sediment samples taken after 1984, with the exception of four (locations 2, 3, 6, and 7 for thorium-230 and location 2 for radium-226 on one occasion), were below DOE guidelines for residual radioactivity in surface soil. Locations of sampling and monitoring points are shown in Figure 2-51.

Surface water samples were collected quarterly from sampling locations established on the basis of potential contaminant migration and discharge routes from HISS. Upstream locations were chosen to establish background conditions, and downstream locations were chosen to determine the effect of runoff from HISS on surface waters in the vicinity. Annual average results for surface water monitoring from 1984 to 1989 are given in Table 2-47. Concentrations of uranium in surface water in the vicinity of HISS have declined substantially since 1984, which reflects the effects of

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TABLE 2-44

SUMMARY OF RADIOLOGICAL CHARACTERIZATION RESULTS FOR HISS

Type of Measurement	Min.	Max.	Average
Near-surface gamma radiation[a] (cpm)	10,000	475,000	--
Gamma radiation exposure rate (μR/h)	13	55	24
Depth of contamination (ft)	0	6	3
Radionuclide concentration (pCi/g)			
Thorium-232	0.4	5	
Radium-226	0.6	700	
Uranium-238	4	800	
Thorium-230[b]	0.8	790	

[a]Ground surface was scanned; an average value could not be calculated.

[b]The maximum thorium-230 concentration on the property is probably much greater than indicated by analytical results because only those samples with no associated gamma-emitting radionuclides were analyzed for thorium-230.

Source: BNI 1987b.

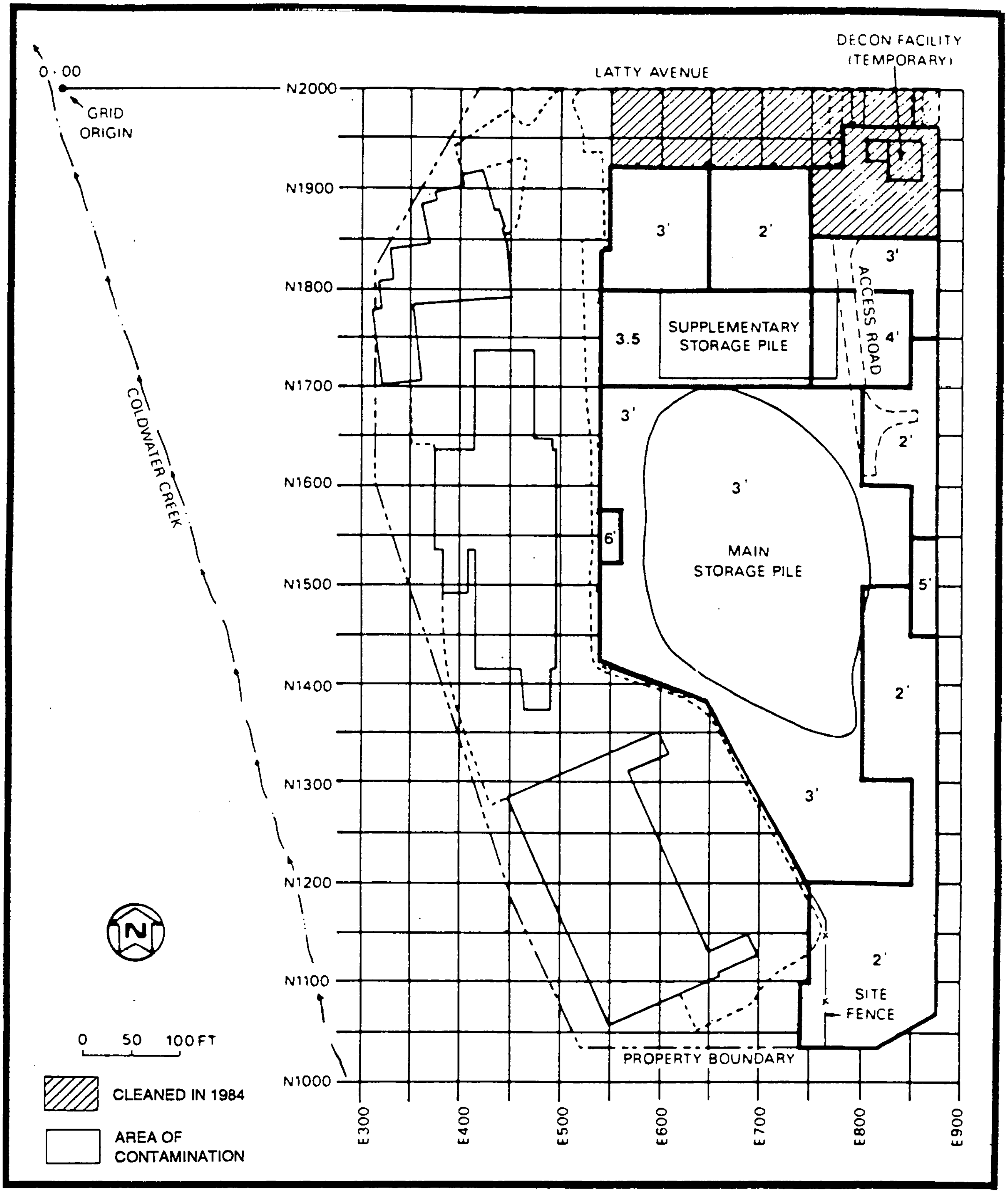

FIGURE 2-50 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HISS

TABLE 2-45

ANNUAL AVERAGE EXTERNAL GAMMA RADIATION LEVELS

AT HISS, 1984-1989

Sampling Location[a]	Radiation Level (mR/yr)[b]					
	1984	1985	1986	1987	1988	1989
1	501	58	34	44	40	6
2	328	87	68	113	116	129
3	219	25	23	20	14	2
4	1,062	83	71	74	83	68
5	466	141	77	46	51	5
6	1,106	287	179	29	44	5
7	613	89	46	50	61	61
8	307	7	17	27	11	0
9[c]	202	261	151	61	49	6
10[d]	--	--	21	17	13	1
11[d]	--	--	15	44	56	36
Background						
16[e]	--	99	97	77	73	61
19[f]	--	--	--	--	--	92

[a]Sampling locations are shown in Figure 2-51.

[b]Measured background has been subtracted from the readings taken at the sampling stations shown in Figure 2-51.

[c]Station 9 is a quality control for station 6.

[d]Sampling station was established in August 1986.

[e]Background station was established in 1985, approximately 24 km (15 mi) northeast of HISS.

[f]Station was established in April 1988 at the Berkeley City Hall, approximately 8 km (5 mi) east of HISS.

Source: BNI 1985d, 1986b, 1987e, 1988b, 1989c, 1990d.

TABLE 2-46

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM, RADIUM-226, AND THORIUM-230 IN SEDIMENT AT HISS, 1984-1989

Sampling Location[a]	Concentration [pCi/g (dry)]					
	1984[b]	1985	1986	1987	1988	1989
Radium-226						
1	--	1.8	1.6[c]	1.2[d]	--[e]	--[e]
2	--	<0.1	8.0[f]	2.0[d]	--[e]	--[e]
3	--	1.4	--[g]	1.2[h]	1.0	2.3
4	--	1.0	--[g]	1.2[h]	1.2	1.2
5	--	1.4	--[g]	1.4[h]	1.6[h]	1.4
6	--	1.7	--[g]	1.2[h]	0.8	1.4
7	--	4.0	--[g]	--[i]	--[i]	1.2[j]
8	--	4.0	--[g]	--[i]	--[i]	--[i]
Thorium-230						
1	--	3.8	6.0[c]	4.2[d]	--[e]	--[e]
2	--	0.2	200.0[f]	0.5[d]	--[e]	--[e]
3	--	15.0	--[g]	2.7[h]	5.8	44.4
4	--	1.2	--[g]	0.9[h]	4.3	2.2
5	--	2.8	--[g]	2.9[h]	7.5[h]	2.1
6	--	1.2	--[g]	20.0[h]	1.5	2.0
7	230	300.0	--[g]	--[i]	--[i]	0.8[j]
8	540	0.1	--[g]	--[i]	--[i]	--[i]
Uranium-234						
1	--	0.7	0.8[c]	0.9[d]	--[e]	--[e]
2	--	0.6	2.4[f]	0.8[d]	--[e]	--[e]
3	--	0.9	--[g]	1.1[h]	0.6	1.0
4	--	0.6	--[g]	1.0[h]	1.1	0.7
5	--	0.4	--[g]	0.9[h]	1.0[g]	0.9
6	--	0.5	--[g]	0.7[h]	0.6	0.9
7	--	9.2	--[g]	--[i]	--[i]	0.9[j]
8	--	2.2	--[g]	--[i]	--[i]	--[i]
Uranium-235						
1	--	0.04	0.04[c]	<0.1[d]	--[e]	--[e]
2	--	0.03	0.08[f]	<0.1[d]	--[e]	--[e]
3	--	<0.05	--[g]	0.07[h]	<0.1	0.1
4	--	0.06	--[g]	0.06[h]	<0.1	0.07
5	--	0.03	--[g]	0.06[h]	<0.1[h]	0.07
6	--	0.02	--[g]	0.06[h]	<0.1	0.08
7	--	0.4	--[g]	--[i]	--[i]	<0.1[j]
8	--	0.11	--[g]	--[i]	--[i]	--[i]
Uranium-238						
1	--	0.7	0.8[c]	0.9[d]	--[e]	--[e]
2	--	0.6	5.6[f]	0.7[d]	--[e]	--[e]
3	--	1.0	--[g]	0.9[h]	0.7	1.0
4	--	0.6	--[g]	1.1[h]	1.0	0.9
5	--	0.5	--[g]	0.9[h]	1.0[h]	0.9
6	--	0.5	--[g]	0.8[h]	0.7	0.9
7	--	9.4	--[g]	--[i]	--[i]	0.9[j]
8	--	2.4	--[g]	--[i]	--[i]	--[i]

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TABLE 2-46

(continued)

Sampling Location[a]	Concentration [pCi/g (dry)]					
	1984[b]	1985	1986	1987	1988	1989
Total Uranium						
1	--	1.4	1.6[c]	1.9[d]	--[e]	--[e]
2	--	1.2	8.0[f]	1.6[d]	--[e]	--[e]
3	--	1.95	--[g]	2.0[h]	1.4	2.1
4	--	1.3	--[g]	2.1[h]	2.2	1.9
5	--	0.9	--[g]	1.8[h]	2.1[h]	1.8
6	--	1.0	--[g]	1.5[h]	1.4	1.9
7	--	19.0	--[g]	--[i]	--[i]	1.9[j]
8	--	4.7	--[i]	--[i]	--[i]	--[i]

[a]Sampling locations are shown in Figure 2-51. Locations 1, 4, and 6 are upstream of HISS and are background locations.

[b]Sediment samples were obtained only during baseline sampling at locations 7 and 8 and were analyzed for thorium-230.

[c]No sediment was collected from sampling location in the third and fourth quarters; construction activities destroyed sampling locations.

[d]Construction activities destroyed the sampling location during the first quarter. The sampling location was reestablished in October 1987, and a sediment sample was obtained in the fourth quarter.

[e]Construction activities in July 1987 destroyed sampling locations 1 and 2.

[f]No sediment was collected from sampling location in the first, third, and fourth quarters due to lack of runoff (first quarter) and loss of sampling locations to construction activities. Single sample taken after extensive excavation near the sampling location.

[g]Sediment sampling was limited to two locations due to road and sewer pipe construction adjacent to HISS and dry weather in the St. Louis area.

[h]No sediment was collected from sampling location in the first quarter.

[i]Locations 7 and 8 were removed from sampling program because of construction activities.

[j]New sampling location.

Source: BNI 1985d, 1986b, 1987e, 1988b, 1989c, 1990d.

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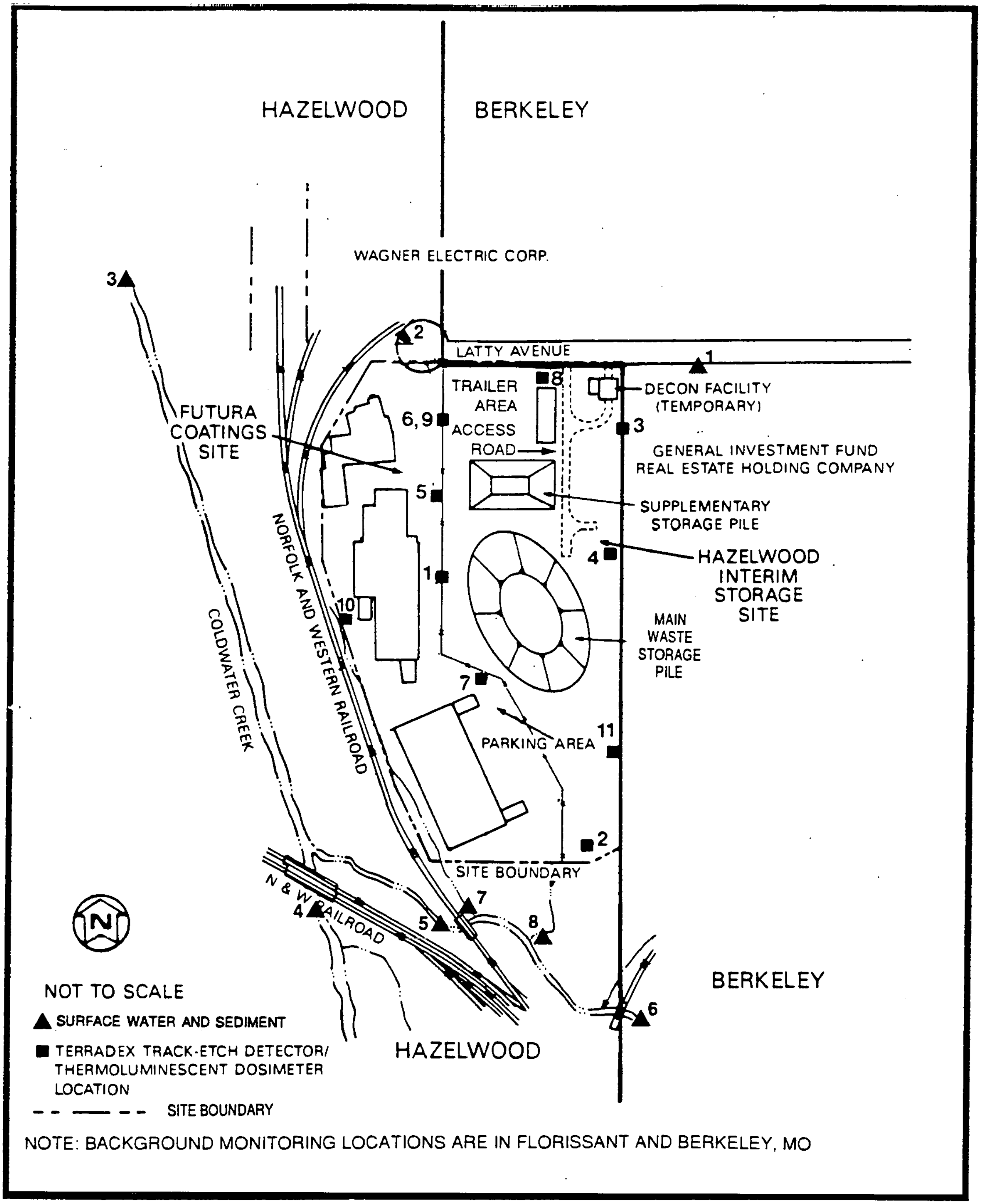

FIGURE 2-51 MONITORING LOCATIONS FOR RADON, EXTERNAL GAMMA RADIATION, SURFACE WATER, AND SEDIMENT AT HISS

TABLE 2-47

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM, RADIUM-226, AND THORIUM-230 IN SURFACE WATER IN THE VICINITY OF HISS, 1984-1989

Sampling Location[a]	Concentration (pCi/L) 1984	1985	1986	1987	1988	1989
Total Uranium						
1[b]	67.0	<3.0	<3.0	--	--	--
2[b]	69.0	<3.0	<3.0	--	--	--
3	97.0	4.3	4.0	4.0	4.0	4.0
4	116.0	4.3	4.0	5.0	4.0	5.0
5	67.0	<3.0	<3.0	<3.0	4.0	4.0
6	69.0	<3.0	<3.0	<3.0	<3.0	4.0
7[c]	--	<3.0	<3.0	<3.0	4.0	<3.4
Radium-226						
1[b]	0.3	0.1	0.3	--	--	--
2[b]	0.3	0.1	0.1	--	--	--
3	0.1	0.1	0.3	0.2	0.3	0.4
4	0.1	0.2	0.3	0.2	0.3	0.3
5	0.1	0.1	0.2	0.3	0.3	0.3
6	0.2	0.2	0.2	0.2	0.3	0.3
7d[c]	--	0.1	0.3	0.3	0.5	0.3
Thorium-230						
1[b]	0.2	0.1	0.2	--	--	--
2[b]	15.4	0.4	<0.1	--	--	--
3	0.4	3.3	0.4	0.3	0.2	0.2
4	0.5	0.2	0.2	0.4	0.3	0.2
5	0.5	0.2	0.4	0.3	0.1	0.1
6	0.5	2.9	0.2	0.1	0.3	0.1
7[c]	--	<0.4	<0.2	0.4	0.3	0.3

[a]Sampling locations are shown in Figure 2-51.

[b]Construction activities in July 1987 destroyed the sampling location.

[c]Located south of Runway 6 at St. Louis Airport, upstream of any influence from SLAPS or HISS.

Source: BNI 1985d, 1986b, 1987e, 1988b, 1989c, 1990d.

remedial action at the property, primarily the covering of the storage pile with a synthetic, low permeability membrane. Concentrations of radium-226 are low and have remained almost unchanged. Overall, thorium-230 concentrations are low and have been relatively stable over the six-year period.

Groundwater investigations. Groundwater samples have also been collected quarterly from seven of the monitoring wells established along the perimeter of the property (Figure 2-52) and from two background wells established on the basis of available hydrogeological data. Results of groundwater analyses from 1984 through 1989 are presented in Table 2-48. Here, as at SLAPS, several wells exhibit uranium concentrations greater than those occurring naturally in groundwater. A steady rise in total uranium concentrations in well HISS-6 has been noted since 1986 (33 to 82.1 pCi/L). Analytical data for total uranium in HISS-6 in 1990 shows a drop to 50.1 pCi/L; monitoring continues. In the future, water samples will be analyzed for both dissolved and suspended uranium to determine whether the uranium reached the groundwater via attachment to sediment particles or through infiltration of surface water. However, since new wells were installed in 1985, most measured values have been relatively consistent between wells, suggesting that no horizontal movement of radionuclides in groundwater is occurring.

Air investigations. Environmental monitoring at HISS also includes quarterly sampling of radon-222; annual averages are listed in Table 2-49. There have been no notable trends in radon concentrations at HISS since 1984. All values are below state regulatory levels and the DOE guideline of 3 pCi/L (DOE Order 5400.5, Section III). Overall, concentrations have remained relatively stable.

Futura Coatings

Characterization of Futura Coatings began in 1986 and was conducted in two phases. Phase I consisted of establishing four environmental monitoring stations inside the buildings. Phase II characterization supported the finding of the 1977 ORNL survey that thorium-230 is the principal radioactive soil contaminant at Futura, although analysis also revealed elevated levels of radium-226, uranium-238, and thorium-232.

Building survey. Characterization of the interior and exterior surfaces of the buildings indicates that there is no nonremovable or removable contamination exceeding DOE guidelines (BNI 1987e).

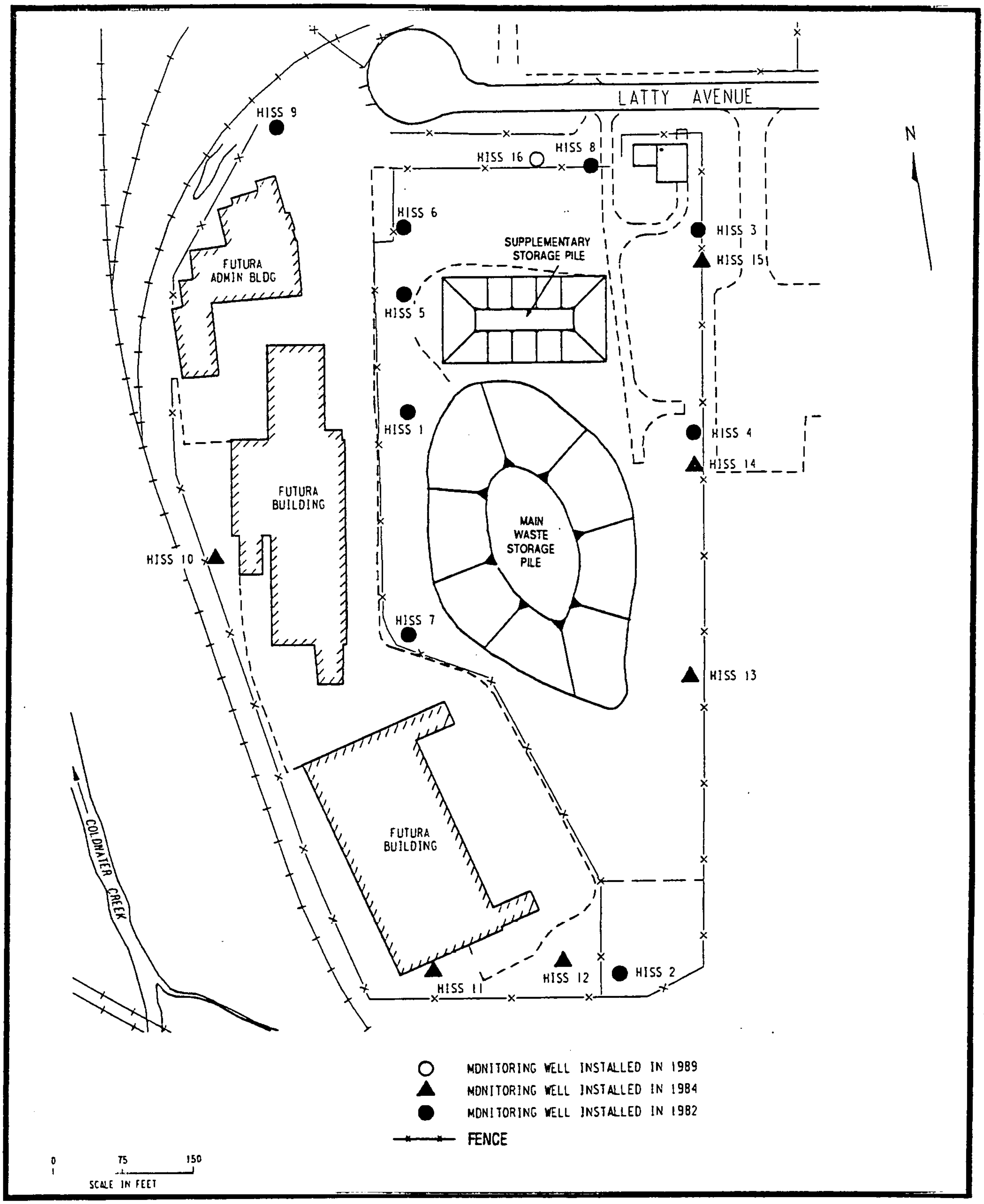

FIGURE 2-52 HISS MONITORING WELL LOCATIONS

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TABLE 2-48

ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM, RADIUM-226, AND THORIUM-230 IN GROUNDWATER AT HISS, 1984-1989

Page 1 of 2

Sampling Location[a]	Concentration (pCi/L) 1984[b]	1985	1986	1987	1988	1989
Total Uranium						
HISS-6	67	71.6	33.0	40.0	50.0	82.1
HISS-9	--	25:6	<3.0	<3.0	<3.0	3.0
HISS-10	--	3.1	6.0	4.0	4.0	5.1
HISS-11	--	3.0	5.0	4.0	5.0	5.9
HISS-12	--	3.0	4.0	5.0	6.0	4.4
HISS-13	--	3.0	8.0	8.0	8.0	4.7
HISS-15	--	3.0	5.0	3.0	6.0	5.1
Background						
B53W01S[c]	--	--	--	--	3.0	<3.4
B53W01D[c]	--	--	--	--	4.0	<3.4
Radium-226						
HISS-6	1.5	0.8	0.7	1.2	1.8	1.6
HISS-9	--	0.4	0.2	0.2	0.6	0.6
HISS-10	--	0.2	0.1	0.2	0.4	0.3
HISS-11	--	0.3	0.4	0.2	1.0	0.7
HISS-12	--	0.4	0.4	0.5	1.3	0.7
HISS-13	--	0.1	0.3	0.3	0.6	0.7
HISS-15	--	0.3	0.4	0.4	0.8	1.2
Background						
B53W01S[c]	--	--	--	--	0.6	0.7
B53W01D[c]	--	--	--	--	1.1	1.0
Thorium-230						
HISS-6	2.2	5.5	2.6	2.9	24.0	5.0
HISS-9	--	0.2	0.6	0.2	0.2	0.2
HISS-10	--	0.2	0.7	0.3	0.7	0.1
HISS-11	--	0.9	1.3	0.8	1.5	0.7
HISS-12	--	0.4	2.0	0.8	2.3	2.3
HISS-13	--	0.3	1.0	0.3	0.6	0.9
HISS-15	--	0.5	1.3	0.8	5.7	8.6

TABLE 2-48

(continued)

Sampling Location[a]	Concentration (pCi/L) 1984	1985	1986	1987	1988	1989
Background						
B53W01S[c]	--	--	--	--	0.2	0.3
B53W01D[c]	--	--	--	--	0.2	0.4

[a]Sampling locations are shown in Figure 2-52.

[b]Of the sampling locations listed, only location 6 existed in 1984.

[c]Background station established in July 1988 at Byassee Rd., approximately 0.8 km (0.5 mi) southwest of HISS.

Source: BNI 1985d, 1986b, 1987e, 1988b, 1989c, 1990d.

TABLE 2-49

ANNUAL AVERAGE CONCENTRATIONS OF RADON-222

AT HISS, 1984-1989

Sampling Location[a]	Concentration (pCi/L)[b]					
	1984	1985	1986	1987	1988	1989
1	2.2	0.3	0.9	1.0	0.9	0.8
2	0.6	0.5	0.8	0.7	0.7	0.9
3	0.3	0.4	0.3	0.6	0.6	0.5
4	0.8	0.5	1.3	1.5	1.3	0.9
5	0.4	0.4	0.6	0.3	0.9	0.5
6	0.4	0.7	0.6	0.8	0.7	0.5
7	0.5	0.4	1.1	1.8	0.6	0.6
8	2.0	0.3	0.2	0.3	0.6	0.5
9	0.4	0.5	0.5	0.3	0.9	0.5
10[c]	--	--	0.2	0.4	0.4	0.5
11[c]	--	--	1.8	1.2	0.8	0.6
Background						
16[d]	--	0.5	0.3	0.4	0.4	0.5
19[e]	--	--	--	--	0.7	0.5

[a]Sampling locations are shown in Figure 2-51.

[b]Measured background has not been subtracted.

[c]Sampling station established in August 1986.

[d]Background station established in 1985, approximately 24 km (15 mi) northeast of HISS.

[e]Background station established in April 1988, approximately 8 km (5 mi) east of HISS.

Source: BNI 1985d, 1986b, 1987e, 1988b, 1989c, 1990d.

Soil survey. The maximum concentrations of thorium-230, radium-226, uranium-238, and thorium-232 in the soil samples analyzed are 2,000, 2,300, 2,500, and 26 pCi/g, respectively. Gamma logging data and analytical results for subsurface soil show that contamination exists at depths ranging from the surface to more than 4.6 m (15 ft) below the surface. The volume of contaminated soil at Futura is 26,000 m^3 (34,000 yd^3). Characterization data are summarized in Table 2-50 (BNI 1987c); areas and depths of contamination at Futura are shown in Figure 2-53. Two thermoluminescent dosimeters installed in September 1986 were recovered and analyzed during the exchange of detectors in January 1987. Calculated radiation doses inside the buildings range from 2 to 22 mrem/yr above natural background. Continuous exposure for one year was assumed in calculating the radiation dose. The DOE radiation protection standard for external radiation is 100 mrem/yr in excess of natural background levels.

Air investigations. Four Track-Etch radon detectors installed in September 1986 were recovered and analyzed during the exchange of detectors in January 1987. The results show radon concentrations inside the buildings to range from 0.3 to 0.7 pCi/L, with an average value of 0.6 pCi/L. The DOE guideline for radon-222 is 3 pCi/L. Radon levels comparable to those measured inside the Futura buildings are typically found in outdoor areas where natural radium is present; results, therefore, indicate minimal intrusion of radon gas into the plant buildings.

Air particulate samplers were established inside the Futura buildings to determine gross alpha concentrations; 50 air particulate filter samples were collected and analyzed. Gross alpha concentrations range from less than 0.001 to 0.004 pCi/m^3. The DOE guideline is 0.04 pCi/m^3 for the maximum thorium-230 concentration in air in uncontrolled areas (lung retention class W) (DOE 1990a).

Latty Avenue Vicinity Properties

Radioactive contamination is present on all six Latty Avenue vicinity properties (Figure 2-4), and thorium-230 was identified as the major contaminant. Depths of contamination range from the surface to 4.3 m (14 ft) at one location on Property 1, but contamination is typically confined to the top 1 m (3 ft) of soil. In general, the areas of contamination are smaller and fewer as distance from HISS and Latty Avenue increases. The ranges of uranium-238, radium-226, thorium-232, and thorium-230 contamination on the six properties are given in Table 2-51; areas and depths of contamination are shown in Figures 2-54 through 2-59.

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TABLE 2-50

SUMMARY OF RADIOLOGICAL CHARACTERIZATION RESULTS FOR FUTURA

Type of Measurement	Number of Samples	Range Min.	Range Max.	Average
Near-surface gamma radiation[a] (cpm)		1,000	117,000	--
Gamma radiation exposure rate (μR/h)		8	27	12
Depth of radioactive contamination[b] (ft)		0	15	--
Radionuclide concentration (pCi/g)				
Thorium-232	547	Background	26	--
Radium-226	547	Background	2,300	--
Uranium-238	547	Background	2,500	--
Thorium-230	221	<1.1	2,000	--
Alpha contamination				
Surface contamination (dpm/100 cm^2)				
Nonremovable	38	20	149	3.7
Removable	22	<1	11	2.4

[a]Ground surface scanned; no average value could be calculated.

[b]There is no consistency in depths of contamination based on systematic drilling. The variable depth of the contamination can be attributed to disturbance of soils caused by previous excavations and subsequent placement of fill material, and to the natural variations in the topography of the property.

Source: BNI 1987c.

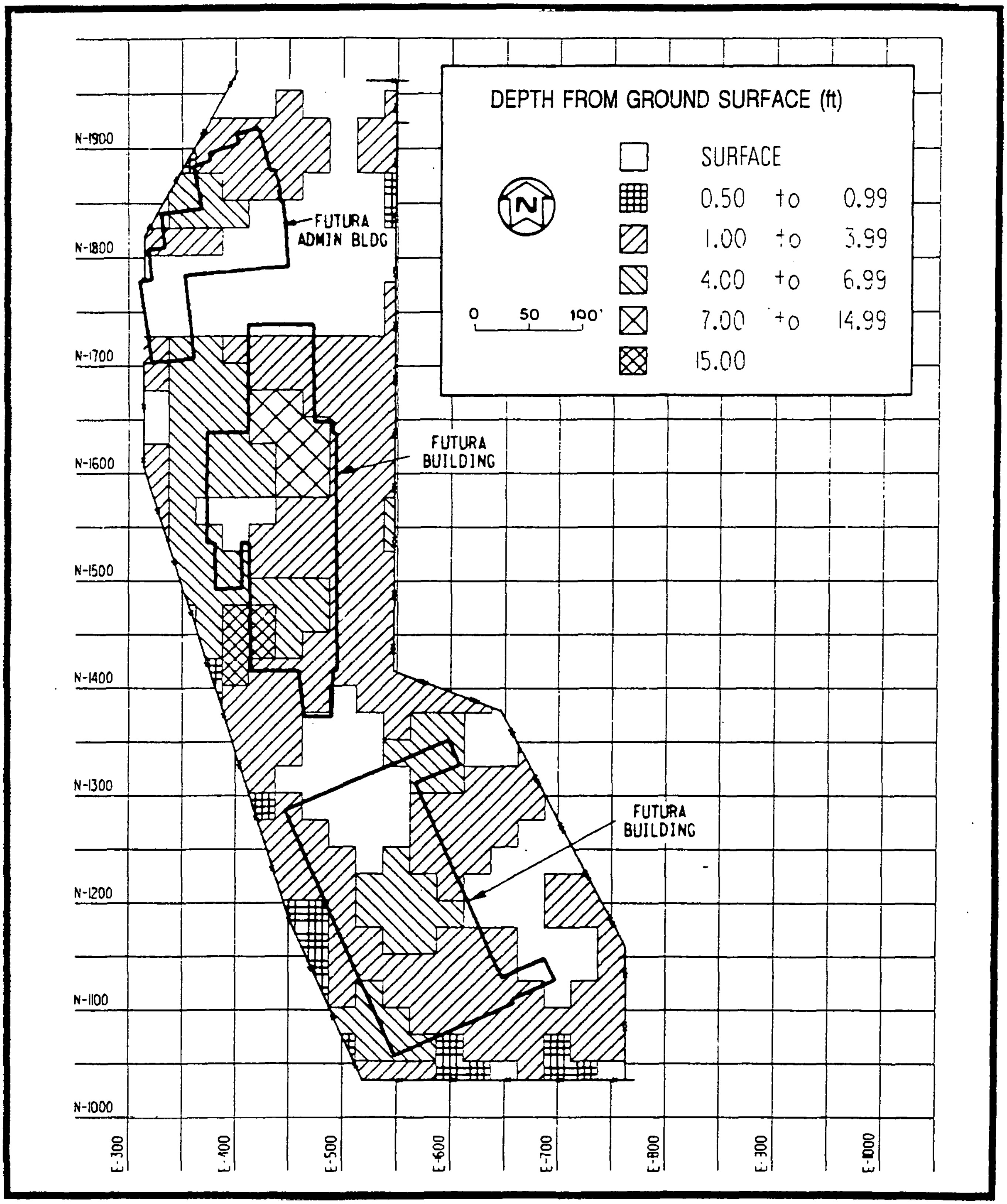

FIGURE 2-53 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE FUTURA COATINGS SITE

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TABLE 2-51

CHARACTERIZATION RESULTS FOR LATTY AVENUE

VICINITY PROPERTIES

Property Number	Concentration (pCi/g)							
	U-238		Ra-226		Th-230		Th-232	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	3	30	0.5	11	0.7	810	0.7	5
2	<3	100	0.6	89	0.4	5,700	0.7	5
3	4	39	0.6	4	0.2	31	<1	5
4	4	20	0.5	10	0.7	460	0.5	4
5	4	30	0.7	4	0.6	12	0.8	7
6	5	14	0.4	3	<0.7	21	0.8	4

Source: BNI 1990b.

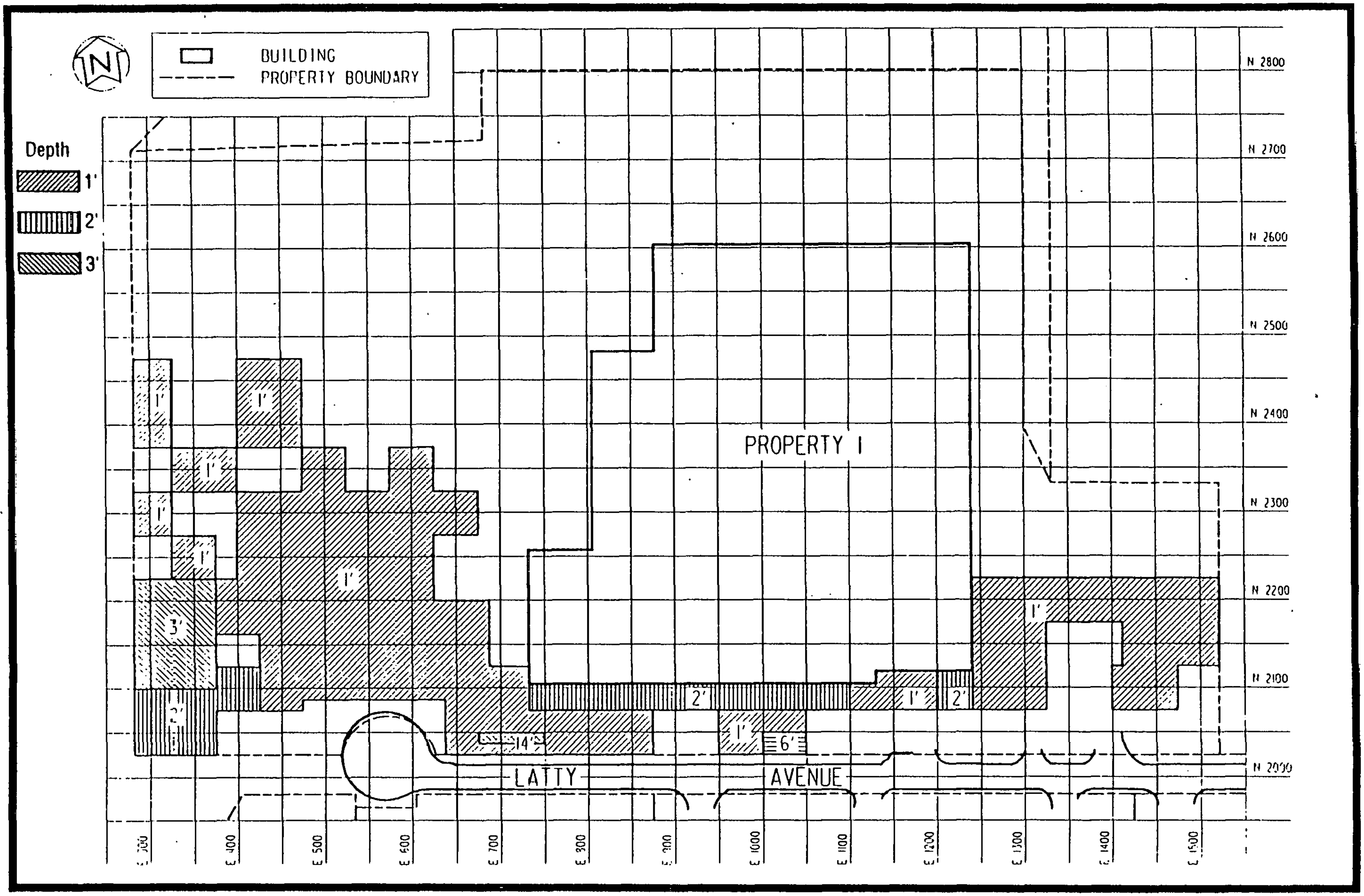

FIGURE 2-54 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 1 ON LATTY AVENUE

S34WMS18.DGN FIG7

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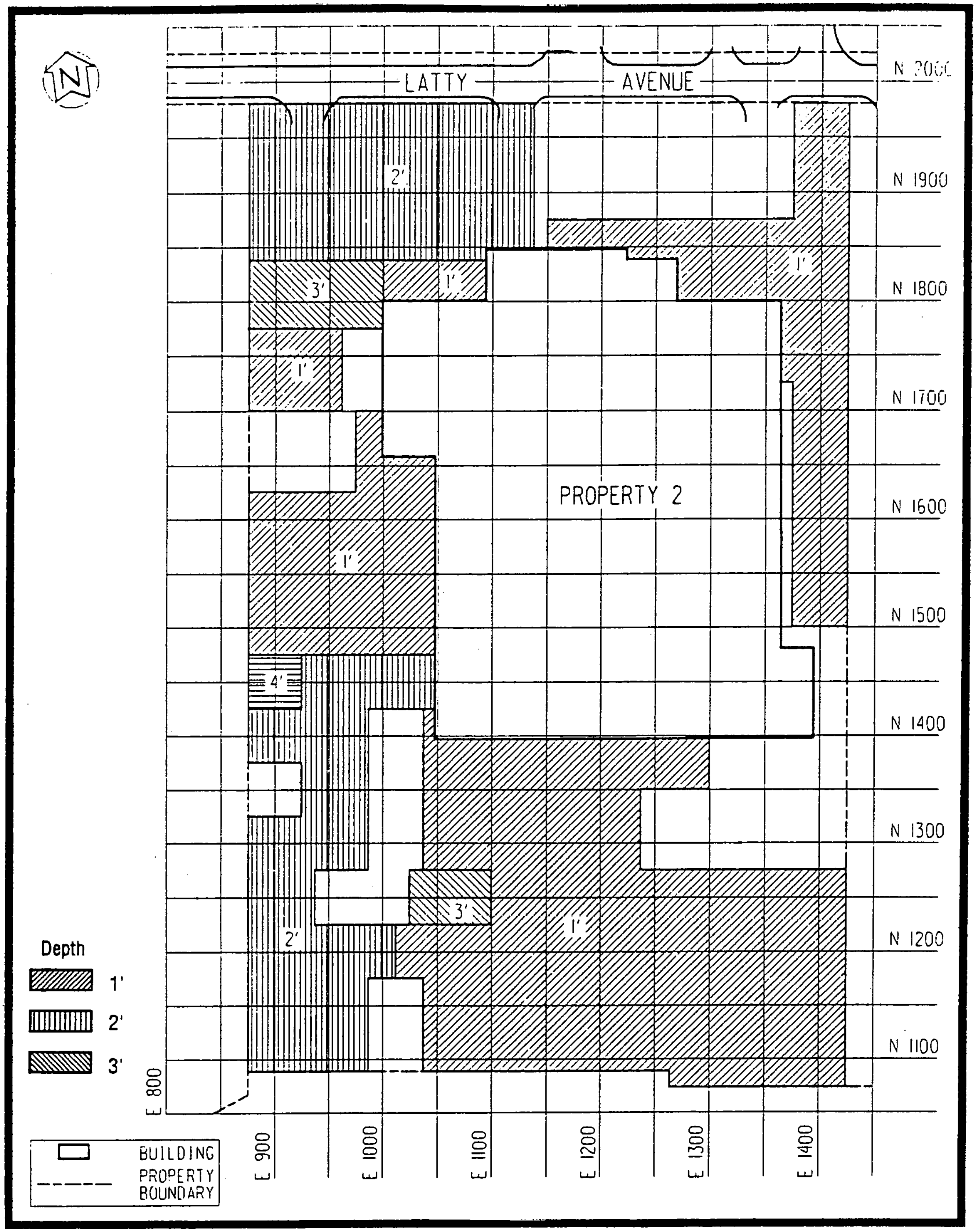

FIGURE 2-55 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 2 ON LATTY AVENUE

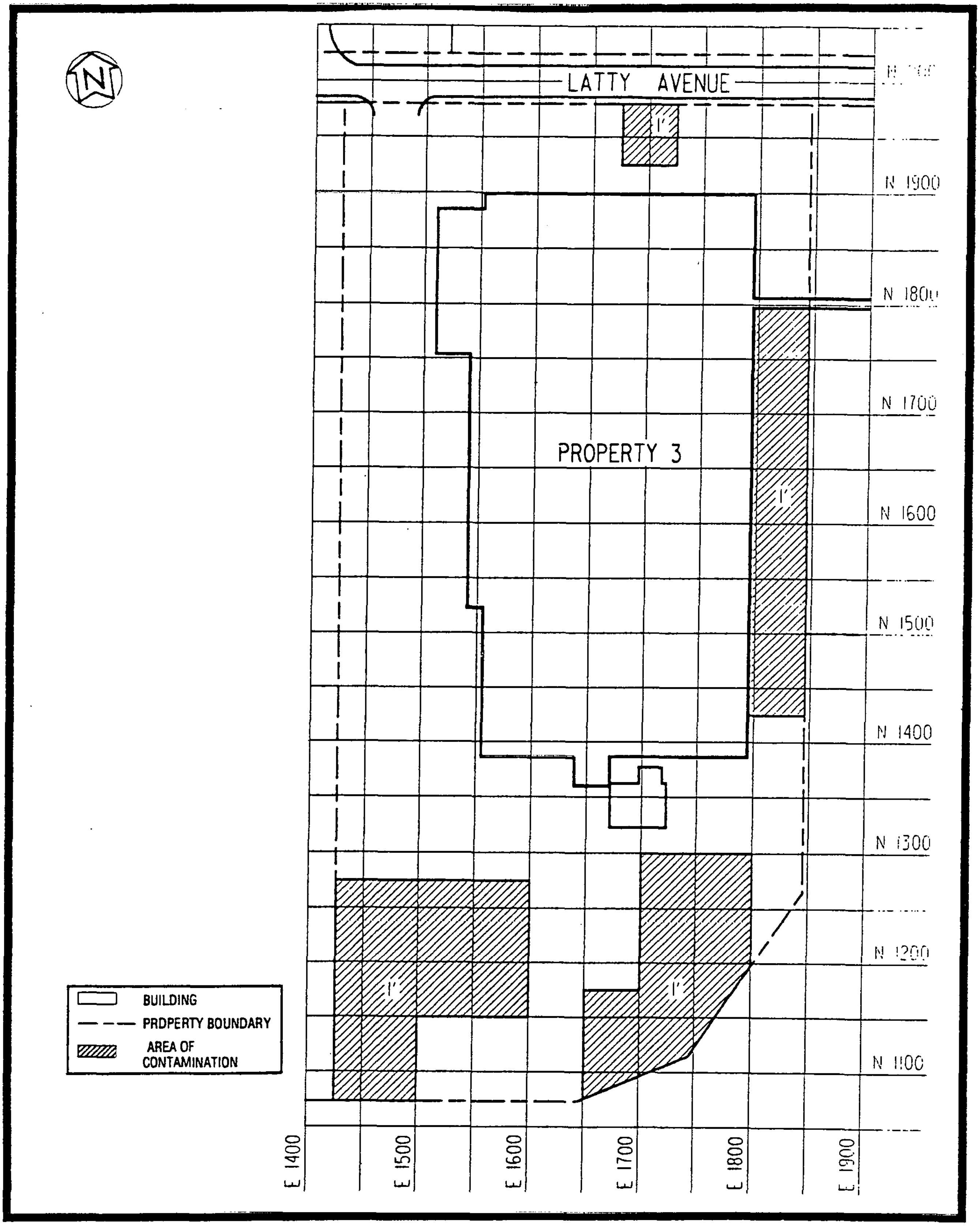

FIGURE 2-56 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 3 ON LATTY AVENUE

S34WMS15.DGN FIG7

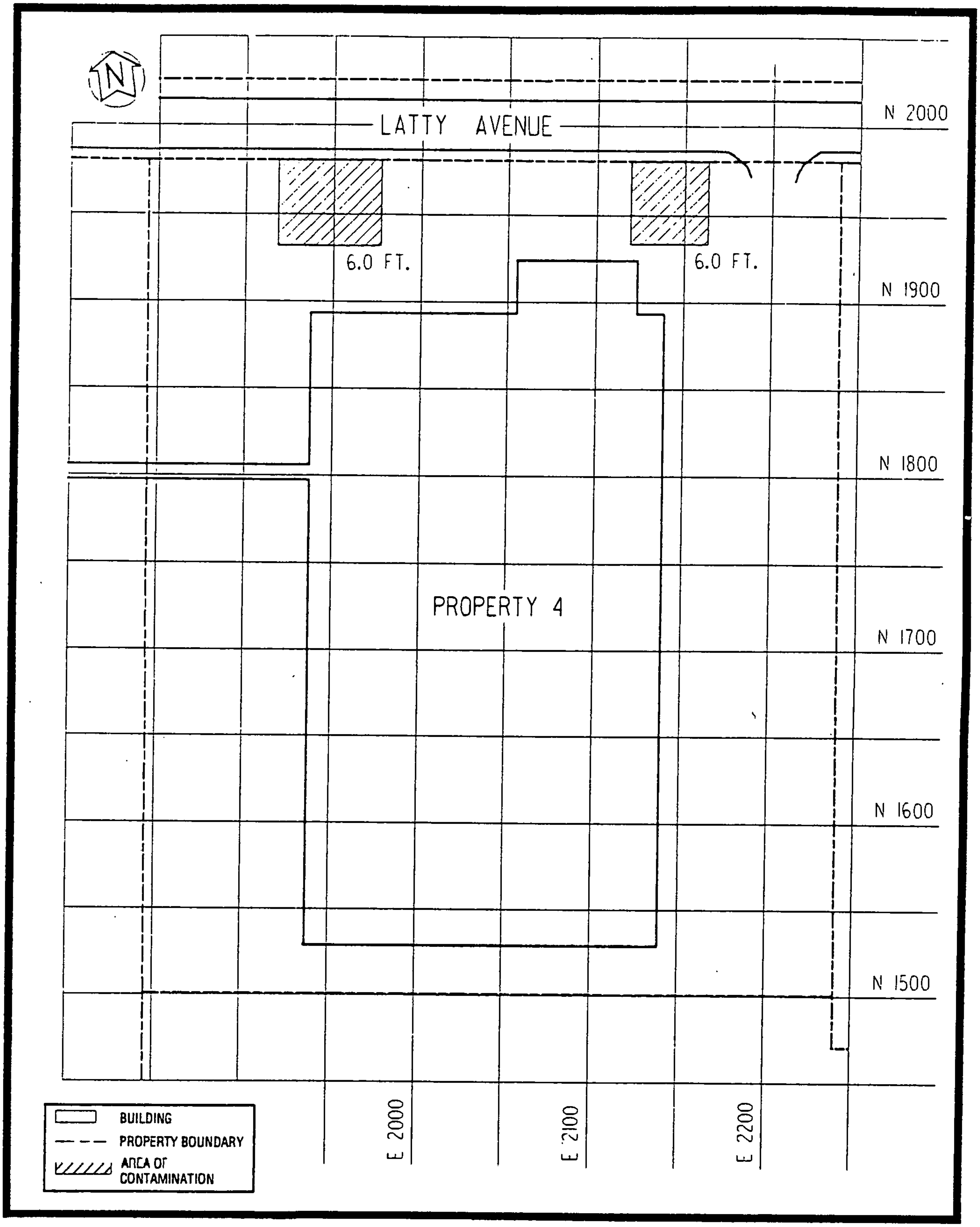

FIGURE 2-57 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 4 ON LATTY AVENUE

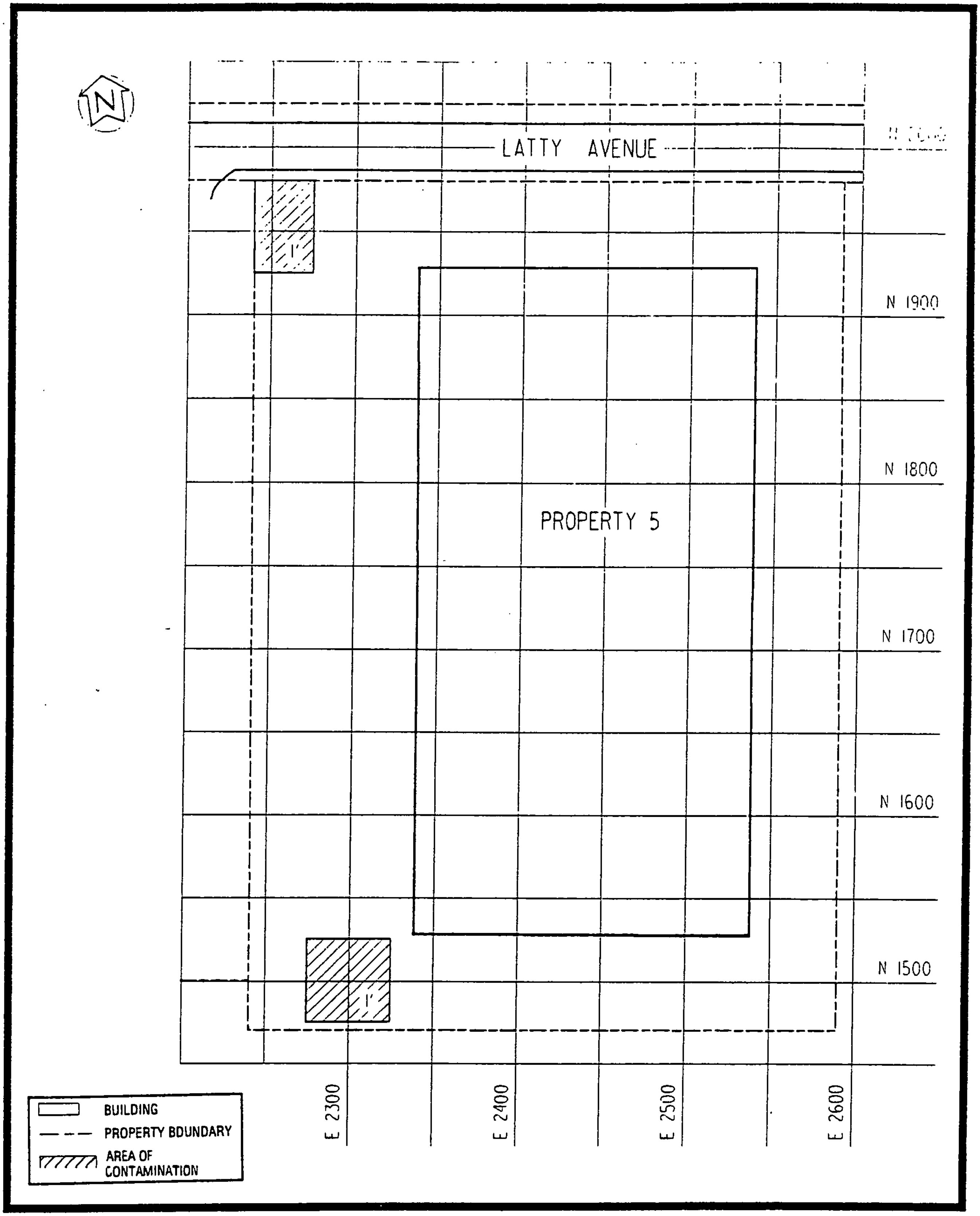

FIGURE 2-58 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 5 ON LATTY AVENUE

S34WMS13.DGN FIG7

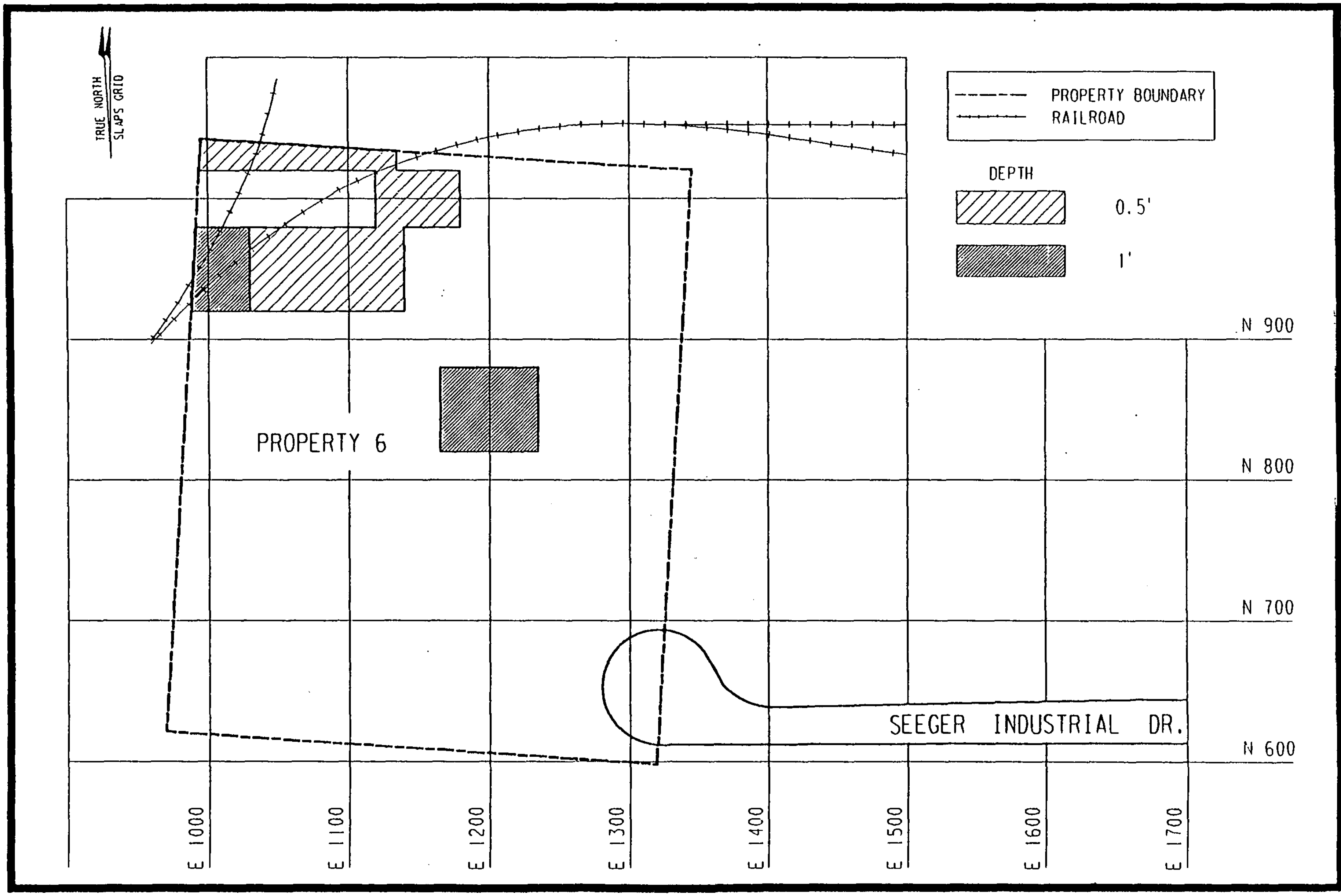

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FIGURE 2-59 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 6 ON SEEGER INDUSTRIAL DRIVE

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2.4.3 Chemical Conditions

Chemical sampling and analysis at the St. Louis site were conducted to meet one or a combination of the following objectives: (1) to identify and quantify the contaminants present, (2) to determine whether the material is classified as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) by analyzing for RCRA-hazardous waste characteristics, (3) to assess the potential health hazards from this material to workers performing remedial action activities so that proper design and implementation of a health and safety plan is possible, and (4) to define chemical characteristics, investigate some of the potential migration pathways, and determine any resulting impact on the design criteria for final disposal of the waste.

The planned field activities were completed based on the objectives of the characterization and the information obtained from scoping activities. These activities provided information needed to evaluate the chemical characteristics of the waste. The following types of analyses were completed for samples collected from the properties: metals, mobile ions, organics, and RCRA characteristics.

Aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc were measured in all soil and water samples. During Phase I, analysis was conducted for mercury in soil at SLDS. Because extraction procedure (EP) toxicity analyses for the presence and leachability of mercury had already been performed, this testing was not conducted during Phase II. Metals were chosen for analysis because of their presence in the uranium ores used in the process that produced the residues; barium was specifically targeted because it was used in the process as a coprecipitator of sulfates and radium. Previous limited chemical characterization of SLAPS showed the presence of metals in excess of background concentrations.

Because of their use in uranium processing at SLDS, mobile ion concentrations (including sulfate, fluoride, and nitrate) were determined for soil and water samples. Also, because of their negative charge, these ions will not bind to negatively charged clay particles. Therefore, the presence of the ions in concentrations exceeding background levels may indicate that waste is migrating from its source.

Priority pollutant organics, including volatiles and semivolatiles, were analyzed in soil and water samples to define the organic constituents in the waste.

Samples were tested for RCRA characteristics (ignitability, reactivity, corrosivity, and leachability for lead, silver, barium, chromium, arsenic, cadmium, mercury, selenium, and several pesticides) to determine whether the waste exhibits hazardous characteristics.

Water samples were analyzed for total organic halides (TOX), total organic carbon (TOC), pH, and specific conductance in accordance with accepted EPA protocol. These parameters are checked to monitor changes in organic and inorganic composition, which is indicative of groundwater quality, and they are used as indicators to determine the need for further chemical sampling. A change in the acidity or basicity (pH) affects the solubility and mobility of chemical contaminants. Specific conductance measures the capacity of water to conduct an electrical current, and it generally increases with elevated concentrations of dissolved solids. TOC and TOX are indicators of the organic content of water: TOC measures the total organic carbon content of water but is not specific to a given contaminant, and TOX measures organic compounds containing halogens.

Chemical sampling locations were selected in both a biased and random manner. Biased locations were sampled in alternating 0.6-m (2-ft) intervals at SLAPS; the samples were analyzed for RCRA characteristics, volatile organics, semivolatiles, and metals. At Futura and HISS, samples were taken at 0.3- to 0.6-m (1- to 2-ft) intervals within the known boundaries of radioactive contamination. Random borehole samples were analyzed for volatiles, semivolatiles, metals or mobile ions, and RCRA characteristics. An additional sample per random hole was collected from below the radioactive waste to determine whether any chemical contamination had migrated outside the boundaries of the radioactive contamination. Analyses for volatile organics, semivolatiles, and metals or mobile ions were performed on these samples.

Chemical constituents in groundwater at SLAPS were monitored in 16 wells for 5 quarters in 1988 and 1989. At the Latty Avenue Properties, chemical constituents were monitored in eight wells for five quarters, also in 1988 and 1989. For characterization at SLDS, eight wells were monitored for four quarters. Samples from SLAPS, SLDS, and Latty Avenue Properties were analyzed for volatile and semivolatile organics and metals. SLDS groundwater was also analyzed for pesticides and polychlorinated biphyenyls (PCBs). Currently available chemical data are summarized in the following subsections; they were compiled from various published and draft reports, as referenced.

St. Louis Downtown Site

Chemical characterization of soil was completed in two phases. In Phase I, 59 of the 109 boreholes were sampled and analyzed to determine the presence or absence of chemicals and to get a general indication of chemical distribution in relation to radioactive constituents. Soil samples were composited for analysis of metals, semivolatile organics, and RCRA-hazardous waste characteristics. Forty discrete samples from 23 boreholes were collected for analysis of volatile organics. In Phase II, 51 boreholes were sampled for chemical constituents to further define chemical distribution. During Phase II, discrete samples were submitted for analyses of metals and RCRA characteristics. Seven composite samples taken from the ground surface down to undisturbed soil were collected and analyzed for RCRA-hazardous waste characteristics. Figure 2-60 shows the locations of chemical boreholes.

Thirteen volatile organic compounds (VOCs) were detected in 20 of the 23 boreholes. Toluene was found in 31 of 40 samples, chloroform and trichlorofluoromethane in 12 of 40 samples, and methylene chloride in 11 of 40 samples. In general, concentrations of compounds detected were low, with mean concentrations ranging from 2.0 to 73 ppb. Table 2-52 shows the analytical results for VOCs in soil at SLDS during Phase I. No VOC analyses were conducted during Phase II because the average concentrations of VOCs detected in Phase I were low, none of the compounds detected are believed to be associated with MED/AEC activities, and the objectives of Phase I were met.

One composite sample each was collected and analyzed for base/neutral and acid extractable (BNAE) compounds from 56 of the 109 boreholes drilled during Phase I. BNAE analysis is an analytical tool for investigating semivolatile constituents that are partitioned into organic solvents and are amenable to gas chromatography. Extensive use of BNAE has been applied for investigative efforts regarding the semivolatile fraction of EPA's Target Compound List (TCL); the primary instrument used for analysis is the gas chromatography/mass spectrometry data system. Twenty-seven BNAE compounds were detected; all but nine were polynuclear aromatic hydrocarbons (PAHs), which are typically found in coal, coal products, or coal breakdown residues (Swann and Eschenroeder 1983, BNI 1990a). A coal-fired boiler and a coal stockpile are located on the property. Past disposal methods for the fly ash and slag generated are unknown, and other residues resulting from coal combustion or storage may have contributed to the distribution of PAHs at SLDS. Semivolatile compounds other than PAHs range from 660 ppb to 14,900 ppb. Of the PAHs, fluoranthene exhibits the highest concentration (300,000 ppb). Phenanthrene, benzo(a)pyrene, and chrysene occur in the next highest concentration. Table 2-53 lists summary statistics for BNAE organics detected in soil.

Analytical results for metals in soil are presented in Tables 2-54 and 2-55 for Phase I and Phase II, respectively. Concentrations of the following metals exceed the maximum expected background levels for natural soil: antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, molybdenum, selenium, silver, sodium, thallium, and

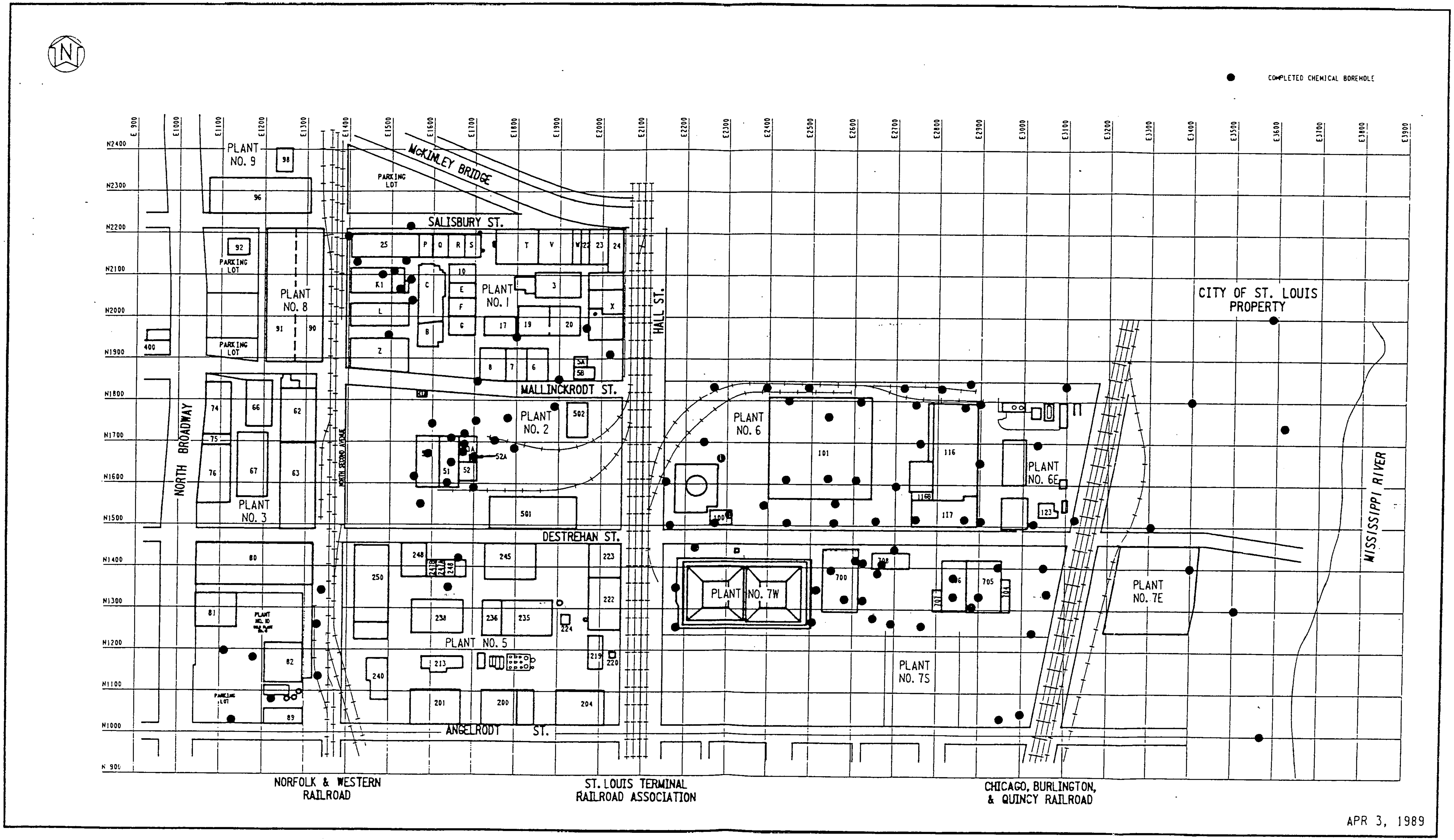

FIGURE 2-60 LOCATIONS OF CHEMICAL BOREHOLES AT SLDS

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TABLE 2-52

SUMMARY STATISTICS FOR VOLATILE ORGANICS DETECTED IN SOIL AT SLDS - PHASE I

Compound	Number of Samples	Number of Samples in Which Compound Was Detected	Concentration (µg/kg) Min.	Max.	Mean
Benzene	40	3	2.2	16	9.3
Carbon tetrachloride	40	1	4.9	4.9	4.9
Chlorobenzene	40	1	4.5	4.5	4.5
Chloroform	40	12	1	62	12
1,1-dichloroethane	40	3	2.2	5.5	4.3
Ethylbenzene	40	4	1	3.6	2.0
Methylene chloride	40	11	4.1	77	14
Toluene	40	31	1.2	340	43
Total xylenes	40	10	1.5	66	11
1,1,1-trichloroethane	40	4	1.4	47	14
Trichloroethene	40	8	1.4	430	73
Trichlorofluoromethane	40	12	1.8	70	10
Trans-1,2-dichloroethene	40	1	6.4	6.4	6.4

Source: BNI 1990a.

TABLE 2-53

SUMMARY STATISTICS FOR BNAEs DETECTED IN SOIL

AT SLDS - PHASE I

Compound	Number of Samples	Number of Samples in Which Compound Was Detected	Concentration (µg/kg) Min.	Max.	Mean
2,4-dimethylphenol	56	2	2,600	5,500	4,050
Phenol	56	1	5,700	5,700	5,700
Acenaphthylene	56	9	450	4,200	1,600
Anthracene	56	34	420	84,000	4,700
Benzyl alcohol	56	1	7,000	7,000	7,000
Benzo(a)anthracene	56	48	400	34,000	4,300
Benzo(a)pyrene	56	40	400	110,000	5,400
Benzo(g,h,i)perylene	56	18	540	6,400	2,400
Benzo(k)fluoranthene	56	31	540	94,000	6,300
Benzo(b)fluoranthene	56	40	510	78,000	5,400
Bis(2-ethylhexyl)phthalate	56	11	310	1,600	820
Chrysene	56	47	430	110,000	6,700
Dibenzo(a,h)anthracene	56	6	440	3,900	1,600
Dibenzofuran	56	17	400	11,000	1,900
Fluoranthene	56	50	410	300,000	14,900
Fluorene	56	16	500	15,000	2,700
Hexachlorobutadiene	56	1	1,900	1,900	1,900
Indeno(1,2,3-cd)pyrene	56	25	430	12,000	2,600
2-methylnaphthalene	56	10	410	8,600	1,600
Naphthalene	56	12	460	32,000	3,600
Phenanthrene	56	49	520	280,000	14,600
Pyrene	56	52	500	63,000	7,300
Acenaphthene	56	19	400	7,400	1,700
Di-n-butyl phthalate	56	2	410	760	585
2-chlorophenol	56	1	660	660	660
4-methylphenol	56	1	3,200	3,200	3,200
4-chloro-3-methylphenol	56	1	880	880	880

Source: BNI 1990a.

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TABLE 2-54

SUMMARY STATISTICS FOR METAL CONTAMINANTS AT SLDS - PHASE I

Metal	Number of Samples: Analyzed	Number of Samples: In Excess of Background	Number of Samples: In Excess of Background and SDL[b]	Concentration (mg/kg)[a]: Mean[c]	Concentration (mg/kg)[a]: Min.	Concentration (mg/kg)[a]: Max.
Antimony	58	58	26	83.1	10.9	3,190
Arsenic	58	23	23	37.8	16.1	96.2
Barium	58	1	1	388	57.7	5,220
Boron	58	12	12	64.3	17.6	253
Cadmium	58	58	44	3.6	0.88	44.1
Copper	58	21	21	106	27.4	617
Lead	58	36	36	1,460	46.2	32,300
Magnesium	58	4	4	3,310	916	17,500
Mercury	58	54	54	3.5	0.12	37.9
Molybdenum	58	58	10	21.6	16.1	35.7
Selenium	58	58	9	28.3	16.1	253
Silver	58	22	22	6.3	1.8	49.7
Thallium	58	58	16	39.3	16.1	234
Zinc	58	31	31	421	38.6	1,530

[a]Maximum and minimum values include results reported below background values.

[b]SDL - sample detection limit.

[c]All values, including those reported as the SDL, were used to calculate the mean.

Source: BNI 1990a.

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TABLE 2-55

SUMMARY STATISTICS FOR METAL CONTAMINANTS AT SLDS - PHASE II

Metal	Number of Samples: Analyzed	Number of Samples: In Excess of Background	Number of Samples: In Excess of Background and SDL[b]	Concentration (mg/kg)[a]: Mean[c]	Concentration (mg/kg)[a]: Min.	Concentration (mg/kg)[a]: Max.
Antimony	126	125	31	33.8	9.3	385
Arsenic	126	23	22	32.0	15.6	200
Barium	126	2	2	321	31.1	7,670
Boron	126	12	11	44.3	15.6	229
Cadmium	126	126	39	1.7	0.78	18.4
Chromium	126	1	1	57.0	4.3	4,400
Cobalt	126	2	1	13.7	7.8	231
Copper	126	21	21	74.6	6.4	1,120
Lead	126	34	34	276	17.1	8,340
Magnesium	126	20	20	4,490	778	44,500
Manganese	126	2	2	544	25.1	5,200
Molybdenum	126	126	0	23.2	15.6	200
Selenium	126	126	78	104	16.3	1,330
Silver	126	21	20	5.7	1.6	159
Sodium	126	1	1	1,230	778	10,000
Thallium	126	126	79	41.9	18.2	318
Zinc	126	34	34	370	29.9	11,300

[a]Maximum and minimum values include results reported below background values.
[b]SDL - sample detection limit.
[c]All values, including those reported as the SDL, were used to calculate the mean.
Source: BNI 1990a.

zinc. In general, these metals were found in comparable levels in composite and discrete samples collected in Phases I and II; however, chromium, cobalt, sodium, and manganese were present in excess of expected background concentrations (at very low concentrations) in Phase II but were absent in Phase I. Most metals exceeding expected background concentrations were found at depths of less than 1.8 m (6 ft), but selenium and thallium appear at depths as great as 5.5 to 6 m (18 to 20 ft).

Of the eight metals analyzed for EP toxicity (lead, silver, barium, chromium, arsenic, cadmium, mercury, and selenium), only a limited number of samples failed the test for lead. Soil samples were also tested for ignitability, reactivity, and corrosivity; no samples failed these tests. Results from Phase I indicate that three very small, isolated areas exist where soil fails the hazardous waste criterion for EP toxicity-lead (boreholes B16C02, B16C30, and B16C37). Therefore, it appears that most metals at SLDS are unlikely to leach from soil to groundwater.

In all likelihood, the materials will not have to be handled as hazardous wastes when excavated because current procedures allow averaging of analytical results obtained from a waste matrix. Before final remedial action begins, the extent of contamination from lead or other metals will be confirmed utilizing the toxicity characteristic leaching procedure (TCLP), which replaced the EP toxicity test. In general, there are chemical contaminants in the form of metals at the St. Louis site, and PAH compounds have been detected at elevated levels at SLDS.

Groundwater monitoring for chemical indicator parameters (pH, specific conductance, TOX, and TOC) was conducted for four quarters to reveal possible changes in the inorganic and organic composition of the groundwater. Fluoride and nitrate samples were collected and analyzed for one quarter. Groundwater was also analyzed for VOCs, BNAEs, pesticides, and PCBs.

Ten organic compounds were detected in wells at SLDS; benzene was the most frequently found (in 6 of 24 samples) but is not believed to have been a component of uranium processing conducted for MED. Table 2-56 is a one-year summary of organics detected at SLDS, and Table 2-57 lists results for water quality parameters for each well.

The majority of the organic groundwater contaminants appear consistently in well B16W03S (7 of 10 organics detected were found in this well); 17 of the 25 positive values detected for all samples were from this well (Table 2-58). Dimethyl ether was detected as a tentatively identified compound, which means that it is probably present but its concentration is uncertain. Dimethyl ether was used in uranium processing at SLDS during MED/AEC activities, but it is probably not the result of MED/AEC activities because it is a volatile compound that would long since have dissipated. It is not a hazardous waste and its presence will not affect engineering design for remedial action.

TABLE 2-56

SUMMARY STATISTICS FOR VOLATILE ORGANICS, BNAEs, AND PESTICIDE/PCB COMPOUNDS DETECTED IN GROUNDWATER AT SLDS

Metal	Number of Samples Analyzed	Number of Samples Above Detection Limit	Concentration (µg/L) Mean[a]	Concentration (µg/L) Min.	Concentration (µg/L) Max:
Volatile organics					
Benzene	24	6	8	< 5	21
Chlorobenzene	24	2	5	< 5	8
1,2-dichloroethene	24	3	12	< 5	150
1,2-dichloropropane	24	3	13	< 5	130
Trichloroethene	24	1	5	< 5	5
Vinyl chloride	24	2	11	<10	29
BNAEs					
1,2-dichlorobenzene	24	3	20	<10	93
Bis(2-ethylhexyl)-phthalate[b]	24	2	69	<10	1,100
Pesticides/PCBs					
4,4'DDT	24	1	0.17	<0.1	0.98
Aroclor-1254	24	2	1.6	<1.0	<5.3

[a]All values, including those reported as sample detection limit, were used to calculate the mean.

[b]Detected in blanks at low concentrations and not found in the next quarter's monitoring results.

Source: BNI 1990a.

TABLE 2-57

RANGES OF WATER QUALITY PARAMETERS IN GROUNDWATER AT SLDS

Sampling Location (Well No.)[c]	Parameter[a,b]					
	pH (Standard Units)	Total Organic Carbon (mg/L)	Total Organic Halides (μg/L)	Specific Conductance (μmhos/cm)	Fluoride[d] (mg/L)	Nitrate[d] (mg/L)
B16W01S	7.3-7.4	6.5-36.8	19-58	231-1220	0.15	<0.10
B16W02S	6.9-7.0	5.9-7.7	<20	1060-1200	0.48	<0.10
B16W03S	6.9-7.8	12.9-24.2	83-690	1770-9820	6.2	<0.10
B16W04S	7.0-7.7	2.5-7.4	<10-68	896-1050	0.47	0.21
B16W05D	7.0	9.8-26.0	13-450	2480-2780	--[e]	--[e]
B16W06D	6.7-6.9	9.7-11.0	20-520	2150-3470	0.21	<0.10
B16W07D	6.8-6.9	5.1-83.6	<10-51	2150-2950	0.30	<0.10
B16W08D	6.8-7.9	6.8-11.8	<10-78	2210-8030	0.28	<0.10

[a]The "<" symbol indicates that the method did not detect the presence of the analyte above the detection limit.

[b]If a single value is given, the same value was obtained for all quarters that the samples were taken.

[c]Monitoring well locations are shown in Figure 2-31.

[d]Analysis for fluoride and nitrate was conducted for samples collected during one quarter.

[e]Sample lost.

Source: BNI 1990a.

TABLE 2-58

RANGES OF VOLATILE ORGANICS, BNAEs, AND PESTICIDE/PCB COMPOUNDS DETECTED IN GROUNDWATER AT SLDS[a]

Analyte (μg/L)	Sampling Location (Well No.)[b,c,d]							
	B16W01S	B16W02S	B16W03S	B16W04S	B16W05D	B16W06D	B16W07D	B16W08D
Volatile organic compounds								
Benzene	ND	6	18-21	21	ND	9	ND	ND
Chlorobenzene	ND	ND	7-8	ND	ND	ND	ND	ND
1,2-dichloroethene	ND	ND	7-150	ND	ND	ND	ND	ND
1,2-dichloropropane	ND	ND	29-130	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	5	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	23-29	ND	ND	ND	ND	ND
BNAEs								
1,2-dichlorobenzene	ND	ND	87-93	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)-phthalate	ND	ND	ND	ND	340[e]	ND	1,100[e]	ND
Pesticides/PCBs								
4,4'DDT	ND	ND	ND	ND	ND	ND	0.98	ND
Aroclor-1254	ND	ND	ND	1.2-1.5	ND	ND	ND	ND

[a]Does not include parameters for which the concentrations were below the limit of sensitivity of the analytical method used.

[b]ND - not detectable at levels above the detection limit.

[c]Sampling locations are shown in Figure 2-31.

[d]A single value indicates that the compound was present during one quarter's sampling results.

[e]Compound was detected in the blank.

Source: BNI 1990a.

Sixteen metals were detected in groundwater (summarized in Table 2-59). Both calcium and sodium were found in all samples analyzed. Boron, magnesium, and manganese were detected in 31 of 32 samples analyzed, and potassium and zinc were detected in 29 of 32. Thallium and lead were completely absent at levels above the detection limit. Metals associated with uranium ores (arsenic, barium, nickel, and selenium) were generally present in concentrations of 100 to 700 µg/L. Cadmium, chromium, and copper (also associated with uranium ores) were detected at much lower concentrations. With the exception of zinc, those metals detected most frequently in soils (thallium, selenium, mercury, cadmium, lead, and zinc) were not frequently found above detection limits in groundwater.

St. Louis Airport Site

Soil samples at SLAPS were collected from biased and randomly selected locations (Figure 2-61). Biased locations were selected based on historical information regarding MED/AEC activities, radiological data obtained from previous characterizations, and current site conditions. Biased sampling locations were first selected from locations where radiological boreholes had been drilled previously; samples from these locations were analyzed for RCRA-hazardous waste characteristics, metals, VOCs, and BNAEs.

One sample per hole was taken from beneath the maximum depth of radioactive contamination and analyzed for VOCs, metals, and semivolatiles. In some instances, random sampling locations were the same used for boreholes in previous radiological sampling. Samples from at least two intervals per borehole were randomly selected and analyzed for VOCs, BNAEs, and metals. The entire depth of the hole in the area of radioactive contamination was composited and tested for RCRA-hazardous waste characteristics in 22 boreholes. Twenty-two and eight boreholes were drilled in random and biased locations, respectively; 109 soil samples were submitted for analysis. Table 2-60 shows the analyses performed on given depth intervals for the biased and random sampling locations.

Three VOCs exceeding detection limits were found in 37 of 90 soil samples submitted for analysis. The concentrations of these compounds (with the exception of toluene) are very low, in the ppb range. The VOCs are generally unevenly distributed at the property; however, toluene was consistently found in borings from the eastern portion of the property. None of those compounds is believed to have been used during uranium processing. Toluene was found in 26 of the samples at concentrations ranging from 1.5 to 1,200 ppb. Trichloroethene was found in six samples at

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TABLE 2-59

SUMMARY STATISTICS FOR METALS IN GROUNDWATER AT SLDS

Metal	Number of Samples Analyzed	Number of Samples Above Detection Limit	Concentration (μg/L) Mean[a]	Concentration (μg/L) Min.	Concentration (μg/L) Max.
Aluminum	32	12	219	<200	400
Antimony	32	0	<55.0	<40.0	<60.0
Arsenic	32	2	101	<100	126
Barium	32	8	253	<200	536
Beryllium	32	0	<5.0	<5.0	<5.0
Boron	32	31	1,050	<100	1,850
Cadmium	32	2	5.2	<5.0	10.9
Calcium (x 1000)	32	32	190	43.4	294
Chromium	32	1	11.3	<10.0	50.0
Cobalt	32	0	<50.0	<50.0	<50.0
Copper	32	4	25.7	<25.0	37.3
Iron	32	24	2,970	<100	20,800
Lead	32	0	<100	<100	<100
Magnesium (x 1000)	32	31	39.2	<5.00	69.8
Manganese	32	31	1,930.0	<15.0	4,520
Molybdenum	32	0	<100	<100	<100
Nickel	32	5	66	<40.0	714
Potassium (x 1000)	32	29	18.9	<5.00	62.7
Selenium	32	1	100	<100	108
Silver	32	0	<10.0	<10.0	<10.0
Sodium (x 1000)	32	32	134	18.3	506
Thallium	32	0	<100	<100	<100
Vanadium	32	0	<50.0	<50.0	<50.0
Zinc	32	29	79.0	<20.0	301

[a]All values, including those reported as the sample detection limit, were used to calculate the mean.

Source: BNI 1990a.

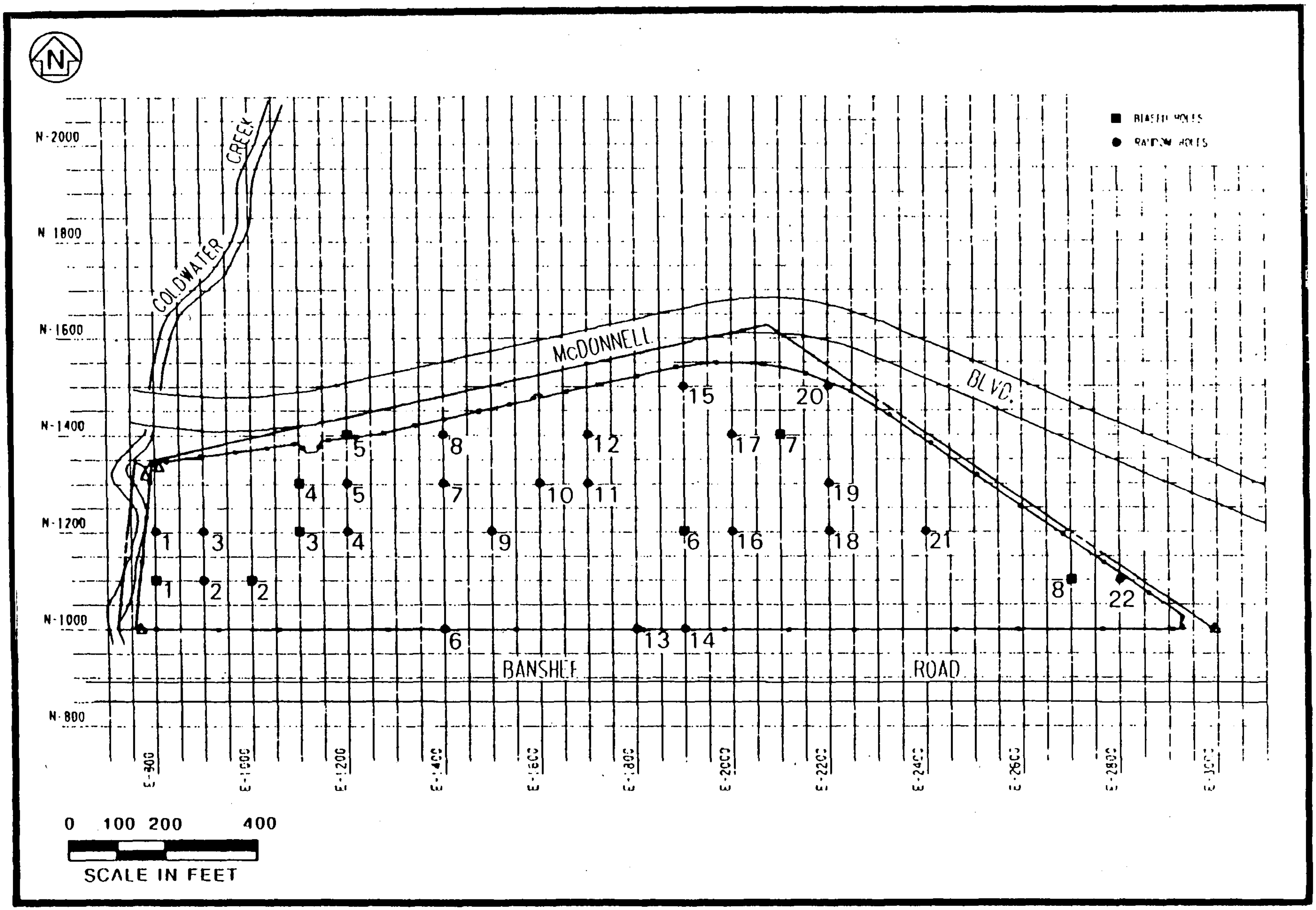

FIGURE 2-61 CHEMICAL SOIL SAMPLING LOCATIONS AT SLAPS

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TABLE 2-60

ANALYSES PERFORMED ON BIASED AND RANDOM SAMPLES FROM SLAPS

		Analyses Performed				
Sampling Location[a]	Depth (ft)	RCRA	Mobile Ions	Metals	Volatile Organics	Semi-Volatile Organics
Biased						
B1	0-2	X	X	X	X	X
	4-6	X	X	X	X	X
	8-10	X	X	X	X	X
	14-16		X	X	X	X
B2	0-2	X	X	X	X	X
	4-6	X	X	X	X	X
	8-10	X	X	X	X	X
	12-14	X	X	X	X	X
	16-18	X	X	X	X	X
	20-22		X	X	X	X
B3	4-6	X	X	X	X	X
	7-8	X	X	X	X	X
	10-12		X	X	X	X
B4	0-2	X	X	X	X	X
	4-6	X	X	X	X	X
	8-10		X	X	X	X
B5	0-2	X	X	X	X	X
	4-6		X	X	X	X
B6	0-2	X	X	X	X	X
	4-6	X	X	X	X	X
	8-10	X	X	X	X	X
	14-16		X	X	X	X
B7	0-2	X	X	X	X	X
	4-6	X	X	X	X	X
	8-10		X	X	X	X
B8	0-2	X	X	X	X	X
	4-6	X	X	X	X	X
	10-12		X	X	X	X

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TABLE 2-60

(continued)

Sampling Location[a]	Depth (ft)	Analyses Performed: RCRA	Mobile Ions	Metals	Volatile Organics	Semi-Volatile Organics
Random						
R1	0-2		X	X	X	X
	0-6	X				
	4-6		X	X	X	X
	8-10		X	X	X	X
R2	0-2		X	X	X	X
	6-8		X	X	X	X
	0-8	X				
	10-12		X	X	X	X
R3	3-5	X	X	X	X	X
	6-8		X	X	X	X
R4	4-6		X	X	X	X
	14-16		X	X	X	X
	0-18	X				
	20-22		X	X	X	X
R5	0-2		X	X	X	X
	2-4		X	X	X	X
	0-10	X				
	12-14		X	X	X	X
R6	0-2		X	X	X	X
	4-6		X	X	X	X
	0-6	X				
	8-10		X	X	X	X
R7	0-2		X	X	X	X
	0-3	X				
	4-6		X	X	X	X
R8	0-1	X	X	X	X	X
	2-4		X	X	X	X
R9	0-2		X	X	X	X
	2-4		X	X	X	X
	0-8	X				
	10-12		X	X	X	X

TABLE 2-60

(continued)

Sampling Location[a]	Depth (ft)	Analyses Performed: RCRA	Mobile Ions	Metals	Volatile Organics	Semi-Volatile Organics
R10	0-2		X	X	X	X
	2-4		X	X	X	X
	0-6	X				
	8-10		X	X	X	X
R11	0-2		X	X	X	X
	2-4		X	X	X	X
	0-6	X				
	8-10		X	X	X	X
R12	0-2		X	X	X	X
	2-4		X	X	X	X
	0-7	X				
	8-10		X	X	X	X
R13	0-2		X	X	X	X
	2-4		X	X	X	X
	0-5	X				
	6-8		X	X	X	X
R14	0-1		X	X	X	X
	2-4		X	X	X	X
	0-5	X				
	6-8		X	X	X	X
R15	4-6		X	X	X	X
	8-10		X	X	X	X
	0-15	X				
	18-20		X	X	X	X
R16	2-4		X	X	X	X
	6-8		X	X	X	X
	0-8	X				
	10-12		X	X	X	X
R17	0-2		X	X	X	X
	2-4		X	X	X	X
	0-7	X				
	8-10		X	X	X	X

TABLE 2-60

(continued)

Sampling Location[a]	Depth (ft)	Analyses Performed: RCRA	Mobile Ions	Metals	Volatile Organics	Semi-Volatile Organics
R18	0-2		X	X	X	X
	4-6		X	X	X	X
	0-8	X				
	10-12		X	X	X	X
R19	0-2		X	X	X	X
	2-4		X	X	X	X
	0-5	X				
	6-8		X	X	X	X
R20	0-2		X	X	X	X
	2-4		X	X	X	X
	0-6	X				
	8-10		X	X	X	X
R21	0-2		X	X	X	X
	2-4		X	X	X	X
	0-6	X				
	8-10		X	X	X	X
R22	1-2	X	X	X	X	X
	4-6		X	X	X	X

[a]Sampling locations are shown in Figure 2-61.

Source: BNI 1990e.

concentrations ranging from 1.6 to 15 ppb. Trans-1,2-dichloroethene was found in five samples at concentrations ranging from 1.3 to 7.7 ppb (BNI 1990e).

Fifty-two of the 90 soil samples contained BNAEs (BNI 1990e).

Analytical results for metals in soil are summarized in Table 2-61; 15 metals are present at concentrations exceeding background levels. Sample results were compared with a range of background metal concentrations for soils, as was done at SLDS. Cadmium, molybdenum, and selenium were detected in all samples at concentrations exceeding background. Barium exceeded the background level in 5 of the 90 samples, but these 5 samples were collected from an area of known barium sulfate cake disposal (BNI 1990e).

Most of the metals found at levels greater than the detection limit appear to be confined to near-surface depths [0 to 2 m (0 to 6 ft)]. Magnesium was detected as deep as 6.7 m (22 ft), which is below the depth of radioactive contamination [down to 5.5 m (18 ft)] previously defined at locations from which biased samples were collected. Magnesium, cadmium, molybdenum, nickel, cobalt, copper, lead, zinc, arsenic, selenium, and barium were detected within the known boundaries of radioactive wastes in these same boreholes. At the random borehole locations, radioactive contamination was detected at depths between 0.15 and 5.5 m (0.5 and 18 ft). Arsenic, cadmium, cobalt, copper, molybdenum, chromium, lead, antimony, zinc, magnesium, barium, nickel, and selenium were detected within the radioactive waste. Magnesium, cadmium, and cobalt were detected in the sample obtained from a depth greater than 5.5 m (18 ft) (BNI 1990e).

Biased samples taken from within the radioactive waste and composite samples from random boreholes were tested for RCRA-hazardous waste characteristics. All samples were below the criteria for reactivity, ignitability, corrosivity, and toxicity.

Soil sample analyses were performed for the mobile ions fluoride, nitrate, and sulfate, selected for analysis because they were present in material used to process uranium ore. SLAPS has sulfate residues with a content of 860 ppm; the background value is 610 ppm. Fluoride was slightly higher than background (1.2 to 31 ppm) in four samples that range from 32.4 to 62.9 ppm (BNI 1990e).

Chemical indicator parameters (pH, specific conductance, TOC, and TOX) were monitored in groundwater to reveal possible changes in inorganic and organic composition. Results indicate groundwater of poor quality (Table 2-62) (BNI 1988a, 1989a, 1990c). Groundwater was analyzed for metals to determine whether metals present in the original uranium ore had leached into the groundwater. The same sixteen metals detected in soil samples obtained from the property were found in groundwater.

TABLE 2-61

SUMMARY STATISTICS FOR METAL CONTAMINANTS IN SOIL AT SLAPS

	Number of Samples			Concentration (mg/kg)[a]		
Metal	Analyzed	In Excess of Background	In Excess of Background and SDL[b]	Mean[c]	Min.	Max.
Antimony	90	1	1	13.0	9.9	53.2
Arsenic	90	3	3	27.0	16.4	237
Barium	90	5	5	810.0	62.3	13,600
Cadmium	90	90[d]	16	1.9	0.82	50.4
Chromium	90	1	1	48.0	3.1	3,240
Cobalt	90	22	22	170.0	8.6	6,050
Copper	90	11	11	100.0	9.0	4,400
Lead	90	5	5	82.0	19.1	1,200
Magnesium	90	30	30	6,200.0	1,360	26,900
Molybdenum	90	90[d]	14	31.0	16.4	255
Nickel	90	4	4	240.0	7.7	7,570
Selenium	90	90[d]	3	24.0	16.4	183
Thallium	90	90[e]	0	22.0	16.4	39.7
Vanadium	90	3	3	95.0	16.1	862
Zinc	90	2	2	110.0	21.1	4,330

[a]Maximum and minimum values include results reported below background values.

[b]SDL - sample detection limit.

[c]All values, including those reported as the SDL, were used to calculate the mean.

[d]Elevated SDLs were encountered in most samples as a result of matrix interference during analysis. All SDLs and measurable concentrations exceed background levels.

[e]Elevated SLDs were encountered in all samples as a result of matrix interference during analysis.

Source: BNI 1990e.

TABLE 2-62

ANALYTICAL RESULTS FOR INDICATOR PARAMETERS IN GROUNDWATER AT SLAPS, 1987-1989

Page 1 of 2

		Parameter			
Year	Sampling Location (Well No.)[a]	pH (Standard Units)	Total Organic Carbon (mg/L)	Total Organic Halides (µg/L)[b]	Specific Conductance (µmhos/cm)
1987	A	6.6 - 6.8	4.8 - 9.0	20 - 190	1,320 - 1,350
1988		6.7 - 6.9	5.0 - 16.2	38 - 88	1,310 - 1,440
1989		6.7 - 6.9	5.0 - 18.6	ND - 88	1,310 - 1,770
1987	B	6.5 - 6.7	7.4 - 13.9	40 - 250	7,540 - 8,810
1988		6.6 - 7.5	6.7 - 20.0	100 - 270	6,870 - 7,620
1989		6.6 - 7.5	6.7 - 24.5	31 - 270	6,870 - 8,070
1987	C	6.7 - 6.9	4.9 - 6.8	23 - 69	1,600 - 1,870
1988		6.7 - 7.0	4.4 - 20.6	19 - 73	1,580 - 1,700
1989		6.9 - 7.0	4.4 - 20	ND - 83	1,580 - 1,800
1987	D	6.7 - 6.9	8.7 - 12.0	34 - 100	2,100 - 2,470
1988		6.7 - 7.8	6.9 - 20.6	82 - 120	2,150 - 2,370
1989		6.7 - 7.8	6.3 - 20.6	ND - 120	1,970 - 2,580
1987	E	6.8 - 7.0	2.7 - 10.1	25 - 110	3,550 - 5,650
1988		6.7 - 7.0	2.7 - 9.0	ND - 58	3,200 - 6,220
1989		6.7 - 7.0	2.7 - 9.0	ND - 58	3,200 - 6,220
1987	F[c]	7.1 - 7.3	1.7 - 44	27 - 120	636 - 746
1988		7.1 - 7.3	1.5 - 7.0	13 - 82	671 - 695
1989		7.1 - 7.4	1.5 - 7.0	ND - 82	676 - 823
1987	M10-8S	6.8 - 7.0	4.5 - 6.0	37 - 100	1,430 - 1,690
1988		6.8 - 7.1	5.1 - 11.4	ND - 41	1,360 - 1,860
1989		6.8 - 7.1	5.1 - 21.1	ND - 41	1,360 - 2,070
1987	M10-8D	7.3 - 7.5	6.5 - 10.7	40 - 78	700 - 886
1988		7.2 - 7.5	4.4 - 9.6	ND - 27	772 - 891
1989		7.2 - 7.5	4.4 - 12.0	ND - 27	772 - 987
1987	M10-15S	6.9 - 7.2	4.4 - 11.6	31 - 69	2,430 - 2,760
1988		6.9 - 7.1	1.5 - 6.9	ND - 11	2,320 - 2,820
1989		6.9 - 7.1	1.4 - 6.9	ND - 40	1,750 - 3,130
1987	M10-15D	7.4 - 7.5	4.7 - 7.9	53 - 80	840 - 971
1988		7.1 - 7.4	3.9 - 15.5	ND - 39	842 - 963
1989		7.1 - 7.4	3.9 - 15.5	ND - 39	842 - 9,690
1987	M10-25S	7.0 - 7.2	3.1 - 7.1	14 - 74	740 - 922
1988		7.1 - 7.3	1.5 - 9.0	ND - 36	700 - 781
1989		7.1 - 7.4	1.5 - 22.9	ND - 63	700 - 923
1987	M10-25D	7.2 - 9.2	3.2 - 7.9	36 - 85	330 - 703
1988		6.9 - 7.6	2.5 - 11.5	ND - 70	687 - 1,090
1989		6.9 - 7.6	2.5 - 11.5	ND - 70	687 - 1,400

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TABLE 2-62

(continued)

Year	Sampling Location (Well No.)[a]	Parameter: pH (Standard Units)	Total Organic Carbon (mg/L)	Total Organic Halides (μg/L)[b]	Specific Conductance (μmhos/cm)
1987	M11-9	6.1 - 6.6	4.0 - 17.5	10 - 160	8,440 - 9,510
1988		6.5 - 6.7	7.6 - 27.3	36 - 370	7,930 - 8,560
1989		6.5 - 6.7	7.6 - 27.3	ND - 370	7,780 - 8,920
1987	M11-21	7.0 - 7.2	5.3 - 10.1	22 - 67	2,900 - 3,320
1988		6.9 - 7.1	4.5 - 16.8	ND - 25	2,360 - 2,950
1989		6.9 - 7.1	4.5 - 17.7	ND - 149	22 - 2,950
1987	M13.5-8.5S	6.8 - 7.4	8.2 - 14.1	10 - 160	1,350 - 1,600
1988		7.0 - 7.4	5.9 - 9.8	ND - 76	796 - 1,570
1989		6.9 - 7.4	5.9 - 15.9	ND - 76	796 - 1,770
1987	M13.5-8.5D	6.8 - 7.6	7.7 - 12.0	41 - 61	770 - 898
1988		6.9 - 7.1	5.8 - 8.8	ND - 31	876 - 1,660
1989		6.9 - 7.6	5.8 - 9.9	ND - 69	670 - 1,660
Background					
1987	B53W01S[d]	-	-	-	-
1988		7.1[e]	2.7[e]	23[e]	1,010[e]
1989		6.9 - 7.1	2.7 - 44.8	ND - 23	909 - 1,010
1987	B53W01D[d]	-	-	-	-
1988		6.8 - 7.0	7.1 - 34.2	ND - 35	932 - 1,010
1989		6.8 - 7.3	5.5 - 23.3	ND - 45	932 - 1,100

[a]Sampling locations are shown in Figure 2-33.

[b]ND - no detectable concentration.

[c]Upgradient well.

[d]Background well added to the monitoring program in July 1988.

[e]Label error for samples taken in October 1988; no analyses performed.

Source: BNI 1988a, 1989a, 1990c.

Calcium, sodium, and beryllium were found in all 32 samples analyzed. Boron, magnesium, and manganese were each detected in 31 of 32 samples, and potassium and zinc were detected in 29 of 32. Except for magnesium and barium, those metals detected most frequently in soil (magnesium, cobalt, cadmium, molybdenum, copper, barium, and lead) were not found frequently in groundwater at levels greater than the detection limit. Thallium and lead were completely absent in groundwater at levels greater than the detection limit. Metal statistics are summarized in Table 2-63 (BNI 1989a, 1990c).

In January 1989, analyses were performed for priority pollutant organics, including 36 VOCs, 65 BNAEs, and 27 pesticides and PCBs. Five organic compounds were detected at low concentrations: the pesticide Endosulfan F, 1,2-dichloroethene, trichloroethene, toluene, and bis(2-ethylhexyl)phthalate. Table 2-64 provides analytical results for organic chemical constituents present in detectable quantities. (Monitoring well locations at SLAPS are shown in Figure 2-33).

SLAPS Vicinity Properties

The ball field area was characterized to identify chemical contaminants associated with the demolition-generated fill material covering the property and to identify pathways for migration of chemical or radioactive contaminants. Samples from 11 boreholes at locations chosen to characterize subsurface conditions and construction-related wastes reportedly buried in the area were analyzed for chemical constituents. Samples were collected 0.6 m (2 ft) into undisturbed soil at randomly selected intervals. At least two intervals per borehole were sampled and analyzed for metals, mobile ions, VOCs, and BNAEs. A composite sample from each borehole was analyzed for RCRA-hazardous waste characteristics, pesticides, and PCBs. Chemical sampling locations are shown in Figure 2-62.

Samples from 10 of 11 boreholes contain toluene and 1,1,1-trichloroethene. Two areas are defined by higher concentrations of toluene: all locations north of Coldwater Creek have toluene in concentrations ranging from 13 to 48 ppb; the other area, the center of the ball field, has concentrations ranging from 12 to 29 ppb. Toluene was detected at every location with the exception of borehole C43 (see Figure 2-62). Locations and depths of volatile organic contamination are listed in Table 2-65 (BNI 1989b).

Samples submitted for metals analysis contained nine metals at concentrations exceeding background levels; these metals are most prevalent at depths ranging from 1.5 to 3 m (5 to 10 ft). Guidelines used to determine whether soil samples contain unusual concentrations of metals and

TABLE 2-63
SUMMARY STATISTICS FOR METALS IN
GROUNDWATER AT SLAPS, 1988-1989

Page 1 of 4

Metal	Well Number[a,b,c] [Concentration (µg/L)] A	B	C	D	E
Aluminum	293.6	785.8	406.2	387.2	405.4
Antimony	84.6	197.9	84.6	85.6	84
Arsenic	92.8	92.8	83.2	83.2	92.8
Barium	173.2	232.8	295	174.8	220.6
Beryllium	5	5	5	5	5
Boron	448.8	257	170.8	253.4	243.2
Cadmium	4.8	8.6	5.4	5.2	5.2
Calcium	183,200	979,800	207,200	292,600	662,600
Chromium	34	12	16.3	86.6	12
Cobalt	44	44	44	44	44
Copper	32.8	68.2	52	43.8	42.7
Iron	214.2	126.4	101.4	111.4	98
Lead	100	100	100	100	100
Magnesium	58,760	309,200	83,700	95,320	83,500
Manganese	487.2	1,360	659.4	6,012	32.7
Molybdenum	100	102.2	101	100	100
Nickel	48.6	39.2	36	36	36
Potassium	4,139.2	4,234	7,162	4,386	4,284.8
Selenium	448.4	183.8	118	81.6	4,898
Silver	14	14	17	14	24.8
Sodium	50,540	159,400	45,640	79,180	128,600
Thallium	120	120.4	120	120	120
Vanadium	42	58	53.6	42	42
Zinc	59.6	56.5	100	76.2	75.7

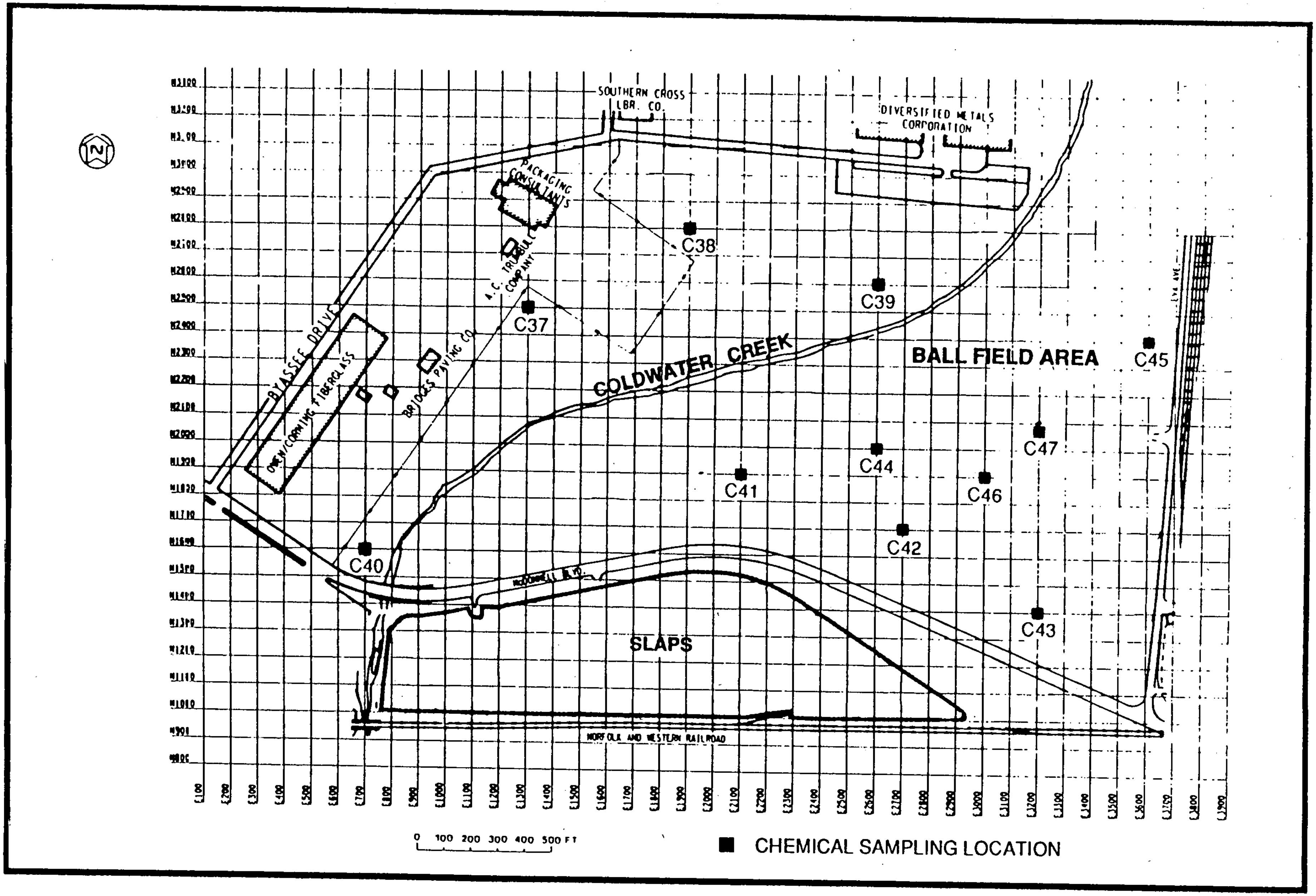

FIGURE 2-62 CHEMICAL SOIL SAMPLING LOCATIONS AT THE BALL FIELD AREA

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TABLE 2-65

VOLATILE ORGANIC CONTAMINATION

AT THE BALL FIELD AREA

Sampling Location[a]	Depth (ft)	Compound	Concentration (μg/kg)
C37	3-8	Toluene	21
C38	1-3	Toluene	15
C39	1-3	Toluene	6
	5-7	Toluene	13
C40	3-5	Toluene	48
	8-10	Toluene	17
C41	6-8	Toluene	2.5
C42	2-4	Toluene	1.3
	5-7	Toluene	29
	10-12	Toluene	2.3
C43	10-12	1,1,1-trichloroethane	1.6
C44	2-4	1,1,1-trichloroethane	1.5
	6-8	1,1,1-trichloroethane	1.7
	16-18	1,1,1-trichloroethane	1.3
		Toluene	1.5
C46	2-4	Toluene	12
	6-8	1,1,1-trichloroethane	1.6
	10-12	1,1,1-trichloroethane	1.5
		Toluene	4.9
C47	6-8	Toluene	15

[a]Sampling locations are shown in Figure 2-62.

Source: BNI 1989b.

mobile ions were obtained from two sources: analytical results for mobile ions in soil samples taken in the surrounding area, and average concentration ranges for metals in soils at various locations, primarily in the United States. Table 2-66 lists the summary statistics for each metal found at the ball field area at concentrations exceeding background levels (BNI 1989b). These results are consistent with information that the area was previously used as a landfill (AEC 1960).

Thirty-three samples were analyzed for the mobile ions sulfate, nitrate, and fluoride as indicators of contaminant migration. Only one sample contained sulfate in excess of background levels.

A composite sample was taken from each of the 11 boreholes and analyzed for RCRA-hazardous waste characteristics and pesticides/PCBs. None of these samples failed the RCRA tests. No PCBs were detected, and only one pesticide (Dieldrin) at very low levels (230 ppb) was detected. No additional sample analysis was conducted on other vicinity properties because only low concentrations of chemicals were detected at SLAPS (BNI 1989b).

Four sediment samples were also collected along Coldwater Creek for chemical analysis. The first was just north of Banshee Road, the second just north of McDonnell Boulevard, the third just south of the Latty Avenue Properties, and the fourth downstream of the Latty Avenue Properties. Metals analyses showed cadmium, magnesium, molybdenum, selenium, thallium, and zinc in excess of maximum expected background concentrations. Only cadmium, magnesium, selenium, and zinc were found to exceed both background levels and sample detection limits. No mobile ions were found to exceed background concentrations. The only volatile found in samples 2, 3, and 4 in excess of the detection limit is acetone. Eight semivolatiles on the TCL were found in the four samples. All of the BNAEs detected were PAHs. These organic compounds are believed to result from runoff from the airport.

Latty Avenue Properties

Soil samples obtained from HISS and Futura Coatings were analyzed for metals, mobile ions, VOCs, BNAEs, and RCRA-hazardous waste characteristics. Six boreholes were drilled at both HISS and Futura: three at random locations and three at biased locations at each property. Fourteen samples were analyzed from HISS and 17 from Futura. Sampling locations are shown in Figure 2-63.

Only 1 of the 12 samples from HISS and 4 of the 16 from Futura had VOCs at levels above detection limits. Toluene and fluorohydrocarbon, the only volatile compounds detected, were found at very low levels. Table 2-67 is a summary of the VOC results (BNI 1990e).

TABLE 2-66

SUMMARY RESULTS FOR METAL CONTAMINANTS AT THE BALL FIELD AREA

Metal	Number of Samples			Concentration (mg/kg)[a]		
	Analyzed	In Excess of Background	In Excess of Sample Detection Limits	Mean	Min.	Max.
Antimony	31	31[b]	2	19.0	10.6	195
Arsenic	31	2		45.0	17.6	668
Boron	31	1		57.0	21.6	761
Cadmium	31	31[b]	26	1.8	0.88	17.6
Cobalt	31	2		18.0	8.8	185
Magnesium	31	4		3,600.0	1,190	8,680
Molybdenum	31	31	29	47.0	17.6	754
Selenium	31	31[b]		48.0	17.6	704
Silver	31	1	28	2.6	1.8	13.9
Thallium	31	31[b]	28	49.0	17.6	726

[a]Maximum and minimum valued include results reported below background values.

[b]Elevated sample detection limits were encountered as a result of matrix interference during analysis. In some instances, the sample detection limits were above the indicated background concentration. The values used for calculation were sample detection limits.

Source: BNI 1989b.

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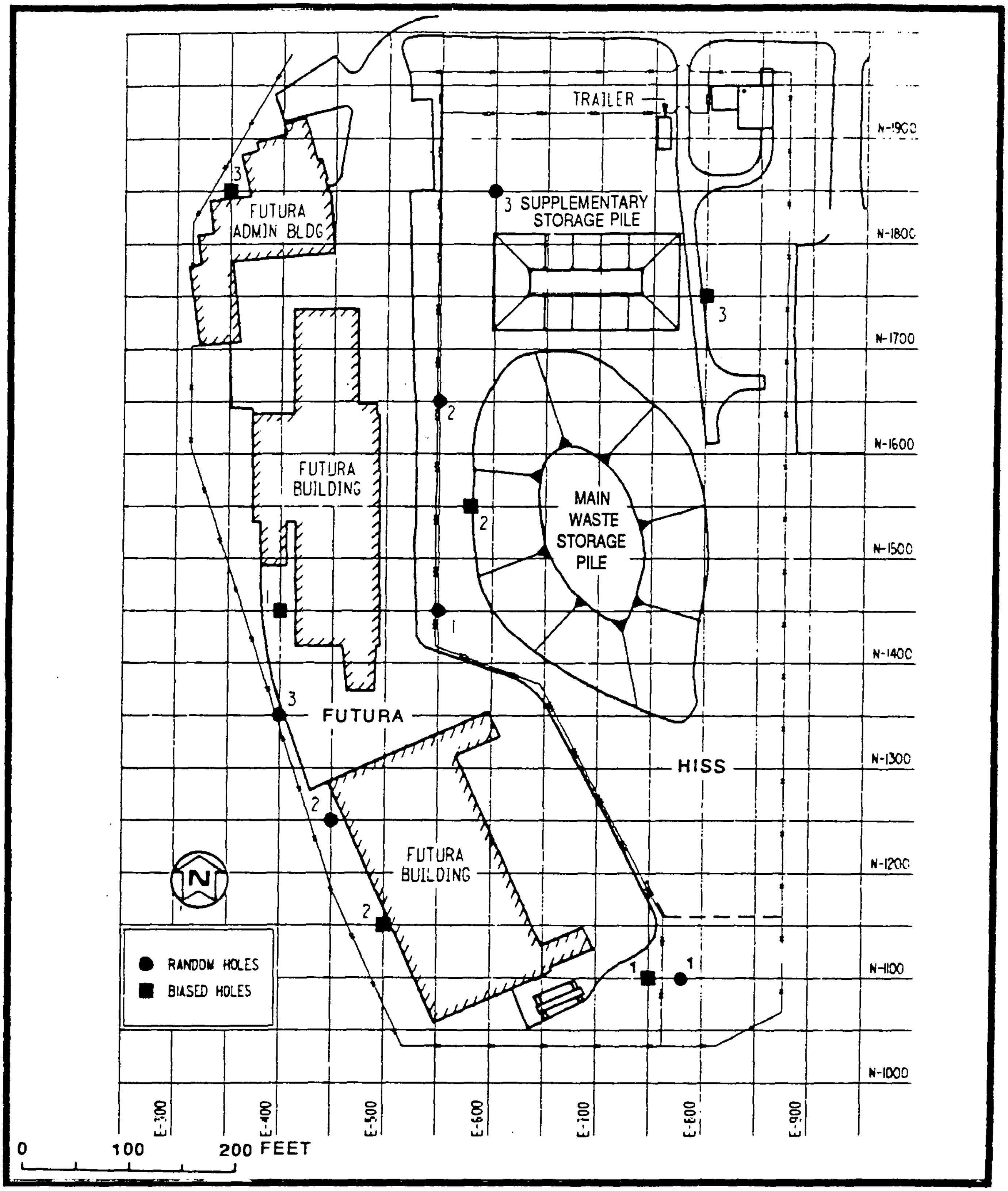

FIGURE 2-63 CHEMICAL SOIL SAMPLING LOCATIONS AT THE LATTY AVENUE PROPERTIES

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TABLE 2-67

SUMMARY OF VOLATILE ORGANIC ANALYSES

AT THE LATTY AVENUE PROPERTIES[a]

Sample	Depth (ft)	Compound	Concentration[b] (μg/kg)
HISS			
R2	4-6	Toluene	2.9
Futura			
B1	0-2	Toluene	15.0
		Trichlorofluoromethane	1.3
B2	0-1	Toluene	1.5
B3	4-5	Toluene	1.7
R1	0-2	Toluene	2.8

[a]Only those compounds detected at levels above the sample detection limit are reported.

[b]Concentrations are presented as they were reported from the laboratory; no values have been rounded.

Source: BNI 1990e.

No TCL compounds were detected at levels exceeding the sample detection limits at either HISS or Futura when the initial BNAE scan was conducted. At HISS, an unidentified compound found was thought to represent breakdown products of substances present from activities unrelated to MED/AEC activities. A benzene compound at 6,300 μg/kg and 2-propanol-1,3-dichlorophosphate at a concentration of 250,000 μg/kg were found at Futura (BNI 1990e).

Results of the metals analyses for HISS indicate that 16 metals are present in soil at concentrations exceeding background (Table 2-68). As was observed for SLAPS, cadmium, molybdenum, thallium, and selenium (when present at levels exceeding the detection limit) were found in all samples at concentrations exceeding the background levels. The distribution of metals with depth at HISS is similar to that observed at SLAPS; most of the metals appear to be confined to depths at or near the surface. Cadmium and magnesium were detected at levels exceeding background (see Figure 2-39) at depths greater [in excess of 1.2 m (4 ft)] than those to which radioactive contamination extended (BNI 1990e).

Results of the metals analyses for Futura indicate that 14 metals are present in soil at concentrations exceeding background levels. As was observed for SLAPS and HISS, cadmium, molybdenum, thallium, and selenium (when present at levels exceeding the detection limit) were found in all samples at concentrations exceeding background. In boreholes 2 and 3, cobalt, magnesium, molybdenum, and copper were detected within the area of radioactive contamination [0 to 2.1 m (0 to 7 ft)] (see Figure 2-50). Only cobalt was found at greater depths [2.4 to 3.3 m (8 to 10 ft)]. In borehole 1, radioactivity extends to 4.6 m (15 ft); no metals were detected below this depth. At the locations from which all random samples were collected, only magnesium and cadmium were detected within the area of radioactivity, and only magnesium was found underneath the known boundary of radioactivity [0.3 to 1.3 m (1 to 4 ft)]. Table 2-69 shows that 12 metals exceed the sample detection limit and background values (BNI 1990e).

Thirteen samples obtained from Futura were analyzed for the mobile ions sulfate, nitrate, and fluoride; results indicate that they are not present at Futura in concentrations exceeding those found in the background soils survey. At HISS, 11 samples were analyzed, and only 2 results are greater than those reported for background. Sulfate was found at a concentration of 824 ppm; the background concentration is 610 ppm. Nitrate was found in one sample at 1,030 ppm; the background concentration is 868 ppm (BNI 1990e). Table 2-70 provides these results.

Analyses for RCRA-hazardous waste characteristics yielded negative results for reactivity, ignitability, corrosivity, and toxicity on the ten samples from Futura and the six from HISS (BNI 1990e).

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TABLE 2-68

SUMMARY RESULTS FOR METAL CONTAMINANTS AT HISS

Metal	Number of Samples: Analyzed	Number of Samples: In Excess of Background	Number of Samples: In Excess of Background and SDL[b]	Concentration (mg/kg)[a]: Mean[c]	Concentration (mg/kg)[a]: Min.	Concentration (mg/kg)[a]: Max.
Antimony	11	11[d]	1	34.0	10.8	242
Arsenic	11	2	2	120.0	18.0	1,010
Barium	11	2	2	930.0	83.3	4,360
Boron	11	1	1	120.0	21.9	1,010
Cadmium	11	11[d]	5	3.7	1.1	26.6
Cobalt	11	5	5	200.0	10.6	1,470
Copper	11	3	3	140.0	8.5	946
Lead	11	1	1	82.0	21.2	464
Magnesium	11	2	2	4,400.0	1,450	8,180
Molybdenum	11	11[d]	3	120.0	19.1	1,100
Nickel	11	1	1	240.0	9.3	1,780
Selenium	11	11[d]	11	120.0	18.0	1,020
Silver	11	1	2	3.8	1.8	18.3
Thallium	11	11	2	110.0	18.0	959
Vanadium	11	1	1	100.0	13.3	712
Zinc	11	1	1	67.0	22.7	308

[a]Maximum and minimum values include results reported below background values.
[b]SDL - sample detection limit.
[c]All values, including those reported as the SDL, were used to calculate the mean.
[d]Elevated SDLs were encountered in most samples as a result of matrix interference during analysis. All SDLs and measurable concentrations exceed background levels.
Source: BNI 1990e.

TABLE 2-69

SUMMARY RESULTS FOR METAL CONTAMINANTS AT FUTURA

Metal	Number of Samples: Analyzed	Number of Samples: In Excess of Background	Number of Samples: In Excess of Background and SDL[b]	Concentration (mg/kg)[a]: Mean[c]	Concentration (mg/kg)[a]: Min.	Concentration (mg/kg)[a]: Max.
Antimony	16	16[d]	0	13.0	10.8	17.9
Arsenic	16	1	1	40.0	18.1	320
Barium	16	1	1	530.0	101	3,480
Boron	16	1	1	55.0	22.8	182
Cadmium	16	16[e]	4	2.0	0.9	15.5
Cobalt	16	7	7	940.0	9.9	14,000
Copper	16	3	3	630.0	6.2	9,090
Lead	16	1	1	75.0	21.8	529
Magnesium	16	8	8	11,000.0	1,200	43,400
Molybdenum	16	16[e]	6	82.0	18.1	947
Nickel	16	1	1	1,200.0	9.6	17,300
Selenium	16	16[e]	1	85.0	18.1	1,040
Thallium	16	16[d]	0	22.0	18.1	29.9
Vanadium	16	1	1	170.0	12.8	2,180

[a]Maximum and minimum values include results reported below background values.

[b]SDL - sample detection limit.

[c]All values, including those reported as the SDL, were used to calculate the mean.

[d]Elevated SDLs were encountered in all samples as a result of matrix interference during analysis.

[e]Elevated SDLs were encountered in most samples as a result of matrix interference during analysis. All SDLs and measurable concentrations exceed background levels.

Source: BNI 1990e.

TABLE 2-70

ANALYTICAL RESULTS FOR MOBILE IONS AT HISS AND FUTURA

Sampling Location[a]	Depth (ft)	Concentration (ppm) Nitrate	Sulfate	Fluoride
HISS				
B1	2-4	0.49[b]	120	1.2
B2	0-1	308	185	4.1
	2-4	1,030	50.0[b]	0.5[b]
B3	3-4	11.8	236	9.1
	6-8	63.3	50.6[b]	3.1
R1	0-2	351	310	4.5
	4-6	702	68.2	0.6[b]
R2	0-2	583	824	16.7
	4-6	275	104	2.2
R3	0-2	240	134	4.7
	4-6	443	85.9	2.1
Futura				
B1	0-2	0.51	351	5.6
	8-10	267	438	10.3
	12-14	238	306	3.0
	20-22	374	215	2.1
B2	2-4	0.51[b]	111	21.0
B3	0-2	4.4	73.3	3.0
	4-5	7.4	127	2.6
	6-8	0.55	77.9	3.1
R1	0-2	0.97	103	9.8
R2	0-2	2.5	110	6.2
	4-6	58.8	235	2.4

TABLE 2-70

(continued)

Sampling Location[a]	Depth (ft)	Concentration (ppm)		
		Nitrate	Sulfate	Fluoride
R3	0-2	0.49[b]	72.0	4.9
	4-6	0.5[b]	126	1.9

[a]Borehole locations are shown in Figure 2-63. ("B" represents biased borehole location; "R" represents random borehole location.)

[b]The compound was analyzed for but not detected. The detection limit (not the method detection limit) is reported.

Groundwater at the Latty Avenue Properties has been analyzed for metals and water quality indicator parameters. Metals were analyzed for five quarters during 1988 and 1989. Results are given in Tables 2-71 and 2-72, respectively. Monitoring well locations are shown in Figure 2-52. Specific conductance values show a good correlation with wells having high metal concentrations. TOC and TOX values show little change from location to location, indicating that there is no notable change in organic content. Groundwater was analyzed for priority pollutant organics in January 1989: 36 VOCs, 65 BNAEs, and 27 pesticides and PCBs. Only one organic BNAE compound [bis(2-ethylhexyl)phthalate] was found (in wells HISS-9 and B53W01D). Because the compound was detected in similar concentrations in laboratory blanks, the presence of this chemical is believed to be a result of laboratory contamination.

Chemical characterization was not conducted at the Latty Avenue vicinity properties because levels of metal and organic contamination are assumed to be comparable to those at the ball field area because the contamination mechanism was similar.

2.4.4 Summary of Site Conditions

The following conclusions are based on historical surveys of the St. Louis site, ongoing environmental monitoring, and site characterization activities:

St. Louis Downtown Site

- SLDS was used for processing uranium and compounds containing uranium from the mid-1940s to 1957 under MED/AEC contracts.

- Land surfaces at SLDS have been modified considerably since the 1940s through destruction of old buildings and construction of new ones.

- For remedial action considerations, the radioactive contaminants at SLDS are thorium-230, uranium-238, radium-226, and thorium-232. Any dose calculations will take into account radionuclides in the three naturally occurring decay chains.

- The maximum depth of contamination at SLDS is 12.8 m (42 ft).

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TABLE 2-71

SUMMARY RESULTS FOR METALS

IN GROUNDWATER AT HISS

	Well Number[a,b,c] [Concentration (μg/L)]				
Metal	1	2	3	4	5
Aluminum	380	300	296	634.8	291
Antimony	103.2	84	91.5	111.2	84
Arsenic	92.8	83.2	83.2	92.8	83.2
Barium	307.4	352.6	351.6	1842	222.3
Beryllium	5	5	5	5	5
Boron	230.8	100.8	156.2	122.4	114.8
Cadmium	7.8	5	4.8	13.3	4.8
Calcium	965,200	181,400	145,200	1,391,200	112,620
Chromium	12.5	12.5	26.32	12.5	12.5
Cobalt	42.5	42.5	115.0	42.5	42.5
Copper	45.38	78.3	40.3	63.66	42.8
Iron	123.8	109.4	4,824	145	84.3
Lead	100	100	100	100	100
Magnesium	267,800	75,060	54,220	455,000	52,100
Manganese	152.3	754.6	5,754	1,678	30.84
Molybdenum	100.6	100	105.4	109.3	100
Nickel	33.3	34.6	78.9	74.6	33.5
Potassium	4,394	5,684	6,216	6,706	6,306.6
Selenium	406.6	77	81.6	147	121.3
Silver	14	14	14.9	14	14
Sodium	156,000	47,380	28,900	303,200	47,980
Thallium	135.8	120	120	137.4	120
Vanadium	45.76	42	42	55	42
Zinc	101.9	684.8	82.94	84.16	185.6

TABLE 2-71
(continued)

Metal	Well Number[a,b,c] [Concentration (μg/L)] 6	7	8	9	10
Aluminum	373.6	533.8	399.2	217.8	243.8
Antimony	1,161.8	93	146.2	81.6	81.8
Antimony	98.3	110.3	90	88	91.9
Arsenic	91	91	91	91	91
Barium	291.0	2,154	186.4	230.6	172
Beryllium	5	5	5	5	5
Boron	132.2	127	135.8	121.5	113.2
Cadmium	6.0	15.5	6.3	5	4.8
Calcium	519,100	1,658,800	510,400	66,860	86,320
Chromium	12.5	12.5	36.8	37.3	34.5
Cobalt	44	44	44	44	44
Copper	58.7	49.1	44	31.7	34.5
Iron	93.3	118	248.4	173	174
Lead	100	100	100	100	100
Magnesium	121,800	619,400	201,600	40,762	48,200
Manganese	25.9	79.9	670.8	249.5	16.4
Molybdenum	118	106	100	100	100
Nickel	33.3	33.3	49	37.6	40.3
Potassium	7,964	4,296	4,516	4,302	4,585
Selenium	120	149.5	120	120	120
Silver	15	15	14	14	14
Sodium	77,760	208,600	85,720	43,200	28,260
Vanadium	46	56	46.4	42	42
Zinc	96.7	118.86	120.06	77	61.4

TABLE 2-71
(continued)

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Metal	Well Number[a,b,c] [Concentration (μg/L)] 11	12	13	14	15
Aluminum	292.5	399.0	620.8	819.8	256.0
Antimony	88	88	122.1	95	88
Arsenic	91	91	91	91	91
Barium	261.6	417.8	231	383	363.2
Beryllium	5	5	5	5	5
Boron	114.6	100.3	144.5	141.3	164.4
Cadmium	5	6.0	10.8	5.3	4.8
Calcium	164,200	378,400	830,200	1,824,000	128,000
Chromium	21.1	14.4	13.1	21.0	14.8
Cobalt	44	44	42.5	42.5	44
Copper	35.6	46.0	73.5	67.2	34.8
Iron	143	94	149	457.6	129.8
Lead	100	100	100	100	100
Magnesium	70,300	182,400	368,800	112,320	51,980
Manganese	27.4	17.6	26.0	48.9	839
Molybdenum	100	100	113.8	100	100
Nickel	35	35	33.3	33.3	36
Potassium	4,274	4,151.4	6,372	4,692	4,171.8
Selenium	94.8	84.6	145.6	111	94.4
Silver	14	14	13.1	15	14
Sodium	47,200	87,520	144,600	289,200	31,500
Thallium	120	120	141.6	120	120
Vanadium	42	46.36	59.4	54.8	42
Zinc	48.52	45.7	58.38	64.76	44.48

[a]Values were determined by averaging values for four quarters unless otherwise noted.

[b]Well locations are shown in Figure 2-52.

[c]The minimum detectable limit value was used in average when metal was below detection limit.

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TABLE 2-72

ANALYTICAL RESULTS FOR INDICATOR PARAMETERS IN GROUNDWATER AT HISS, 1987-1989

Year	Sampling Location (Well No.)[a]	pH (Standard Units)	Total Organic Carbon (mg/L)	Total Organic Halides (μg/L)[b]	Specific Conductance (μmhos/cm)
1987	6	6.7 - 6.9	1.2 - 6.2	24 - 45	3,900 - 6,360
1988		6.9 - 7.3	3.4 - 20.3	23 - 52	467 - 8,060
1989		6.9 - 7.0	3.9 - 5.7	ND - 29	3,980 - 6,340
1987	9	7.2 - 8.7	2.2 - 3.0	33 - 47	510 - 846
1988		7.8 - 8.7	1.6 - 4.1	11 - 35	625 - 775
1989		7.1 - 8.2	3.2 - 8.6	ND - 20	837 - 910
1987	10	7.2	3.2 - 3.9	26 - 37	922 - 1,110
1988		7.2 - 7.4	1.3 - 4.8	20 - 49	686 - 953
1989		7.2 - 7.4	1.6 - 22.1	ND - 40	714 - 966
1987	11	6.9 - 7.0	2.7 - 4.1	18 - 48	1,560 - 1,790
1988		6.9 - 7.1	1.7 - 4.3	ND - 48	1,330 - 1,560
1989		7.0	1.4 - 21.2	ND - 29	1,400 - 1,650
1987	12	6.7	4.7 - 7.2	22 - 39	3,420 - 4,300
1988		6.7 - 6.9	1.9 - 6.9	ND - 58	2,660 - 4,100
1989		6.2 - 6.8	3.4 - 12.6	ND - 30	2,960 - 3,740
1987	13	6.6 - 6.8	0.62 - 5.8	28 - 55	7,460 - 8,200
1988		6.7 - 6.9	2.0 - 7.2	ND - 38	6,280 - 8,000
1989		6.5 - 6.8	5.7 - 21.2	ND - 20	7,420 - 8,380
1987	15	6.7 - 6.9	2.3 - 14.2	19 - 40	1,190 - 1,320
1988		6.8 - 6.9	4.2 - 6.9	19 - 110	909 - 1,210
1989		6.9 - 7.0	3.0 - 33.5	ND - 52	988 - 1,190
Background					
1988	B53W01S[c]	7.1	2.7	23	1,010
	B53W01D[c]	6.8 - 7.0	7.1 - 34.2	ND - 35	932 - 1,010
1989	B53W01S[c]	6.9 - 7.1	2.8 - 44.8	ND - 32	909 - 958
	B53W01D[c]	7.1 - 7.3	5.5 - 23.3	ND - 45	1,040 - 1,100

[a]Sampling locations are shown in Figure 2-52.

[b]ND - no detectable concentration.

[c]Background wells B53W01S and B53W01D were added to the monitoring program in July 1988; located at Byassee Road, approximately 2.4 km (1.5 mi) southwest of HISS.

Source: BNI 1988b, 1989c, 1990d.

- The volume of contaminated soil at SLDS is 220,200 m^3 (288,000 yd^3).

- Metals (i.e., antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, molybdenum, selenium, silver, sodium, thallium, and zinc) exceed background concentrations in soil typically found throughout the United States (Table 2-8).

- There are a few small, isolated areas at SLDS where soil fails the hazardous waste criterion for EP toxicity-lead.

- Thirteen VOCs were detected in soil samples obtained at SLDS. Toluene was detected most frequently (20 of 23 boreholes), followed by chloroform and trichlorofluoromethane. In general, concentrations are low, with mean concentrations in the low parts per billion.

- Twenty-seven BNAE compounds (18 PAHs) were detected in soil samples obtained at SLDS. Pyrene was found most frequently, followed by fluoranthene, phenanthrene, and benzo(a)anthracene.

- For four quarters, groundwater monitoring was conducted at SLDS for pH, specific conductance, TOX, TOC, fluoride, nitrate, VOCs, BNAEs, and metals. Ten organic compounds were found, benzene most frequently. Indicator parameters show poor-quality groundwater. Sixteen metals were detected; those associated with uranium ores (arsenic, barium, nickel, and selenium) were present in concentrations of 100 to 700 µg/L. Metals detected most frequently in soil were not found at elevated concentrations in groundwater.

- Data from the subsurface investigation indicate a basal bedrock unit overlain with two distinct unconsolidated units. A layer of rubble/fill material of variable thickness covers the surface. Groundwater flow direction is consistently eastward toward the Mississippi River.

- The limestone bedrock unit is shallow [5.8 m (19 ft)] under the western portion of the site, increasing in depth to 24.4 m (80 ft) with increasing proximity to the Mississippi River. Hydraulic conductivities for the bedrock range from 1.1×10^{-3} to 5.1×10^{-4} cm/s.

- The unconsolidated material above the bedrock consists of an upper hydrostratigraphic unit that is primarily fine materials and a lower hydrostratigraphic unit of coarser materials. An alluvial aquifer exists under semiconfined conditions.

- The upper hydrostratigraphic unit is made of unconsolidated clays and silts that are laterally continuous across the property. Hydraulic conductivities average 1 x 10^{-5} cm/s.

- The lower hydrostratigraphic unit is composed of unconsolidated silty sands and sands and is only present below the eastern portion of the property. Hydraulic conductivity is high in the lower unit.

St. Louis Airport Site

- SLAPS has been leveled since MED/AEC activities ceased, thus altering the original pattern of radioactive waste contamination.

- Uranium-238, radium-226, thorium-232, and thorium-230 were found at SLAPS as deep as 5.5 m (18 ft). The entire ground surface is contaminated in excess of DOE guidelines.

- The volume of contaminated soil at SLAPS is 191,000 m^3 (250,000 yd^3).

- Environmental monitoring results for SLAPS indicate that radon levels and measured concentrations of radionuclides in surface water have remained low and relatively constant since 1984, when monitoring began. External gamma radiation levels are measured at nine locations. For the last four years, only one location has shown readings greater than 130 mR/yr above background (background readings in the St. Louis area average approximately 100 mR/yr). Radon levels at only one location have shown a reading greater than 3.0 pCi/L, the DOE post-remedial action guideline for radon, for the last six years, although Missouri state regulations for radon (1 pCi/L) have been exceeded at several locations. Surface water concentrations of total uranium, radium-226, and thorium-230 have been less than 5.0 pCi/L for the last five years. Groundwater has shown relatively stable levels of radium-226 and thorium-230; however, uranium levels have fluctuated and, in monitoring wells A, B, D, E, F, M11-21, and M11-9, exceed the proposed Uranium Mill Tailings Radiation Control Act (40 CFR 192) guideline of 30 pCi/L for concentrations of uranium in groundwater.

- Chemical characterization of soil at SLAPS indicates very low concentrations of VOCs. No samples failed the RCRA-hazardous waste characteristics tests.

- At SLAPS, 15 metals are present in soil at concentrations exceeding background levels. Most of the metals appear to be confined to near-surface depths; only magnesium, cadmium, and cobalt were detected beneath the maximum depths of radioactive contamination.

- Groundwater at SLAPS was analyzed for pH, specific conductivity, TOX, TOC, and metals; results show the groundwater to be of poor quality. The same sixteen metals found in soil samples from the property were also detected in groundwater. Five organics were detected at very low levels.

- Data from the subsurface investigation indicate three major geologic units: a basal limestone unit, a siltstone unit, and an unconsolidated unit. Monitoring well data confirm that the entire stratigraphic sequence is saturated from an average depth of 3 m (10 ft) below ground surface. Locally, a substantial vertical hydraulic gradient potential exists in the upward direction at SLAPS. Regional flow direction is northwest to the Missouri River.

- The basal limestone unit is encountered at 21.3 to 27.4 m (70 to 90 ft). Hydraulic conductivities average 1 x 10^{-6} cm/s.

- The siltstone unit overlying the basal limestone unit is encountered at a shallow depth [15.4 m (50 ft)] only under the southeastern portion of the property.

- The unconsolidated material overlying the siltstone unit consists primarily of clays, silty clays, and peat, and it is continuous over the entire property. Abundant zones of decomposed organic material are included in the unit and encountered throughout the central portion of the property. Hydraulic conductivity for the overburden material ranges from 10^{-6} to 10^{-8} cm/s.

Hazelwood Interim Storage Site and Futura Coatings

- The HISS and Futura radiological characterization found that a majority of the ground surface is contaminated in excess of DOE guidelines. Radioactive contamination was found to a depth of 2 m (6 ft) at HISS and 4.6 m (15 ft) at Futura.

- The volume of contaminated soil at HISS is 53,520 m^3 (70,000 yd^3), including the stockpiled material. The volume of contaminated soil at Futura is 26,000 m^3 (34,000 yd^3).

- Environmental monitoring results for HISS indicate that external gamma radiation levels have decreased sharply since 1984 at most monitoring locations; overall radon concentrations have remained basically stable since 1984; and concentrations of uranium, radium-226, and thorium-230 in surface water have been stable since 1985. Concentrations of most radionuclides in groundwater have changed little since 1985; however, uranium concentrations in well 6 have shown increases in the last four years. Since 1987, annual average external gamma radiation levels have remained less than 85 mR/yr, after background has been subtracted, except at one sampling location. All annual averages of radon-222 have remained less than 2.0 pCi/L since 1985. Annual average measurements for surface water show total uranium concentrations to be less than 5.0 pCi/L since 1985; radium-226 and thorium-230 have shown concentrations of less than 0.4 pCi/L since 1984.

- Chemical characterization at HISS and Futura indicates concentrations of metals exceeding background (as also shown at SLDS and SLAPS). The distribution of metals within the regions of radioactive contamination at HISS was similar to that at SLAPS; both properties show contamination at shallow depths, but metals exceeding background concentrations were found at shallower depths at Futura than at HISS.

- Analyses for VOCs and BNAEs at HISS and Futura resulted in the identification of only two VOCs (toluene and trichlorofluoromethane) and no BNAEs that are on the TCL (see Appendix D).

- No samples at HISS or Futura exhibited any RCRA-hazardous waste characteristics.

- Groundwater at the Latty Avenue Properties was analyzed for pH, specific conductance, TOX, TOC, and metals; results are similar to those found for SLAPS.

- At HISS, groundwater levels in the overburden range in depth from 1.5 to 4.9 m (5 to 16 ft). The consistent groundwater flow pattern is radial outward from the downslope toe of the main pile. Seasonal fluctuations in the water levels reflect insignificant changes in gradient value and flow directions.

Vicinity Properties

- All vicinity properties have been characterized for radioactive contamination only, with the exception of the ball field area and surface water from Coldwater Creek. Thorium-230 was found to be the primary contaminant on all vicinity properties.

- The ball field chemical characterization found two VOCs--toluene and 1,1,1-trichloroethene--in soil. Nine metals were found in excess of background concentrations. No samples exhibit any RCRA-hazardous waste characteristics. Dieldrin was found in low concentrations when PCB/pesticide analysis was conducted.

- Samples collected for chemical analysis from Coldwater Creek show four metals at concentrations exceeding background levels. Acetone exceeds the detection limit in three samples, and eight semivolatiles were detected in the four samples.

- Subsurface data are limited to the unconsolidated overburden materials, which are clays and silts. Abundant organic material of variable thicknesses is included in the overburden.

2.5 RESPONSE ACTIONS CONDUCTED TO DATE

In 1984, DOE directed ORNL to conduct a survey of the Latty Avenue vicinity properties. ORNL discovered that redistribution of contamination had occurred when compared with the 1981 and 1983 surveys conducted by ORAU and ORNL, respectively. The redistribution was probably a result of flooding, surface runoff, and utility company activities. The major contaminant found is thorium-230; radium-226 and uranium-238 are present in lesser amounts.

In 1984, DOE directed BNI to perform remedial action on the contaminated areas within the temporary slope and construction line along Latty Avenue (BNI 1985e). The temporary slope and construction line included all areas that could potentially have been disturbed during a drainage improvement project being conducted by the cities of Hazelwood and Berkeley. During the remedial action, contamination exceeding guidelines was found to extend beyond the temporary slope and construction line. Approximately 10,700 m^3 (14,000 yd^3) of contaminated soil from this work was moved to interim storage at HISS.

In 1985, erosion on the west side of SLAPS along Coldwater Creek necessitated emergency maintenance. Sloughing and seepage were causing erosion of contaminated fill material into the creek. During a 7-week period beginning in March, a retaining wall was installed along the bank.

In 1986, DOE directed BNI to provide radiological support to Berkeley and Hazelwood during a road improvement project. Radium-226 and thorium-230 contamination in excess of DOE remedial action guidelines was found at depths ranging from 0.6 to 2.4 m (2 to 8 ft) along and under Latty Avenue. Materials contaminated in excess of remedial action guidelines were removed and placed in storage at HISS. Approximately 3,517 m^3 (4,600 yd^3) of material was placed in a storage pile developed specifically to accommodate it and covered with a low-permeability membrane. In addition to gamma scanning the soil that was not placed in storage at HISS, gross alpha counting was used as a screening technique. Soil samples were scanned for alpha-emitting radionuclides (such as thorium-230) that exceed DOE guidelines. Soils that did not exhibit contamination in excess of DOE guidelines were used as fill material on the railroad property between Futura Coatings and Coldwater Creek and along the entire length of Latty Avenue. Contaminated material at Latty Avenue was loaded directly into trucks, transported to HISS, and placed in interim storage. Both piles are covered with a low-permeability membrane called Futura Ply II.

3.0 INITIAL SITE EVALUATION

This section presents results of the initial site evaluation. Available characterization and monitoring data were used to perform a preliminary assessment of potential risk to human health and impacts to the environment from exposure to site contaminants. The purpose of this initial evaluation was to allow identification of any potential near-term health and environmental threats at the site and of any other potentially significant pathways of exposure warranting more detailed evaluation. A comprehensive baseline risk assessment will be conducted to assess these potentially significant pathways; results will be published in a baseline risk assessment report.

Because certain properties comprising the St. Louis site have unique characteristics with respect to the extent of contamination, land use, and environmental setting, the affected properties were further categorized into three groups to afford a more efficient and meaningful preliminary evaluation of the risks posed by contaminants. The three groupings are (1) SLDS and SLDS vicinity properties; (2) SLAPS and HISS; and (3) "other properties."

3.1 PRELIMINARY SITE ASSESSMENT OF POTENTIAL HUMAN HEALTH IMPACTS

This section summarizes potential human exposure to site contamination for both current and future land use conditions at the different areas comprising the site.

3.1.1 St. Louis Downtown Site and Vicinity Properties

SLDS is located in a highly industrialized area, and the numerous buildings and facilities that comprise the 10 plant areas are currently used for the production of specialty chemicals. Because of its past direct involvement in processing uranium ores, elevated levels of contamination are present on the property. Most of the contamination, however, is found under buildings and asphalt or concrete and is therefore not accessible to humans. Access to the property is limited to plant employees, and human activity there is substantial because SLDS is an operating industrial facility. Plant health and safety staff and DOE currently monitor activities and conditions at the plant to ensure that inadvertent exposure to contaminants does not occur or is minimal.

The primary source of contamination at SLDS is soil underneath buildings or paved areas. An estimated 220,200 m^3 (288,000 yd^3) of soil is contaminated, extending to depths of approximately 6 m (20 ft). Some contamination also exists inside buildings and drains. Contaminants in soils are radioactive and chemical in nature and include radionuclides in the uranium, thorium, and actinium decay series and inorganic (i.e., metals) and organic (i.e., PAH) compounds. Contamination inside buildings has been found to be mainly surface, nonremovable or removable, radioactive contamination and airborne radon decay products. Because of ongoing operations at SLDS, the extent of contamination in each drainage pathway will be determined when final building surveys are conducted, just prior to remediation.

Several groundwater samples from this property (ORNL 1981) contain uranium levels that exceed the water ingestion guideline in DOE Order 5400.5 (DOE 1990a). Additionally, various metals and some organic compounds (e.g., benzene) are present at levels exceeding federal drinking water standards.

Six SLDS vicinity properties have also been investigated; three are railroad properties running north and south through SLDS, and three are commercial properties that border SLDS to the north and south. A portion of one vicinity property was formerly used as part of the MED/AEC activities conducted at SLDS; past use of the other vicinity properties is unknown. Contaminant levels at the SLDS vicinity properties are variable, with the highest levels of radioactivity found on the property adjacent to SLDS Plant 7.

Current risk

Under current conditions, because the primary sources of contamination at SLDS are either located underneath substantial cover (i.e., buildings, concrete, or asphalt) or are inaccessible (i.e., contaminated drains), exposure to existing contamination may only occur for persons working inside plant buildings due to potential inhalation of radon and its decay products and exposure to external gamma radiation emanating from the soil underneath the buildings. Intrusion into the soil could also expose workers. Groundwater in the area is not used as a drinking water source or household supply. Though there may be limited industrial use of groundwater, this use does not generally involve substantial human contact with the water and is not considered to present significant risks.

Current exposure pathways at the SLDS vicinity properties are similar to those at SLDS, except for contaminated structures, which do not exist at the vicinity properties and therefore are not a consideration.

Future risk

Because of the extensive industrial use of the immediate areas surrounding SLDS and its vicinity properties, it is anticipated that these properties will remain industrial in the future. Based on this assumption and other factors such as potential loss of site protective measures (i.e., access controls, monitoring programs, and waste containment measures), the potential for exposure to existing contaminants may be greater and include additional pathways in the future. In addition, ingrowth and decay of radionuclides might significantly change the mix of contaminants in the future, altering the risks. There may be exposure via inhalation of contaminated airborne dust, inhalation of radon and its decay products, incidental ingestion of contaminated soil, and external gamma radiation fields present.

3.1.2 St. Louis Airport Site and Hazelwood Interim Storage Site

These two properties (including the ditches surrounding SLAPS) have several characteristics in common: both contain relatively high levels of contamination resulting from their use for storage of radioactive materials; both areas are fenced to preclude unauthorized access; and both have been subject to routine environmental monitoring programs implemented by DOE. Minimal human activity, other than routine site surveillance and maintenance activities, occurs at either area. In addition, as discussed earlier in this work plan, both areas have been characterized for radioactive and nonradioactive contaminants.

The primary source of contamination at these two properties is soil, both surface and subsurface. Soil contamination at SLAPS extends to a depth of 5.5 m (18 ft); at HISS contamination has been detected down to 1.8 m (6 ft). The volume of the two covered waste piles of contaminated material at HISS (which consist mainly of soil) is approximately 24,500 m^3 (32,000 yd^3).

Groundwater in several shallow wells at SLAPS contains uranium at concentrations 4 to 6 times the water ingestion guideline in DOE Order 5400.5. Several wells at HISS also contain uranium at levels greater than background levels, but not exceeding the DOE water ingestion guideline. However, as at SLDS, the groundwater in the area is not used for drinking water or for household supplies, so there are no current human receptors.

Current risk

Under current conditions, potential pathways for exposure at both properties include inhalation of radon in ambient air, inhalation of contaminants from resuspended dust, ingestion of contaminants in soil, direct dermal exposure to contaminated soil, and exposure to external gamma radiation. Direct exposure to or ingestion of contaminants in the waste piles at HISS is not a current exposure pathway because these piles are covered and monitored.

Although there is potential for exposure via the aforementioned pathways, current human exposure is limited because only a few trained personnel are employed at the properties and adequate access controls (i.e., fences) are in place. Additionally, a monitoring program ongoing since 1984 has indicated that external gamma exposure and radon levels do not exceed DOE radiation protection guidelines. However, radon-222 levels at locations along the fenceline have, at times, exceeded Missouri radiological regulations for unrestricted access areas.

Future risk

In considering future risks at SLAPS and HISS, it is assumed that site protective measures may no longer exist and that land use in these areas may be residential. The shift in land use could increase exposures via the relevant pathways. Direct dermal exposure to site soils, enhanced exposure to external gamma radiation fields, emissions of radon and subsequent inhalation of radon decay products, ingestion and inhalation of contaminated site soils, and ingestion of contaminated homegrown produce are all potential exposure pathways. As appropriate, these pathways will be quantitatively assessed as part of the baseline risk assessment.

3.1.3 Other Properties

These properties include the ball field area across from SLAPS to the north, the Futura Coatings property, commercial vicinity properties associated with SLAPS and Latty Avenue, residential vicinity properties, railroad vicinity properties, haul roads, the SLDS city property, and Coldwater Creek. The primary source of contamination at all of these properties is soil.

The baseline risk assessment will address potential radiological and chemical risks associated with current and future land uses at these properties. Quantitative assessment will be performed for radiological risks for all these properties; however, quantitative assessment for chemical risks will be performed only for the Futura Coatings property, the ball field area, and the SLDS city property because these properties have been characterized for chemical contaminants, too. A qualitative assessment for chemical risks at the remaining properties included in this grouping will also be included in the baseline risk assessment, assuming that chemical levels at these properties are equal to or less than those at the source areas or SLAPS and HISS. Potential risks associated with current and future land use for these properties are discussed below.

Ball field area

Soil at this property has been characterized for both radioactive and chemical constituents. In one isolated location, radioactive contamination extends to a depth of 3 m (10 ft), but most contamination is in the upper foot of soil. Chemical concentrations are lower in the ball field soils than in other areas where chemical levels have been characterized. Although there is currently a "No Trespassing" sign posted on the property, the area is not fenced and may occasionally be used for recreational activities. Potential current risks at the ball field area would be associated with inhalation of radon, inhalation of contaminants from resuspended dust, ingestion of contaminants in soil, direct dermal exposure to contaminated soil, and exposure to external gamma radiation. Preliminary estimates of current risks posed by using the area indicate that radiological dose is comparable to that received from natural background sources (BNI 1990b); more detailed assessment of risks will be conducted as part of the baseline risk assessment. Future risks would be associated with residential occupancy and the same pathways as were given for future residential use of the SLAPS or HISS areas.

Futura Coatings and other commercial properties

Because the Futura Coatings property was formerly used as a storage area for wastes from SLDS and SLAPS operations, this area has the highest contaminant levels of all areas categorized as other properties. Radionuclide and inorganic compound contamination in soil extends to a depth of 4.6 m (15 ft). Current radon-222 measurements in Futura buildings indicate levels comparable to those in ambient air. Contaminants at the other commercial properties are generally at lower concentrations and are not found at depths greater than 1 m (3 ft). Because these properties are currently used for commercial purposes and employees are on site regularly, current potential risks are associated with inhalation of radon, inhalation of contaminants from resuspended dust, ingestion of contaminants in soil, direct dermal exposure to contaminated soil, and exposure to external gamma radiation. Future risks and pathways at Futura and commercial vicinity properties associated with SLAPS and Latty Avenue would be the same as those associated with residential occupancy. Because of their proximity to SLDS, commercial land use at the SLDS commercial vicinity properties is more plausible. Future risks at these properties would be associated with future employees through the same aforementioned pathways.

Residential vicinity properties

Contamination at seven nearby residential properties is along the roadsides, at depths of 0.6 m (2 ft) or less. Current and future risks from these small areas of contamination are minimal because exposure opportunities are limited. Nonetheless, exposure is possible via inhalation of radon and/or resuspended dusts from these areas, ingestion of soil, direct dermal exposure to soil, and external gamma radiation.

Railroad vicinity properties

Radiological characterization of seven railroad properties in the vicinity of SLAPS and HISS indicates contamination generally extending to 1 m (3 ft) or less, with contamination at one location extending to a depth of 2 m (7 ft). Railroad workers are not known to spend a significant amount of worktime in these areas; however, the baseline risk assessment will assess potential exposure to a worker who spends a limited amount of time on the most contaminated of the railroad properties. Potential exposure at the railroad properties would be via external exposure, dust inhalation, incidental ingestion, inhalation of radon, and direct dermal exposure. Future risks would be associated with residential occupancy and the same pathways listed above.

Haul roads

Soil beneath the road and at the edges of the main roads that were used for transportation of wastes to and from SLAPS and HISS contains elevated levels of radionuclides. At one haul road (McDonnell Boulevard), the contamination extends to a depth of 4.5 m (15 ft), but contamination is generally confined to the upper 1 m (3 ft) of soil. Substantial human exposure along these roads is not expected to occur because much of the contamination is beneath the pavement and human receptors do not spend significant amounts of time near the contaminated areas of the haul roads. However, there is potential for limited exposure to haul road contamination via inhalation of radon and/or dusts, ingestion of soil, dermal contact, and direct exposure to external gamma radiation. Future risks would be associated with residential occupancy and these pathways.

SLDS city property

This property, adjacent to SLDS, is contaminated to a depth of 12.6 m (42 ft). The city property is not fenced and is accessible to the general public, although apparently is not often used by the public. Current potential exposure to contaminants exists via inhalation of radon and/or dusts, ingestion of soil, dermal contact with soil, and direct exposure to external gamma radiation. There are no buildings on this property. Furthermore, because of its proximity to SLDS, future risks would be associated with employees at a future commercial establishment on this property. The pathways would be similar to those given for future use of the SLDS vicinity properties.

Coldwater Creek

Sediments in Coldwater Creek and soil along the banks contain elevated levels of radioactive contaminants to a depth of 0.3 m (1 ft); the highest levels are found in the stretch of the creek between SLAPS and Pershall Road, but some contamination exceeding guidelines extends past Pershall Road. Current and future exposure is possible via ingestion or dermal contact with sediments or soil along the banks.

3.2 ECOLOGICAL IMPACTS

Because the majority of the St. Louis site is located in industrial areas, species found on site are probably affected by site-related contamination as well as other sources of contamination. Although there are no known critical habitats or threatened and endangered species at the site, some wildlife habitats do exist. Aquatic habitats potentially affected include Coldwater Creek and its drainages. Coldwater Creek is polluted by runoff both upstream and downstream of SLAPS and HISS.

Based on current land use, impact to site environment from site contaminants is expected to be similar to that typically encountered at industrial sites. Some contaminants in the soils (e.g., several metals) are at concentrations that have been found to adversely affect wildlife in laboratory and field experimental conditions. However, the mobility of species that inhabit the site, coupled with similar (nonradioactive) contaminants throughout the urban area, render a quantitative assessment of the environmental impacts of the site to wildlife impracticable. However, qualitative assessment of environmental impacts at the St. Louis site will be included in the baseline risk assessment report prepared for the site. If the potential for adverse impacts to wildlife is identified for the St. Louis site, these impacts would occur only at the level of the individual. No impacts of ecological significance (i.e., impacts that would occur at the population or community level) would be expected.

3.3 TOXICOLOGICAL AND ENVIRONMENTAL PROPERTIES OF SELECTED CONTAMINANTS

As background information for this work plan, a general description of the toxicological effects associated with radiation exposure and brief descriptions of the major toxicological effects of selected chemical contaminants associated with the St. Louis site are presented in Subsections 3.3.1 and 3.3.2. For most of the contaminants identified, the potential is greater for chronic (long-term) than for acute (short-term) effects of humans and biota under current site conditions.

3.3.1 Radiation Toxicity

Radiation exposures at the St. Louis site are all classified as low level. For these low-level exposures, dose rates are relatively close to background radiation levels; exposure periods of several years to a lifetime are usually required to accumulate significant doses; and health effects, if they appear, are difficult to discern from naturally occurring incidence rates.

Radiation health effects for humans have only been confirmed at relatively high dose rates or with large populations. For low doses, health effects are presumed to occur but can only be estimated statistically. Risk estimates are strictly applicable only to large populations because the appearance of an effect after an exposure is a chance event.

Medical practice has shown that the body has mechanisms to repair radiation-damaged cells. It is believed that these mechanisms probably operate for low-level radiation exposure where doses and dose rates are low, but this has not been confirmed.

The potential health effects associated with exposures at the St. Louis site are somatic, primarily increased risks of various types of cancer in the exposed individual. Studies with insects and animals have also shown that the offspring of exposed subjects may be affected, but such effects have not been established for humans. The sources of increased risk are emissions of alpha and beta particles and gamma and X rays from decay products in the thorium, uranium, and actinium decay chains. The potential contaminants of concern are discussed in Subsection 3.4.1.

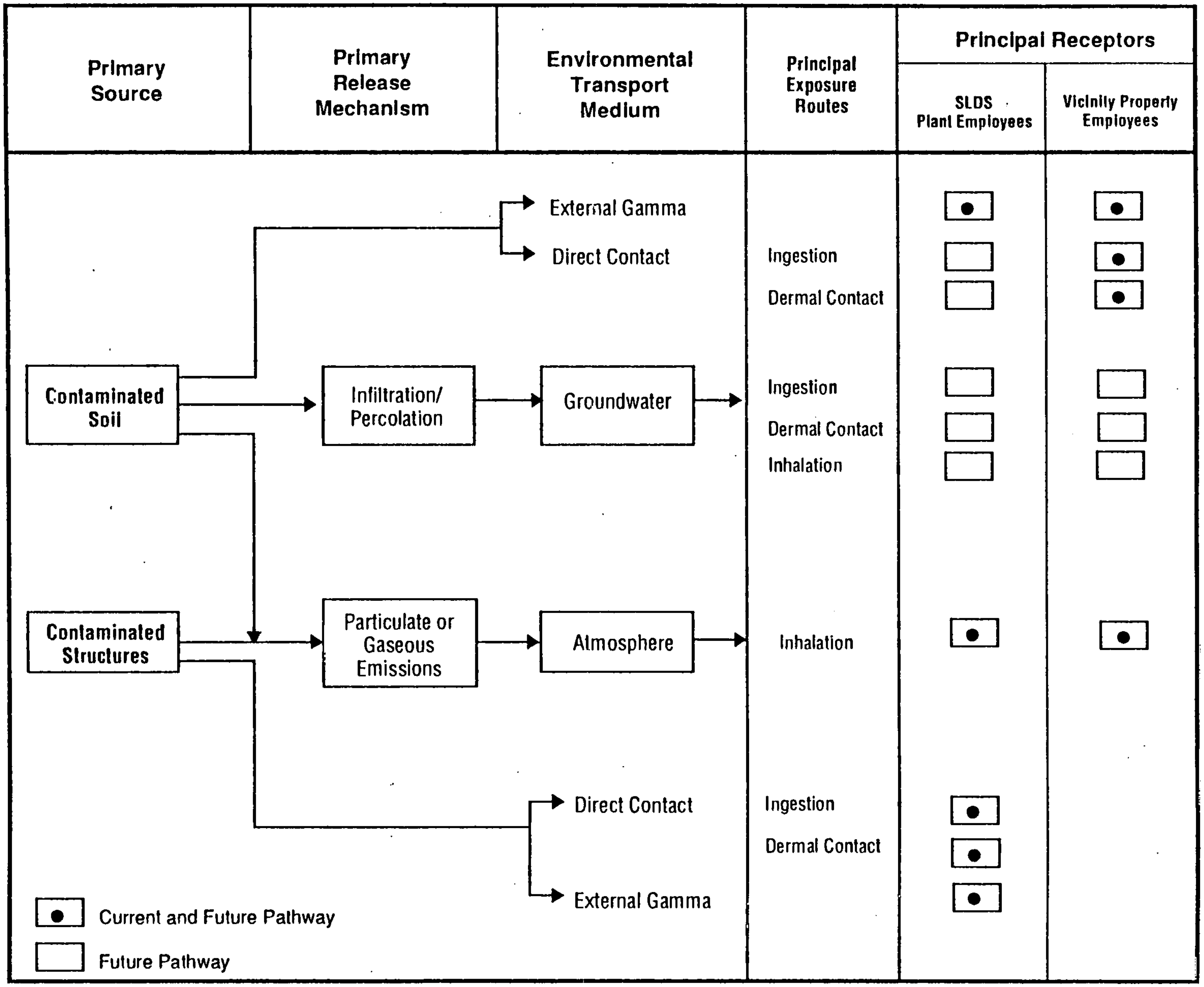

FIGURE 3-1 SITE MODEL FOR CURRENT AND FUTURE PATHWAYS AT SLDS AND VICINITY PROPERTIES

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4.‹3 2992.1

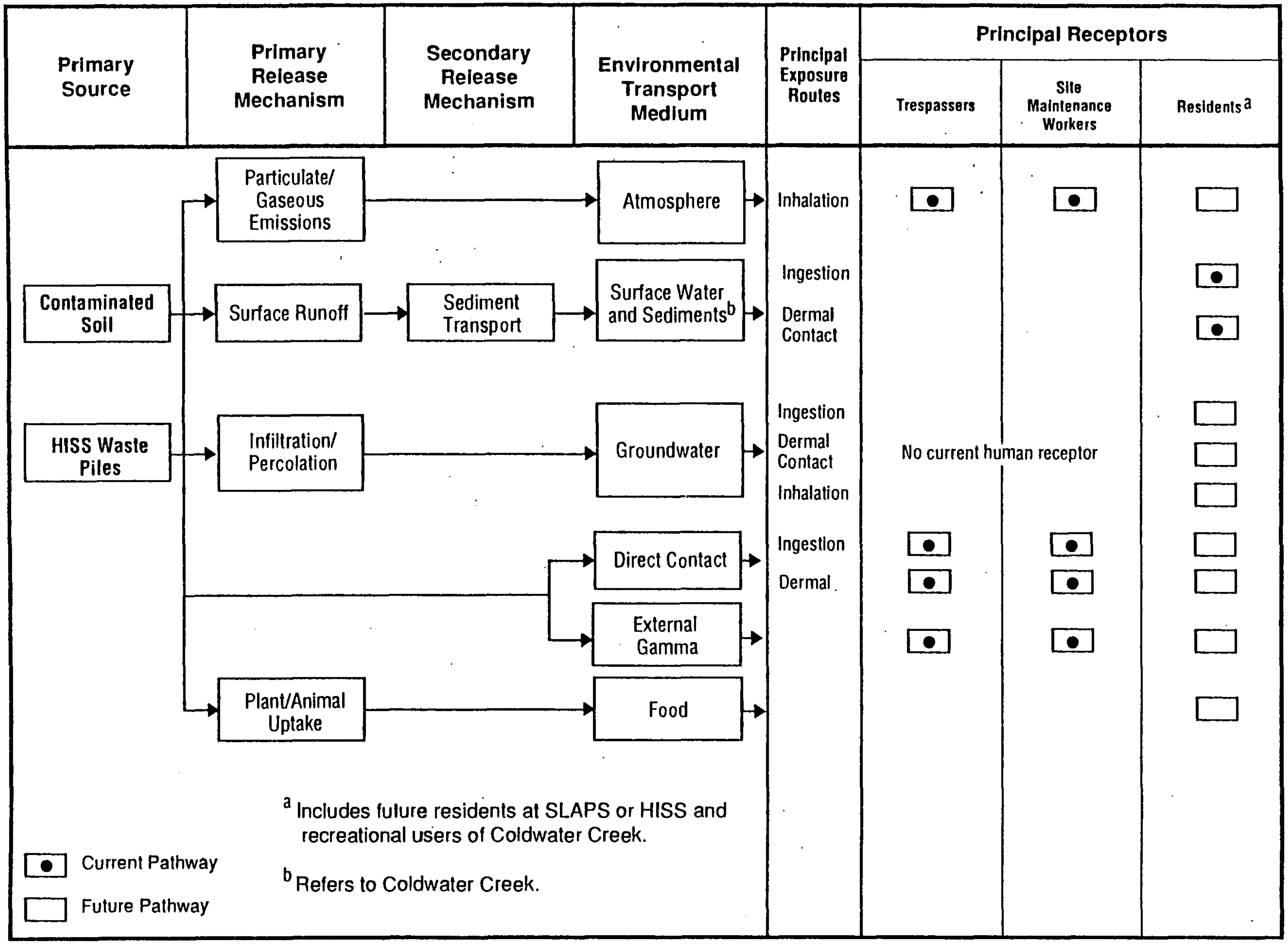
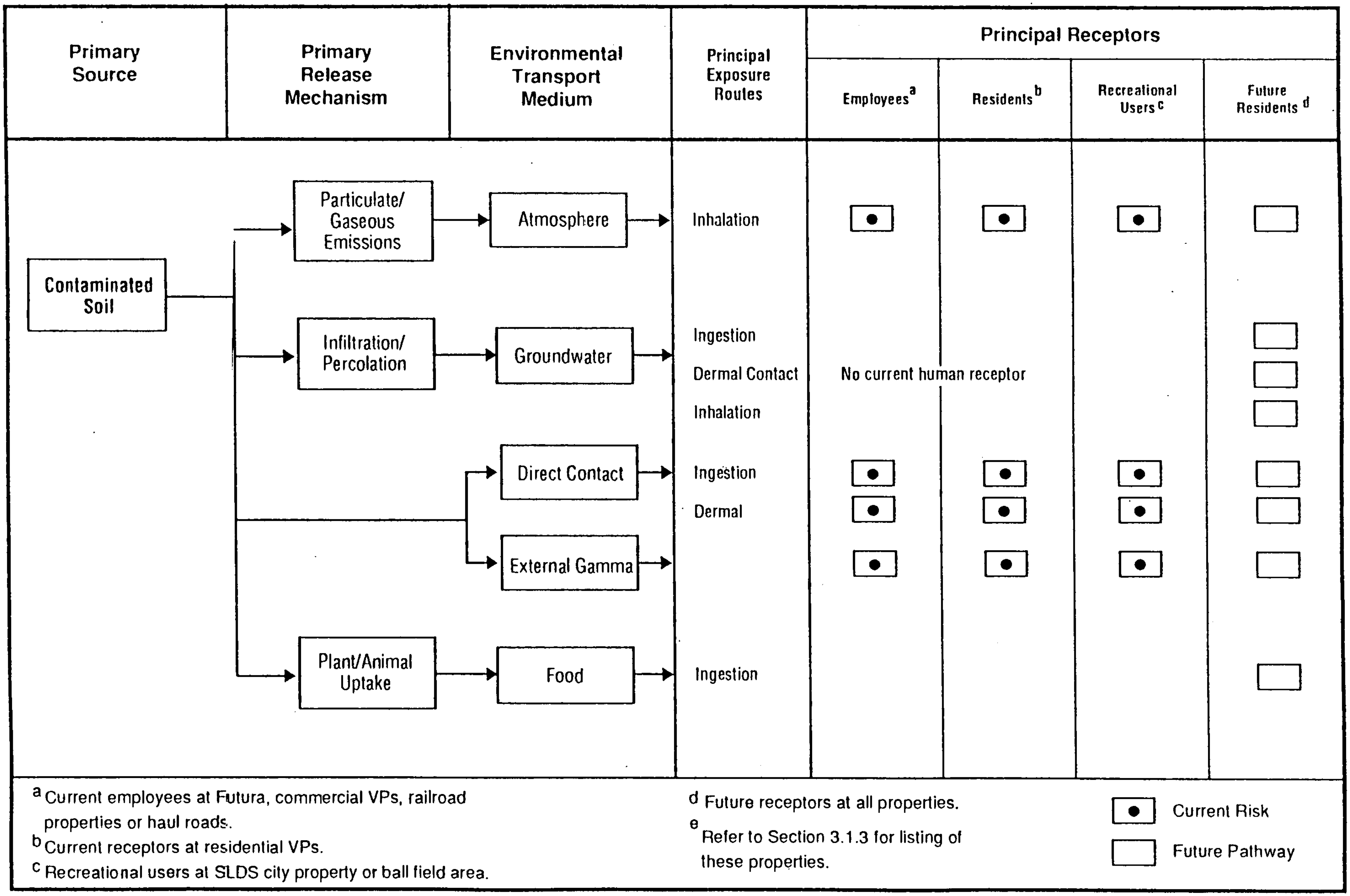


FIGURE 3-2 SITE MODEL FOR CURRENT AND FUTURE PATHWAYS AT SLAPS/HISS

08462 8



[a] Current employees at Futura, commercial VPs, railroad properties or haul roads.
[b] Current receptors at residential VPs.
[c] Recreational users at SLDS city property or ball field area.
[d] Future receptors at all properties.
[e] Refer to Section 3.1.3 for listing of these properties.

FIGURE 3-3 SITE MODEL FOR CURRENT AND FUTURE PATHWAYS AT OTHER PROPERTIES [e]

3.4.3 Potential Routes of Exposure and Receptors

Concentrations of gaseous and particulate contaminants in air will be the greatest at locations on site. For radon, the concentrations would be greatest inside site buildings. Potential exposure routes for all the areas comprising the St. Louis site are inhalation, ingestion of exposed contaminants (i.e., in soil or on building surfaces), and direct dermal contact with contaminants. At SLDS and its vicinity properties, current potential receptors include employees and possibly recreational users of the contaminated city property adjacent to the plant and the Mississippi River. At SLAPS and HISS, the few workers who maintain these areas are potential receptors but are trained to minimize exposure, so ingestion and dermal contact should be minimal. Trespassers onto these areas may also be exposed via inhalation, ingestion, external exposure, and dermal contact; however, because of the brevity of time spent on site, exposures will be minimal. Potential receptors on the land categorized as "other properties" include employees at commercial properties, recreational property users (e.g., the ball field area), and residents on the properties. All four exposure routes are possible for these receptors. In the future, land use at some of the properties comprising the St. Louis site may change. Potential residential land use of contaminated areas is considered to lead to the greatest magnitude of exposure, although construction workers may experience short-term exposure to higher levels of contaminants.

3.5 PRELIMINARY RESPONSE OBJECTIVES AND TECHNOLOGIES

The overall objective of the response action at the St. Louis site (including both removal and remedial actions) is to clean up, stabilize, or otherwise control contamination to ensure protection of human health and the environment. Additional broad objectives, established on the basis of specific criteria identified in CERCLA, as amended, are presented in Subsection 3.5.1. Potential response actions and technologies are discussed in general in Subsection 3.5.2, and preliminary response action objectives that are specific to contaminated environmental media at the St. Louis site are addressed in Subsection 3.5.3 and Appendix B. In Subsection 3.6, general response technologies are assembled into preliminary remedial action alternatives to fulfill the response objectives identified for the site. These objectives, technologies, and alternatives will continue to be developed during the RI/FS-EIS process.

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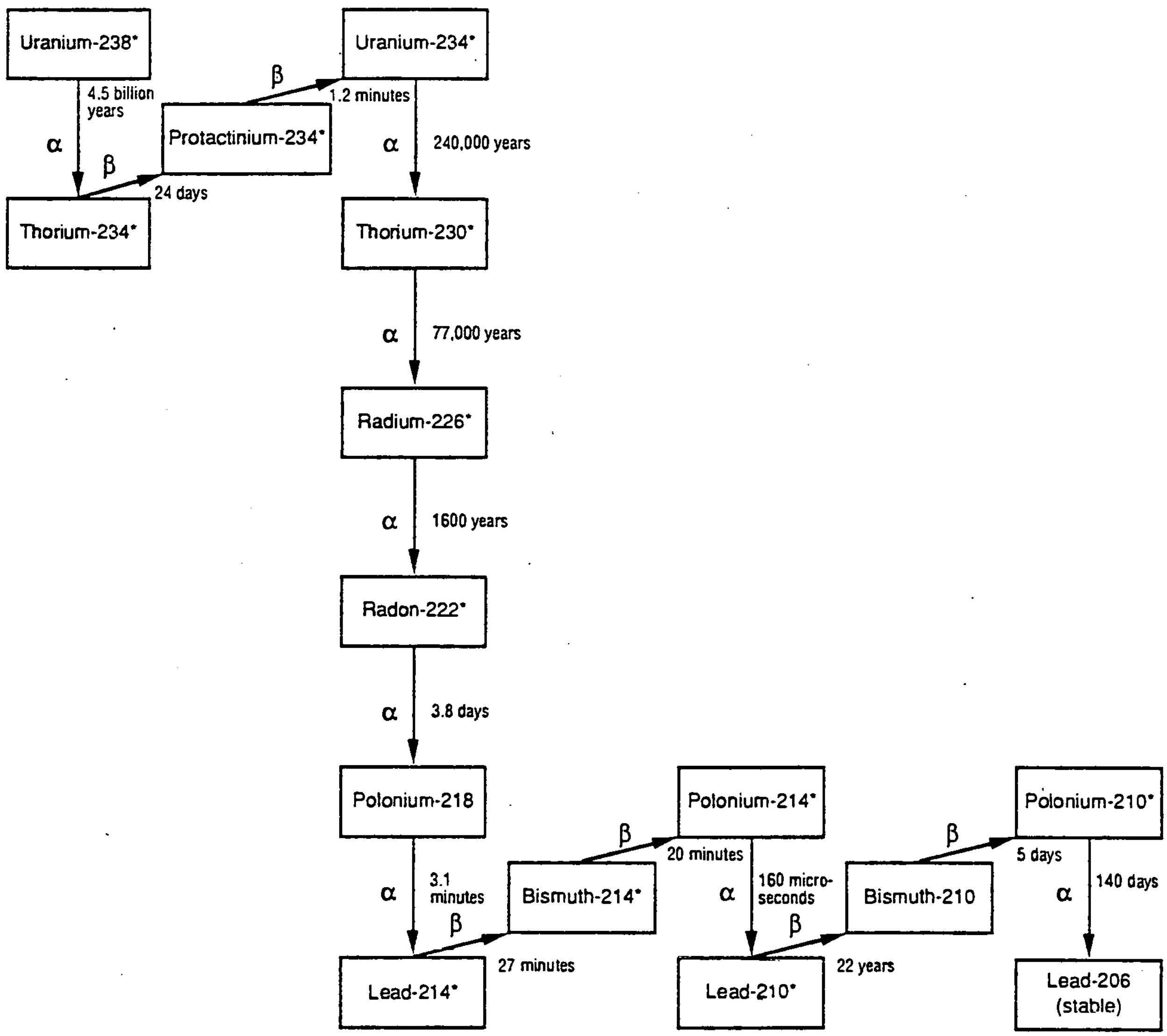
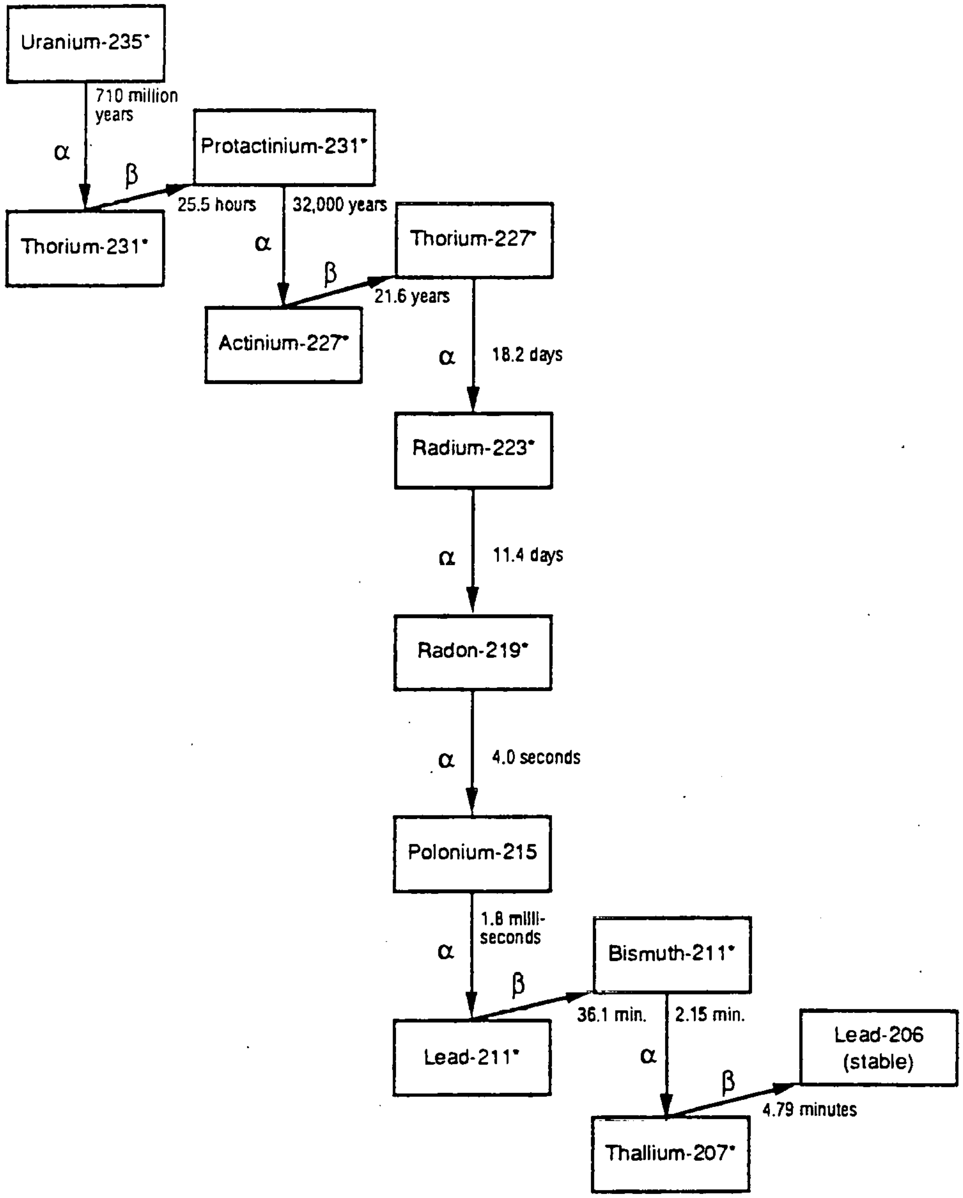


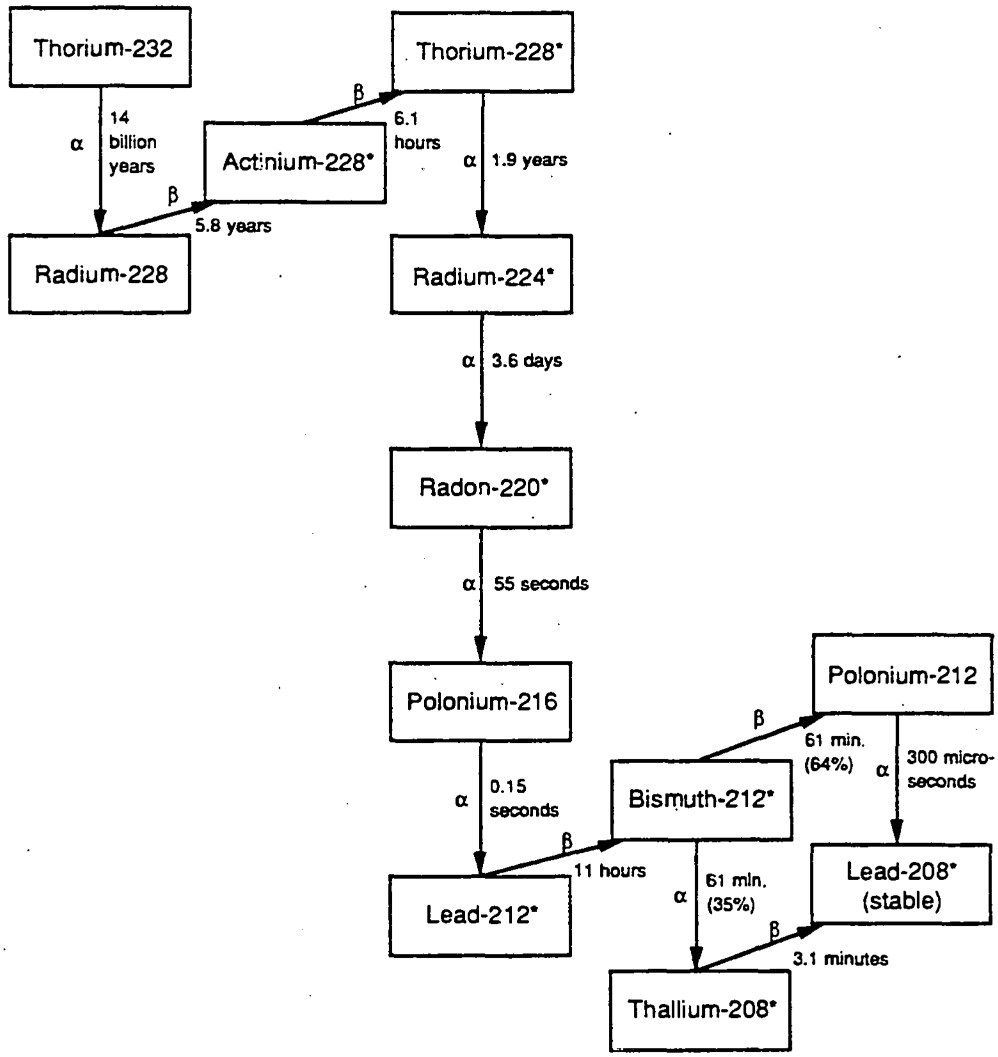
NOTES:
Only the dominant decay mode is shown.
The times shown are half-lives.
The symbols α and β indicate alpha and beta decay.
An asterisk indicates that the isotope is also a gamma emitter.

FIGURE 3-4 URANIUM-238 RADIOACTIVE DECAY SERIES



NOTES:
Only the dominant decay mode is shown.
The times shown are half-lives.
The symbols α and β indicate alpha and beta decay.
An asterisk indicates that the isotope is also a gamma emitter.

FIGURE 3-5 URANIUM-235 RADIOACTIVE DECAY SERIES



NOTES:
The times shown are half-lives.
The symbols α and β indicate alpha and beta decay.
An asterisk indicates that the isotope is also a gamma emitter.

FIGURE 3-6 THORIUM-232 RADIOACTIVE DECAY SERIES

3.5.1 Selection Criteria for Remedial Actions

Section 121 of CERCLA, as amended, identifies a strong statutory preference for remedial actions that are reliable and provide long-term protection. The primary requirements for a final remedy are that it protect human health and the environment, utilize permanent solutions, and be cost-effective. Additional selection criteria include the following:

- Preferred remedies are those in which the principal element is treatment to permanently or significantly reduce the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants.

- Where practical treatment technologies are available, off-site transport and disposal without treatment is the least preferred alternative.

- Permanent solutions and alternative treatment technologies or resource recovery technologies should be assessed and used to the maximum extent practicable.

The NCP lists nine criteria against which alternatives for a final remedy must be assessed. These criteria are: (1) overall protection of human health and the environment, (2) compliance with ARARs, (3) long-term effectiveness and permanence, (4) reduction of toxicity, mobility, or volume through treatment, (5) short-term effectiveness, (6) implementability, (7) cost, (8) state acceptance, and (9) community acceptance.

These criteria for final remedies constitute the general objectives for remedial actions at the St. Louis site. Long-term protection and permanence are the primary objectives in determining how the site materials should be managed. Cost-effectiveness and practical treatment technologies that are applicable to contaminated materials will also be considered during the development of remedial action alternatives.

3.5.2 General Response Actions and Technologies

This subsection presents a broad overview of response actions and technologies that could be implemented to achieve the objectives of remedial action at the St. Louis site, based on the current understanding of site contamination. The discussion is divided into two general categories as prescribed in the NCP: source control response actions and groundwater response actions.

Source control response actions

The objective of source control response actions is to directly control the source of contaminated materials at a waste site to minimize the potential for population exposure. A range of alternative technologies that reduce the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants will be developed. This range will seek to include an alternative that removes or destroys the contaminants to the maximum extent feasible or that eliminates or minimizes the need for long-term management. Other alternatives will vary in the degree of treatment, the quantities and characteristics of the treatment residuals, and the untreated wastes that must be managed. One or more alternatives will be included that involve little or no treatment but provide protection of human health and the environment, primarily by preventing or controlling exposure to the contaminants through engineered controls. The alternatives will be developed and screened on the basis of effectiveness, implementability, and cost. Source control response actions that may be applicable to managing the St. Louis site include institutional controls, removal, treatment, temporary storage, and disposal.

Institutional controls can involve the use of access restrictions, such as physical barriers (e.g., fences) and ownership or deed restrictions, and/or monitoring to reduce the potential for public exposure to contaminated materials. Such controls are currently in place at SLDS, SLAPS, and HISS to limit access and use. However, these methods generally serve as a reliable means of protecting human health and the environment only when used as support for other response actions. Removal of contaminated materials can be achieved by excavation, decontamination and/or demolition, and collection technologies. Contaminated soils and sludges can be excavated with standard construction equipment. Structural surfaces can be decontaminated by a number of conventional methods (e.g., vacuuming, abrasive blasting, and scabbling), and buildings can be demolished by standard construction equipment. Finally, contaminated groundwater can be collected by various conventional methods (e.g., extraction wells and gravity drain and pumping systems). Care must be exercised in designing groundwater collection and treatment systems to avoid release or concentration of naturally occurring radioactive materials.

Treatment encompasses a wide range of chemical, physical, and biological technologies that address various types of contamination in different media. Materials associated with the St. Louis site that contain chemicals and radionuclides include soils and sludges, mixed solids and process wastes, and groundwater. Only a limited number of technologies are effective when radionuclides are present because radioactivity cannot be destroyed by treatment. Technologies that can reduce the toxicity, mobility, and/or volume of radioactive wastes can be divided into two general categories: those that remove radioactive constituents from the waste matrix and those that change the form of the waste and/or matrix. The first category generally consists of chemical processes (although there are exceptions, such as physical separation techniques), and the second generally consists of physical processes. Biological processes are typically used to treat chemical organic wastes rather than radioactive wastes.

Chemical treatment technologies alter the nature of hazardous chemical constituents in contaminated liquids, sludges, or solids and can reduce waste toxicity, mobility, and/or volume. When radioactive components are present, a chemical extraction or leaching process can be used to remove them from the waste matrix and reduce the volume and/or mobility of the waste; the liquid leachate can then be reprocessed to isolate the radioactive components. Chemical treatment of groundwater (e.g., by precipitation and adsorption) typically follows its collection and removal, although treatment can also be conducted in situ. Soils, sludges, and solid wastes can be chemically treated either in situ (e.g., with a lixiviant wash) or following removal/excavation (e.g., in an engineered treatment system).

Physical treatment technologies can reduce the toxicity, mobility, and/or volume of waste materials, although in certain cases (e.g., sludge stabilization), the total contaminated volume may increase. Physical treatment can be used to remove contaminants from groundwater (e.g., by sedimentation, filtration, and distillation) and is typically conducted following groundwater collection and removal. Physical treatment technologies can also alter the structure of contaminated solids to facilitate stabilization and handling, and they can be implemented in situ or following excavation. Contaminated sludges can be physically treated by dewatering technologies in situ (e.g., by gravity drainage trenches and pumping) or following excavation (e.g., by vacuum filtration or drying beds). Physical treatment technologies that could be considered for contaminated soils and sludges include solids separation, nonthermal and thermal extraction, and thermal destruction.

Biological treatment technologies can alter the nature of a waste and remove contaminants (typically organics) from a waste matrix; they can be implemented in situ or following removal of contaminated materials. Biological processes are routinely employed in conventional wastewater treatment systems and can reduce waste toxicity, mobility, and/or volume. Such processes include trickling filters and surface impoundments (e.g., aerated lagoons). Organic debris and soils and sludges that contain nitrogen compounds and/or organic contaminants can also be treated by biological processes.

Temporary storage reduces waste mobility by isolating contaminants in a manner that protects human health and the environment during the short term until the ultimate disposition of the materials can be determined. Temporary storage can involve the placement of contaminated materials in an existing engineered structure or in a structure newly constructed for containment purposes.

Disposal typically reduces waste mobility through the permanent placement of contaminated materials in a manner that protects human health and the environment for the long term. Disposal options for solids/sludges include (1) on-site disposal in a land-based facility, (2) off-site disposal in a land-based facility, and (3) disposal in the ocean. (The latter option is not currently viable because of such factors as regulatory restrictions and public concern.) For contaminated liquids, disposal is typically preceded by treatment; discharge options include land application and release to a surface water, either on site or off site.

Groundwater response actions

The objective of groundwater response actions is to develop remedial alternatives that attain site-specific remediation levels within different restoration time periods using one or more different technologies. One or more innovative technologies will be developed for further consideration if, compared with demonstrated treatment technologies, they offer the potential for comparable or superior performance or implementability, fewer or lesser adverse impacts, or lower costs for similar levels of performance. The alternatives will be developed and screened on the basis of effectiveness, implementability, and cost; a no-action alternative, i.e., involving no further action, may also be included. Groundwater response actions that may be applicable to managing the St. Louis site include institutional controls and containment/treatment.

Institutional controls can include the use of access restrictions, such as physical barriers and ownership or deed restrictions, and/or monitoring. When used alone, physical barriers might reduce the potential for contaminant migration by human activities and limit contact with areas to which contaminants may already have migrated. However, ownership or deed restrictions alone are not generally effective in preventing contact with contaminants that have already migrated outside a controlled area. Similarly, monitoring is ineffective when used alone as a migration-control method and merely serves to identify the need for active controls or remediation, as appropriate. Thus institutional controls generally serve as a reliable means of protecting human health and the environment only when used as support for other response actions.

Containment can reduce waste mobility and the associated potential for contaminant migration and population exposure, and it can be achieved by in situ techniques. For example, groundwater can be contained by barriers to horizontal flow (e.g., slurry walls) and barriers to vertical flow (e.g., injected grout layers). Capping can reduce rain intrusion and potential leaching. The hydraulic gradient may also be controlled (e.g., by pumping systems) to limit groundwater migration. The groundwater system would require monitoring and maintenance to ensure system integrity.

When treatment technologies are used in conjunction with containment technologies for migration control, waste volume and toxicity may be reduced in addition to waste mobility. For example, contaminated groundwater can be treated by injecting reactive agents into areas of potential contamination or by using permeable treatment beds. Technologies for treating contaminated solids in a containment system include dewatering and stabilization/fixation.

3.5.3 Medium-Specific Response Objectives and Technologies

Preliminary response objectives for remedial actions at the St. Louis site have been identified for soil/sludge, surface water, groundwater, and structural materials. Potential response actions and technologies associated with source control and groundwater response actions for these objectives (see Subsection 3.5.2) are summarized in Appendix B. Additional objectives and technologies that may be appropriate for the St. Louis site will be identified and evaluated (screened) during the RI/FS-EIS process.

3.6 CONCEPTUAL REMEDIAL ACTION ALTERNATIVES

Preliminary alternatives for remedial action at the St. Louis site were developed according to the categories specified for remedial action in the current NCP, as follows:

- No action
- Alternatives for treatment or disposal at an off-site facility, as appropriate
- Alternatives that attain ARARs for protecting human health and welfare and the environment
- Alternatives that exceed ARARs

- Alternatives that do not attain ARARs but will reduce the likelihood of present or future threats from hazardous substances and will provide significant protection to human health and welfare and the environment (including an alternative that closely approaches the level of protection provided by those alternatives that attain ARARs)

Section 105 of CERCLA, as amended, required the president (who subsequently delegated this responsibility to EPA) to propose amendments to the NCP. A revision was promulgated on March 8, 1990 (EPA 1990b). The two categories of final remedial action alternatives (discussed in Subsection 3.5.2) developed in the revised NCP are:

- Source control response actions -- response actions that reduce the toxicity, mobility, or volume of the contaminants, ranging from alternatives that involve little or no treatment and rely on engineered controls to alternatives that remove or destroy the contaminants, thereby reducing the need for long-term management

- Groundwater response actions -- response actions that attain site-specific remediation levels within different restoration time periods, ranging from alternatives involving no action to alternatives that offer superior performance or implementability, fewer adverse impacts, and lower cost

A limited number of conceptual remedial action alternatives have been identified for the St. Louis site on the basis of these categories and the preliminary response objectives and technologies presented in Appendix B. (Only a general discussion of ARARs is possible at this stage of the RI/FS-EIS process; see Subsection 3.9.) These conceptual alternatives address the radioactively and chemically contaminated materials -- including soil/sludge, surface water, groundwater, and structural materials -- at the St. Louis site. The alternatives are:

- Alternative 1: No action
- Alternative 2: On-site disposal
- Alternative 3: Off-site (including out of state) disposal
- Alternative 4: On-site treatment with on-site disposal
- Alternative 5: On-site treatment with off-site disposal
- Alternative 6: Off-site (including out of state) treatment with off-site disposal

These alternatives are briefly described in Subsections 3.6.1 through 3.6.6 and represent basic combinations of potential response actions. Options may be identified within certain of the action alternatives -- i.e., Alternatives 2 through 6 -- to incorporate appropriate elements of other alternatives as the RI/FS-EIS process develops. For example, Alternative 4 might be varied to incorporate an element of Alternative 6 (off-site treatment and/or disposal) on a limited basis if a licensed facility were available for certain materials. Similarly, Alternative 5 could incorporate the focus of Alternative 2 (on-site containment for disposal) on a limited basis (e.g., if excavation of a small area of contaminated soil located beneath a paved surface would create a greater risk to workers than if it were contained in place and monitored/maintained for the long term).

3.6.1 No Action

The no-action alternative is included pursuant to the requirements of NEPA and CERCLA to provide a baseline for comparison with other alternatives and to assess the impacts on human health and the environment from current and projected conditions at the St. Louis site. If this option were selected, no reduction would occur in the toxicity, mobility, or volume of contaminated materials at the site. Potential exposure to contaminants would probably continue for the short term at current levels; over time, long-term exposure would likely increase in terms of both levels of exposure and size of potentially affected population.

3.6.2 On-Site Disposal

On-site disposal would reduce waste mobility and would require monitoring and maintenance, permanent access restrictions, and other institutional controls (e.g., management of a buffer zone between the facility and surrounding areas). On-site disposal could involve in situ containment (e.g., with caps and slurry walls) and/or construction of an engineered facility to isolate materials following their removal (e.g., via building demolition or soil excavation). Most importantly, this alternative would involve a determination of site suitability -- including site capacity and consideration of its location in an urbanized area -- prior to any waste removal or design and construction activities.

3.6.3 Off-Site Disposal

Off-site disposal would reduce waste mobility and could require either (1) use of an existing disposal facility or (2) siting and construction of a new facility to receive the radioactively and chemically contaminated wastes from the St. Louis site. This alternative would involve removing the wastes, satisfying transportation requirements, and complying with general operational and management requirements for the disposal facility (similar to those identified for the on-site disposal option in Subsection 3.6.2). The total waste volume, without treatment, is estimated to be about 721,018 m^3 (943,000 yd^3).

3.6.4 On-Site Treatment with On-Site Disposal

On-site treatment with on-site disposal would reduce the mobility and could reduce the toxicity and/or volume of contaminated materials. This alternative would involve issues similar to those identified for the on-site disposal alternative (see Subsection 3.6.2), in addition to issues related to the design, construction, and operation of various treatment systems to accommodate the site's contaminated materials. On-site treatment and disposal could be conducted in situ (e.g., using vitrification or cementation and capping/grouting technologies). Conversely, treatment could be conducted in an engineered facility following removal of the contaminated materials. Either method would require the implementation of institutional controls during treatment operations.

3.6.5 On-Site Treatment with Off-Site Disposal

On-site treatment with off-site disposal would reduce the mobility and could reduce the toxicity and/or volume of contaminated materials. This alternative would involve issues related to on-site treatment following excavation (similar to those identified in Subsection 3.6.4) and issues related to off-site disposal (similar to those identified in Subsection 3.6.3).

3.6.6 Off-Site Treatment with Off-Site Disposal

Off-site treatment with off-site disposal would reduce the mobility and could reduce the toxicity and/or volume of the contaminated materials. This alternative would involve general issues related to treatment (similar to those identified in Subsection 3.6.4) and issues related to off-site disposal (similar to those identified in Subsection 3.6.3). Siting, design, construction, and operation of off-site treatment systems would be required if existing facilities were not available to treat all of the site's contaminated materials.

3.7 OPERABLE UNITS AND REMOVAL ACTIONS

The St. Louis site will be addressed as three areas: (1) SLDS, (2) SLAPS and HISS/Futura, and (3) vicinity properties. Because of the proximity of these properties to each other and the similarity in origin and nature of the contamination, remedial actions at these properties will be addressed in one RI/FS process supplemented as necessary to meet EIS requirements under NEPA. This will lead to the issuance of one record of decision (ROD).

Several removal actions planned for the St. Louis site will be addressed by several engineering evaluation/cost analyses. Cleanup of selected vicinity properties at SLAPS and Latty Avenue will be undertaken before the ROD is issued, where necessary, to minimize or prevent impacts to human health and the environment from contamination existing at these properties. To prevent or minimize inadvertent exposure due to spreading of contaminated waste, interim on-site storage of contaminated materials resulting from maintenance activities or plant development at SLDS is also planned; this on-site storage may be within an existing structure (i.e., building) or in an outdoor engineered pile.

3.8 DATA GAPS

Substantial information on the nature and extent of site contamination exists to support the decision-making process for the RI/FS-EIS being conducted for the St. Louis site. Some limited additional data will be required, however, to support remedial action. Examples include the completion of additional radiological surveys in some sumps, drains, and building interiors at SLDS, completion of TCLP analyses for lead in soil at one location at SLDS, and sediment sampling in Coldwater Creek. These additional data that will be obtained are logical continuations of previous work described in Section 2.0 and are not critical to support the RI/FS process for the St. Louis site. For the most part, the data described above will be most efficiently obtained just prior to remedial action. In other instances, data will be collected as necessary to support property development and site maintenance by utilizing previous plans. Additional information also continues to be acquired as part of the ongoing DOE environmental monitoring program and will be incorporated and evaluated as it becomes available.

Additional information may be required in the future if, for example, SLAPS is identified as the preferred permanent disposal site. Such information would include the height of the stratigraphically lower aquifer and data on groundwater flow, direction, and gradient. Additionally, treatment technologies applicable to radioactively contaminated materials at the site would have to be identified and waste treatability studies initiated, as appropriate, to evaluate the feasibility and effectiveness of the technologies.

Several potential remedial action technologies may require bench-scale or pilot-scale treatability studies. The technologies that may warrant such testing for use at the FUSRAP properties in the St. Louis area include:

- Building decontamination - On-site testing of various decontamination methods may be necessary to determine their effectiveness for specific application to SLDS. This information is needed to determine both feasibility and cost.

- Solids separation - Historically, separation of soil and radioactive contaminants has been ineffective and has also been highly dependent on physical characteristics of the soil and the radionuclides of concern. Bench-scale testing may be needed to determine the usefulness of this treatment approach for soils and sediments.

- In situ tests - Technologies to reduce the mobility of hazardous constituents of the wastes may need to be tested to determine applicability to the FUSRAP properties in the St. Louis area. These may include surface spraying for contaminated buildings and equipment, cutoff walls and grouting/stabilization for groundwater protection, and vitrification for contaminated soils and sediments.

3.9 PRELIMINARY IDENTIFICATION OF REGULATORY REQUIREMENTS

Remedial action activities at the St. Louis site will be conducted in accordance with DOE orders and all pertinent ARARs for protecting human health and the environment. Specific requirements of certain orders are presented in Appendix E. The requirements of DOE Order 5400.5, for radiation protection of the public and the environment, are considered pertinent to the proposed action because residual soil and surface radionuclide contamination at the St. Louis site has been found to exceed the requirements specified in this order. Major ARARs potentially associated with remedial action at the site are highlighted in the following subsections, grouped on the basis of location-specific, contaminant-specific, and action-specific requirements consistent with EPA guidance. Additional discussion of these and other regulatory requirements with which the remedial action will comply is provided in Appendix E.

Activities at the St. Louis site are also conducted in compliance with worker protection requirements, including those identified in the Occupational Safety and Health Act and in a number of specific DOE orders. Because these requirements address employee protection rather than environmental protection, they are not subject to consideration for attainment or waiver under the ARAR evaluation process. Rather, they are requirements with which the remedial action activities must comply. Some of these requirements are listed in Appendix E for informational purposes rather than as an indication of a formal ARAR evaluation.

Finally, because Appendix E presents a comprehensive list of requirements with considerable overlap of regulated conditions, all determinations have been identified as "potentially" applicable, relevant and appropriate, or to be considered. These determinations will be finalized in consultation with the State of Missouri and EPA Region VII before implementing the proposed action.

3.9.1 Location-Specific Requirements

Location-specific requirements are based on the specific setting and nature of a site, e.g., its location in a floodplain and proximity to wetlands or the presence of archeological and cultural resources. Location-specific requirements pertinent and applicable to remedial action at the St. Louis site are requirements promulgated under Executive Order 11988; 40 CFR 6.302 (b) because portions of the site are located in the floodplain.

3.9.2 Contaminant-Specific Requirements

Contaminant-specific requirements address certain chemical species or a class of contaminants, e.g., uranium or PAHs, and relate to the level of contamination allowed for a specific pollutant in soil, water, and/or air. Potential contaminant-specific requirements considered for remedial action at the site include those promulgated under the Clean Air Act, such as the National Emission Standards for Hazardous Air Pollutants (NESHAPs). The NESHAPs requirements for radionuclides (given in 40 CFR, Part 61, Subparts H and Q) are considered ARARs for proposed action at the site and would be met during implementation. Other contaminant-specific requirements considered pertinent for the proposed action include those for radon-222, as promulgated under the Uranium Mill Tailings Radiation Control Act.

3.9.3 Action-Specific Requirements

Action-specific requirements relate to specific activities that are proposed to be implemented at a site, e.g., incineration of organically contaminated soil. Action-specific requirements pertinent to the remedial action involve material handling and storage. The management of chemically hazardous material is addressed under the Solid Waste Disposal Act, as amended by RCRA (see Table E.3 of Appendix E). Chemically contaminated material that results from implementing the proposed action and that meets the RCRA definition of hazardous waste will be handled according to the substantive requirements of RCRA. Mixed radioactive and chemically hazardous waste will be managed in compliance with DOE Order 5400.3.

4.0 WORK PLAN RATIONALE

4.1 OVERVIEW OF DATA OBJECTIVES AND ASSOCIATED ACTIVITIES

A major element of the RI/FS-EIS process is obtaining sufficient site-specific information and data to support assessment of site risks and evaluation of remedial action alternatives. Collection and documentation of data are conducted during the RI phase; analysis of alternatives is conducted in the FS-EIS phase. The level of detail and the quality of data required vary, based on the intended uses of the data.

Work at the St. Louis site needed to support the RI/FS is complete, and associated data objectives have been met. Investigation objectives and field activities associated with each area of the St. Louis site are summarized in Table 4-1. Results from the data acquisition activities will be documented in an RI report to support FS activities for the site.

4.2 QUALITY ASSURANCE OBJECTIVES FOR REMEDIAL INVESTIGATION

This subsection provides an overview of the quality assurance (QA) objectives that were considered during the RI. In general, QA objectives were divided into three major categories: analytical requirements, data QA requirements, and sample handling requirements.

4.2.1 Analytical Requirements

Selection of analytical requirements was based on two primary factors: that the method detection limit for the method selected was adequate to identify potential contaminants for which DOE is responsible, and that the method selected was a standard method. The analytical techniques selected for analysis of chemical, radiological, and engineering/geochemical parameters are given in Tables 4-2 through 4-4. In cases where the selected analytical technique could not be used or had to be modified, the appropriate section of the RI report will note the change and discuss any impacts on the data.

TABLE 4-1

SUMMARY OF DATA OBJECTIVES AND FIELD ACTIVITIES FOR THE ST. LOUIS SITE

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
SLDS				
Determine nature and extent of contamination; determine presence of RCRA-hazardous wastes.	Phase I - Analyzed soil samples from 59 boreholes for metals, VOCs, semivolatiles, and RCRA characteristics. Phase II - Sampled and analyzed soil from 51 boreholes for chemical constituents to further define boundaries of chemical contamination by testing for metals and RCRA characteristics.	ORNL radiological survey. BNI characterization, which included walkover gamma scans conducted on the city property and portions of SLDS, gamma logging in boreholes to identify areas of elevated radioactivity in subsurface soils. 297 surface samples collected and 218 boreholes sampled; analyzed for uranium-238, radium-226, thorium-232, and thorium-230.	BNI installed 10 geologic boreholes (9 of which were completed as monitoring wells).	Need radiological surveys of sumps/drains and building interiors.
Investigate potential migration of contaminants from soil into groundwater.	BNI analysis of groundwater from 8 wells (4 deep, 4 shallow) for various chemical parameters including VOCs, semivolatiles, pesticides, PCBs, metals, pH, specific conductance, TOX, and TOC.	BNI analysis from 9 wells quarterly for uranium-238, radium-226, thorium-230, and thorium-232.		Complete

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TABLE 4-1
(continued)

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
SLAPS				
Determine extent and nature of surface and subsurface radioactive and chemical contamination including RCRA wastes.	BNI limited characterization to provide information regarding the nature and potential presence of hazardous wastes in soil. BNI characterization included analysis for metals, mobile ions, VOCs, semivolatiles, and RCRA characteristics. 30 boreholes sampled and 109 samples analyzed.	ORNL radiological investigation of drainage ditches designated for remedial action. BNI radiological survey of ditches. BNI radiological characterization of the property, which included walkover gamma scans, near-surface gamma radiation levels, gamma radiation exposure rates, downhole gamma logging to identify areas of elevated radioactivity in subsurface soils. Analyzed samples from 102 boreholes for uranium-238, radium-226, thorium-232, and thorium-230 in some cases.	18 geologic boreholes (backfilled with grout).	Complete
Determine baseline conditions of and monitor changes in groundwater and surface water, radon concentrations, and gamma radiation levels to determine whether detrimental leakage of contaminants is occurring.	BNI environmental monitoring: quarterly analysis of groundwater for pH, specific conductance, TOC, TOX, and metals (1988-1989). BNI analysis for metals in groundwater for 5 quarters.	BNI environmental monitoring includes groundwater, sediment, and surface water for uranium, radium-226, thorium-232, thorium-230, radon, and external gamma radiation levels. 12 radon monitoring locations.		Ongoing
			10 monitoring wells for EM program.	Complete
			Canvass area wells.	Complete

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Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
HISS				
Determine the nature and extent of surface and subsurface contamination; identify indicator contaminants; determine presence of RCRA-hazardous wastes.	BNI characterization included analysis for RCRA waste characteristics, mobile ions, metals, VOCs, and semivolatiles. 15 samples analyzed (3 random boreholes and 3 biased boreholes).	NRC radiological survey. ORNL radiological characterization. ORAU radiological characterization of storage pile at HISS. ORNL detailed radiological survey of north and south shoulders of Latty Avenue. BNI radiological characterization included walkover surveys, near-surface gamma measurements, gamma exposure rates, downhole gamma logging in all boreholes, continuous sampling at 1-ft increments in each borehole, and analysis for uranium-238, radium-226, and thorium-232. Selected samples from 36 boreholes analyzed for thorium-230.		Complete
Determine baseline conditions of and monitor changes in groundwater and surface water, radon concentrations, and gamma radiation levels to determine whether leakage of contaminants is occurring.	BNI environmental monitoring: quarterly analysis of groundwater for pH, specific conductance, TOC, TOX, and metals (for 5 quarters during 1988 and 1989).	BNI environmental monitoring includes groundwater, sediment, and surface water for uranium, radium-226, thorium-230, radon, and external gamma radiation levels. 13 radon monitoring locations.	10 monitoring wells.	Ongoing
			Canvass area wells.	Complete

TABLE 4-1
(continued)

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
FUTURA COATINGS, INC.				
Determine nature and extent of surface and subsurface contamination; identify indicator contaminants; determine extent of contamination inside buildings.	BNI characterization included analysis for RCRA waste characteristics, mobile ions, metals, VOCs, and semivolatiles. 3 random boreholes and 3 biased boreholes.	ORNL radiological characterization. BNI characterization. Phase I - Environmental monitoring inside buildings for radon and gamma levels and gross alpha concentrations. Phase II - Included walkover surveys, near-surface gamma measurements, gamma exposure rates, downhole gamma logging allowing for selected samples to be analyzed for uranium-238, radium-226, thorium-232, and thorium-230. 48 exterior radiological boreholes were drilled. All samples from 10 boreholes beneath the building were analyzed.		Complete

TABLE 4-1
(continued)

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
VICINITY PROPERTIES				
Ball field (SLAPS)				
Determine nature and extent of contamination; identify indicator parameters; determine presence of RCRA-hazardous wastes; determine the boundaries of contamination	BNI chemical characterization. Samples from 11 boreholes analyzed for mobile ions, VOCs, semivolatiles, RCRA characteristics, pesticides/PCBs, and metals.	BNI radiological characterization included near-surface gamma measurements and downhole gamma logging and analysis of 680 soil samples (some composites) for uranium-238, radium-226, thorium-232, and/or thorium-230.	27 monitoring wells.	Complete
Ditches north and south of SLAPS				
Determine the nature and extent of radioactive contamination.	None	BNI radiological characterization included near-surface gamma measurements, downhole gamma logging, and analysis of surface and subsurface samples from 87 radiological boreholes for uranium-238, radium-226, thorium-232, and/or thorium-230.		Complete
St. Louis Airport Authority property				
Determine the nature and extent of radioactive contamination.	None	BNI radiological characterization included near-surface gamma measurements, downhole gamma logging, and analysis of soil samples from 66 radiological boreholes for uranium-238, radium-226, thorium-232, and/or thorium-230.		Complete

TABLE 4-1
(continued)

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
<u>Coldwater Creek</u>				
Determine the boundaries and extent of radioactive contamination and determine whether chemical contamination exists along the creek.	Analyzed 4 samples for metals, mobile ions, volatiles, and semivolatiles	BNI - radiological characterization of ditches and portions of Coldwater Creek. BNI radiological characterization of Coldwater Creek from SLAPS to HISS included drilling 519 radiological boreholes, performing a walkover gamma survey, downhole gamma logging, and sediment sampling. Analysis was conducted for uranium-238, radium-226, thorium-232, and/or thorium-230. Analyzed 110 samples for all radionuclides of interest extending 1.5 mi past previous survey. Analyzed 100 samples for all radionuclides of interest extending 4.8 mi from Bruce Drive in Florissant to Old Halls Ferry Road. Analyzed 125 samples for all radionuclides of interest from areas on either side of Coldwater Creek extending to the Missouri River.		Complete

TABLE 4-1
(continued)

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
<u>Coldwater Creek vicinity properties</u>				
Determine extent and boundaries of radioactive contamination.	None	BNI radiological characterization included walkover gamma scans and downhole gamma logging. Analyzed 120 samples for uranium-238, radium-226, thorium-232 and thorium-230.		Complete
<u>Haul roads vicinity properties</u>				
Determine extent and boundaries of radioactive contamination.	None	ORNL radiological survey. BNI analyzed 3,000 soil samples for thorium-230. Further characterization of 13 properties involved analyzing 240 soil samples (to a depth of 3 ft) for uranium-238, radium-226, thorium-232, and thorium-230.		Complete
<u>Norfolk and Western Railroad Property</u>				
Determine extent and boundaries of radioactive contamination.	BNI sampled and analyzed soil from 4 boreholes for chemical constituents to further demonstrate the lack of chemical contamination on these properties by testing for metals, VOCs, BNAEs, and RCRA characteristics.	BNI characterization included gamma exposure rates, downhole gamma logging, and analysis of soil samples from 200 radiological boreholes for uranium-238, radium-226, thorium-232, and/or thorium-230.		Complete

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TABLE 4-1
(continued)

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
Railroad property adjacent to Coldwater Creek				
Determine extent and boundaries of radioactive contamination.	None	Radiological characterization included analyzing 120 samples from 30 boreholes for uranium-238, radium-226, thorium-232, and thorium-230.		Complete
Banshee Road				
Determine extent and boundaries of radioactive contamination.	None	BNI radiological characterization included downhole gamma logging in 47 boreholes. Analyses for uranium-238, radium-226, thorium-232, and/or thorium-230 were conducted for soil samples from 48 boreholes.		Complete
SLDS vicinity properties				
Determine nature and extent of radioactive contamination.	None	BNI preliminary radiological characterization included analyses of soil samples for uranium-238, radium-226, thorium-232, and thorium-230.		Complete

TABLE 4-1
(continued)

Area/ Investigation Objective	Chemical Characterization	Radiological Characterization	Geological/Physical Characterization	Status
<u>Hanley Road at intersection with Latty Avenue</u>				
Determine extent and boundaries of radioactive contamination.	None	Further radiological characterization included analysis of soil samples from 12 boreholes for uranium-238, radium-226, thorium-232, and thorium-230.		Complete
<u>Pathway from SLDS to SLAPS</u>				
Determine whether radioactive contamination exists on possible transportation routes.	None	Conducted ORNL mobile gamma scan from SLDS to SLAPS.		Complete

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TABLE 4-2

METHODS FOR ANALYSIS OF WATER

Parameter	Analytical Technique	Method Detection Limit[a]
Metals[b,c,d]	ICPAES[c]: EPA 200-7-CLP-M As[c]: EPA 206.2-CLP-M Tl[c]: EPA 279.2-CLP-M Se[c]: EPA 270.2-CLP-M Pb[c]: EPA 239.2-CLP-M All others: U.S. EPA[c]	0.3 - 7.4 μg/L[f] 0.001 μg/L 0.001 μg/L 0.002 μg/L 0.001 μg/L 5-5000 μg/L[f]
Volatile organics	EPA method 8240 (SW 846)	5-10 μg/L[f]
Semivolatile organics	EPA method 8270 (SW 846)	10-50 μg/L[f]
Pesticides/ polychlorinated biphenyls	EPA method 8080 (SW 846)	0.05-1.0 μg/L[f]
pH	Electrometric: EPA 150.1	--
Total organic carbon	EPA 415.1	1 mg/L
Specific conductance	Electrometric: EPA 120.1	0.1 mg/L
Fluoride	Ion-selective electrode: EPA 340.2	0.1 mg/L
Nitrate	Ion chromatography: EPA 353.1	0.14 mg/L
Sulfate	Colorimetric: EPA 375.1	10 mg/L
Total organic halides	EPA method 9020 (SW 846)	--
Thorium	Alpha spectrometry EML-Th-03 (modified)	0.5 pCi/L
Radium	Alpha spectrometry of radon emanation: EPA 903.1	0.1 pCi/L
Uranium	Fluorimetry EML-U-03	5 μg/L

[a]Published method detection limits. The laboratory attempts to maintain the published method detection limits; however, matrix interference will raise the detection limits.

[b]Include aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lanthanides, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, and zinc. Arsenic, selenium, thallium, and lead analyses are by furnace atomic absorption.

TABLE 4-2
(continued)

[c]Samples will be prepared for analyses in accordance with procedures outlined in Exhibit D of the CLP-SOW for inorganics analyses (EPA 1988b).

[d]For boron, lithium, molybdenum, and lanthanides, which are not standard CLP analyses, the following was done: interference standards were prepared and a calibration curve determined, initial calibration verification (ICV) and calibration curve verification (CCV) standards were prepared at a midrange concentration, and a laboratory control sample was prepared by digesting the ICV standard.

[e]ICPAES - Inductively coupled plasma atomic emission spectrophotometry.

[f]Range of detection limits.

TABLE 4-3

METHODS FOR ANALYSIS OF SOIL

Parameter	Analytical Technique	EPA Method No.
Metals[a,b]	ICPAES[c]	200.7-CLP-M
Sulfate	Colorimetric	9035
Nitrate	Kjeldahl, distillation, titration	351
Fluoride	Distillation, ISE	340.1
Mercury	Cold vapor atomic absorption	--
Volatile organics	GC/Hall/PID[d]	Modified[e] 8010/8015
Base/neutral and acid extractable organics	GC/FID and GC/MS[f]	Modified[g] 8250
Extraction procedure toxicity	Various	1310
Corrosivity	Electrometric	111.0
Ignitability	--	1010
Reactivity-sulfide	Titration	9030
Reactivity-cyanide	Titration	9010
Isotopic uranium	Radiochemical	U-04[h]
Isotopic radium	Radiochemical	Ra-07[h]
Isotopic thorium	Radiochemical	Th-03[i]
Uranium-238	Gamma spectrometry	C-02[h]
Radium-226	Gamma spectrometry	C-02[h]
Thorium-232	Gamma spectrometry	C-02[h]

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TABLE 4-3
(continued)

[a]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lanthanides, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, and zinc.

[b]Soil samples will be prepared for analyses in accordance with procedures outlined in Exhibit D of the CLP-SOW for inorganic analysis (EPA 1988b).

[c]ICPAES - Inductively coupled plasma atomic emission spectrophotometry.

[d]GC/Hall/PID - Gas chromatography/Hall detector/pressurized ionization detector.

[e]Modification substitutes the use of GC/Hall/PID for the GC/MS.

[f]GC/FID/MS - gas chromatography/flame ionization detector/mass spectrometry.

[g]Modified to include use of GC/FID instead of GC/MS.

[h]TMA/E utilizes laboratory procedure developed by Environmental Measurements Laboratory-300 (EML-300).

[i]Modified by Environmental Measurements Laboratory procedure to accommodate the matrix.

TABLE 4-4

ENGINEERING/GEOTECHNICAL TEST METHODS[a]

Test	Method[b,c]
Gradation/hydrometer	ASTM D422
Cation exchange capacity	ASTM STP-805
Distribution coefficient	ASTM D4319
Atterberg limits	ASTM D4318
Unit weight (wet/dry)	DA EM 1110-2-1906
Moisture content	ASTM D2216
Centrifuge moisture equivalent	ASTM D425
Specific gravity	ASTM D854

[a]All analyses meet industry standard detection limits.

[b]ASTM - American Society for Testing and Materials.

[c]DA EM - Department of Army Engineer Manual.

Analytical methods and equipment were also selected based on the quality of data required for the RI. The EPA guidance on data quality objectives (DQOs) establishes five levels of quality applicable to various chemical data gathering activities during the RI/FS process (Figure 4-1) (EPA 1987b). For the St. Louis site RI, the radiological and chemical data collected with field instruments correspond to analytical level I. The chemical data obtained from samples analyzed at the fixed-base laboratory correspond to level III. EPA does not currently have defined DQOs for radiological analyses; however, the quality of radiological analyses conducted by the fixed-base laboratory corresponds to level III.

4.2.2 Data Quality Assurance Requirements

The data QA requirements used to guide sample collection and data use were that: (1) the accuracy of the data was acceptable for guiding future remedial action efforts, (2) the precision of the data provided a high level of confidence in the analytical methods being used, (3) the data collected were complete with respect to the planned activities, (4) the data represented the medium/environment sampled, and (5) the data sets received were comparable.

Accuracy

Accuracy is the degree of agreement between a measurement and an accepted reference, or true value, of the analytical method used. Accuracy is normally established through analysis of spiked samples and standard reference materials (SRMs). Spiked soil samples could not be obtained for the radiological analyses, but accuracy was determined by analyzing SRMs of known activity. In general, an SRM sample was analyzed with each batch of 20 samples or fewer. The accuracy of the chemical analyses was evaluated with the use of method spikes (prepared in the laboratory), matrix spikes (field samples spiked in the laboratory), and SRMs. The method spikes and SRMs were analyzed with each batch of 20 samples or fewer. The matrix spikes were also analyzed with each batch of 20 samples or fewer when sufficient volume of sample was available.

The accuracy of each set of measurements will be discussed in the RI report.

Precision

Precision is the measure of mutual agreement among individual measurements of the same property under similar conditions. Precision is normally determined from the results of field

DATA USES	ANALYTICAL LEVEL	TYPE OF ANALYSIS	LIMITATIONS	DATA QUALITY
• SITE CHARACTERIZATION • MONITORING DURING IMPLEMENTATION	LEVEL I	• TOTAL ORGANIC/INORGANIC VAPOR DETECTION USING PORTABLE INSTRUMENTS • FIELD TEST KITS	• INSTRUMENTS RESPOND TO NATURALLY OCCURRING COMPOUNDS	• IF INSTRUMENTS CALIBRATED AND DATA INTERPRETED CORRECTLY, CAN PROVIDE INDICATION OF CONTAMINATION
• SITE CHARACTERIZATION • EVALUATION OF ALTERNATIVES • ENGINEERING DESIGN • MONITORING DURING IMPLEMENTATION	LEVEL II	• VARIETY OF ORGANICS BY GC/MS; INORGANICS BY AA, XRF	• TENTATIVE IDENTIFICATION ANALYTE-SPECIFIC • TECHNIQUES/INSTRUMENTS LIMITED MOSTLY TO VOLATILES, METALS • DETECTION LIMITS VARY FROM LOW ppm TO LOW ppb	• DEPENDENT ON QA/QC STEPS EMPLOYED • DATA TYPICALLY REPORTED IN CONCENTRATION RANGES
• RISK ASSESSMENT • PRP DETERMINATION • SITE CHARACTERIZATION • EVALUATION OF ALTERNATIVES • ENGINEERING DESIGN • MONITORING DURING IMPLEMENTATION	LEVEL III	• ORGANICS/INORGANICS USING EPA PROCEDURES OTHER THAN CLP CAN BE ANALYTE-SPECIFIC • RCRA CHARACTERISTICS TESTS	• TENTATIVE IDENTIFICATION IN SOME CASES • CAN PROVIDE DATA OF SAME QUALITY AS LEVEL IV	• DETECTION LIMITS SIMILAR TO CLP • LESS RIGOROUS QA/QC
• RISK ASSESSMENT • PRP DETERMINATION • EVALUATION OF ALTERNATIVES • ENGINEERING DESIGN	LEVEL IV	• TCL ORGANICS/INORGANICS BY GC/MS, AA, ICP • LOW ppb DETECTION LIMIT	• TENTATIVE IDENTIFICATION OF NON-TCL PARAMETERS • SOME TIME MAY BE REQUIRED FOR VALIDATION OF PACKAGES	• GOAL IS TO OBTAIN DATA OF KNOWN QUALITY • RIGOROUS QA/QC
• RISK ASSESSMENT • PRP DETERMINATION	LEVEL V	• NONCONVENTIONAL PARAMETERS • MODIFICATION OF EXISTING METHODS • APPENDIX 8 PARAMETERS (EPA)	• MAY REQUIRE METHOD DEVELOPMENT/MODIFICATION • MECHANISM TO OBTAIN SERVICES REQUIRES SPECIAL LEAD TIME • METHOD-SPECIFIC DETECTION LIMITS	• METHOD-SPECIFIC

AA - ATOMIC ABSORPTION
CLP - CONTRACT LABORATORY PROGRAM
EPA - ENVIRONMENTAL PROTECTION AGENCY
GC/MS - GAS CHROMATOGRAPHY/ MASS SPECTROMETRY
ICP - INDUCTIVELY COUPLED PLASMA
ppb - PARTS PER BILLION
ppm - PARTS PER MILLION
PRP - POTENTIALLY RESPONSIBLE PARTY
QA/QC - QUALITY ASSURANCE/QUALITY CONTROL
RCRA - RESOURCE CONSERVATION AND RECOVERY ACT
TCL - TARGET COMPOUND LIST
XRF - X-RAY FLUORESCENT ANALYZER

SOURCE: ENVIRONMENTAL PROTECTION AGENCY, *Data Quality Objectives for Remedial Response Activities, Development Process*, EPA/540/6-87/003, WASHINGTON, D.C., MARCH 1987.

FIGURE 4-1 SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

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duplicates (a duplicate sample collected under the same conditions and in the same location as a previous sample), laboratory duplicates (a separate, laboratory-prepared aliquot of a sample received for analysis), and split samples (a separate, field-prepared aliquot of a sample).

The precision of the radiological analyses for gamma activity was determined by reanalyzing 1 sample in every batch of 20 or fewer. This technique was used because the measurement is noninvasive and the sample is not disturbed between measurements. The precision of thorium-230 measurements was determined through the use of laboratory duplicates. A laboratory duplicate was analyzed for each batch of 20 samples or fewer.

The precision of the chemical analyses was determined through the use of field duplicates, laboratory duplicates, and split samples. In general, the measurements were conducted on 1 sample from each batch of 20 samples or fewer. In some cases, however, a sufficient volume of sample could not be recovered to provide the required duplicate and split samples.

The precision of each set of measurements will be discussed in the RI report. Also included is a discussion of the usefulness of the results for those cases where the planned quality control (QC) samples could not be collected.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount expected to be obtained under correct, normal conditions. In general, each data set collected contained sufficient information to fulfill the data gaps identified for the area under investigation. A detailed discussion of the completeness of each data set will be included in the RI report.

Representativeness

Representativeness is the degree to which the data accurately and precisely represent the medium/environment where the samples were obtained. For all sampling events, sampling locations were selected using either random or systematic strategies to ensure that the vertical and horizontal boundaries of the waste were identified and that the characteristics of the waste were known.

Comparability

Comparability is the degree to which the data generated during one portion of the RI can be compared with data generated during another. Comparability was ensured through the use of EPA-designated reference or equivalent sampling procedures and analytical methods. Additionally, compatible units were selected for all chemical and radiological results.

4.2.3 Sample Handling

Sample handling includes tracking the collection, preservation, shipment, and documentation of a sample. The QA/QC objectives for the sample collection, packaging, and shipment portion of the field activities were to verify that decontamination, packaging, and shipping are not introducing variables into the sampling chain that could make the validity of the samples questionable. To fulfill these QA objectives, trip, field, and method blank QC samples were used. These samples were typically analyzed with each batch of samples shipped. Results of these measurements will be discussed in the RI report.

Table 4-5 summarizes the types of samples collected and the analyses performed on each type. Table 4-6 provides information on preservation methods, holding times, and types of containers used for the applicable chemical parameters.

Records of samples collected, measurements taken, and observations of events and conditions that could affect data quality were made during field activities. The records provided sufficient data and observations to enable participants to reconstruct events that occurred during that data collection process, help qualify data, and refresh the memories of field personnel. All original data collected in the field are considered permanent records.

4.2.4 Sample Custody

Identification and documentation of the possession history of a sample from collection through analysis and ultimate disposition was important to ensure that the validity of the sample has not been compromised. Chain-of-custody procedures provide for sample labeling and tracking reports that contain unique sample identification, documentation of specific reagents or supplies that became an integral part of the sample, sample preservation methods, and sample custody logs.

TABLE 4-5

SAMPLE TYPES AND ANALYTICAL PARAMETERS

Parameter	Medium: Soil	Ground-water	Surface Water	Sediment
Radiological				
Thorium-230	0	0	0	0
Thorium-232	0	0	0	0
Radium-226	0	0	0	0
Uranium-238	0	0	0	0
Metals[a]				
ICPAES[b]	0	0	0	0
TCLP or EP tox[c]	0	--	--	--
Mobile Ions				
Fluoride	0	0	0	0
Nitrate	0	0	0	0
Sulfate	0	--	--	--
Organics				
Volatile organics	0	0	0	0
Semivolatile organics	0	0	0	0
TCLP or EP tox	0	--	--	--
Engineering and Geotechnical				
Gradation/ hydrometer	0	--	--	0
Cation exchange capacity	0	--	--	0
Distribution coefficient	0	--	--	0
Atterberg limits	0	--	--	--
Specific gravity	0	--	--	--
Unit weight (wet/dry)	0	--	--	--
Moisture content	0	--	--	--
Centrifugal moisture equivalent	0	--	--	--

TABLE 4-5
(continued)

Parameter	Soil	Ground-water	Surface Water	Sediment
	Medium			
Miscellaneous Indicators				
Temperature	--	0	0	--
pH	0	0	0	--
Specific conductance	--	0	0	--
Dissolved oxygen	--	0	0	--

0 - Analysis conducted.

-- - Analysis not performed.

NOTE: For characterization purposes, radon was monitored within buildings and at property perimeters. At SLAPS and HISS, it is monitored quarterly at the property fencelines.

[a]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Arsenic and lead analyses are by furnace atomic absorption.

[b]ICPAES - Inductively coupled plasma atomic emission spectrophotometry.

[c]TCLP - Toxicity characteristic leaching procedure; EP tox - extraction procedure toxicity.

TABLE 4-6

PRESERVATION METHODS, HOLDING TIMES, AND CONTAINERS FOR CHEMICAL SAMPLES

Parameter	Sample Matrix	Preservation Method	Maximum Holding Time	Type of Container
Volatile organics	Water/sediment/soil	Cool, 4°C Cool, 4°C	5 days 10 days	(2) 40-ml glass vial (2) 120-ml wide-mouth glass vial with Teflon liner
Base/neutral and acid extractable organics	Water	Cool, 4°C	5 days until extraction, then 40 days until analysis	(1) 8-oz wide-mouth glass bottle with Teflon cap liner
	Sediment/ soil	Cool, 4°C	10 days until extraction, then 40 days until analysis	
Metals	Water	Nitric acid to pH <2	6 months	(1) 1-L polyethylene bottle
	Sediment/ soil	Cool, 4°C	6 months	(1) 8-oz wide-mouth glass bottle with Teflon cap liner
<u>Mobile Ions</u>				
Cyanides	Water	NaOH to pH >12 Cool, 4°C	14 days	(1) 1-L polyethylene bottle
	Sediment/ soil	Cool, 4°C	14 days	1-L polyethylene bottle (included in the metals sample)
Nitrate	Water	H_2SO_4 to pH <2 Cool, 4°C	14 days	1-L polyethylene bottle

Chemical samples

Prior to sampling, a staff member in the BNI Oak Ridge office obtained a copy of the analytical services notification form and completed the form with the assistance of the BNI/RFW liaison. An example of the completed form is shown in Figure 4-2. This form was checked by the BNI/RFW liaison to ensure completeness before submittal to the laboratory. Upon receipt of the form, the laboratory determined the number of sample containers needed and shipped them to the site. A copy of the completed form was sent to field sampling personnel. Generic information was copied to the request form for analytical services (Figure 4-3), including the analyses requested to ensure that the correct sample analyses were requested by field personnel. This process also ensured that the correct sample containers (containing all required preservatives) were provided to the field sampling team. Finally, the process provided early notification to RFW of upcoming sampling, thereby allowing them to stage samples appropriately.

Each chemical sample had a unique identification, and a chain-of-custody record accompanied each sample submitted for analysis. Samples for chemical analysis were handled in accordance with the EPA manual User's Guide to the Contract Laboratory Program (EPA 1986). Samples were traceable from the time they were collected until they, or their derived data, were documented in a report. The final custody documentation procedure was used in conjunction with RFW sample documentation for all samples processed through RFW to maintain a record of sample collection, transfer between personnel, and shipment and receipt by the laboratory. RFW used a request form for analytical services that was completed for each sample type. Each time samples were transferred to another custodian, the signature(s) of the person(s) relinquishing the sample and receiving the sample, the reason for relinquishing the sample, and the time and date were documented. A sample was considered to be in a particular individual's custody if it was (1) in that person's physical possession, (2) in view of the person who took possession or secured by that person so that no one could tamper with it, or (3) in a secure area.

A sample custodian designated by the laboratory accepted custody of the samples and verified that the information on the labels matched that on the request for analytical services. The custodian then entered the information from the sample label into the laboratory sample tracking system. Samples were distributed to the appropriate analyst, who was responsible for them until they were exhausted or returned to the custodian. After all analyses were completed, the samples (if radioactively contaminated) were returned to the site or to TMA/E for storage. Nonradioactively contaminated samples were sent for commercial disposal.

WESTON BECHTEL

Analytical Services Notification

Bechtel Subcontr 14501-191-SC-205

SIGNATURE OF BECHTEL/WESTON LIAISON:			DATE:
John P. Doe			9/9/90
WORK ORDER NUMBER: 999	SITE: 140	AREA: HISS	DATA CODE: CH-SOIL

PRIORITY LEVEL	MATRIX	TOTAL NO. SAMPLES	DATE CONTAINERS ARE NEEDED BY	DATE SAMPLES WILL BE RETURNED FOR ANALYSIS
6	SOIL	26	10/9/90	10/18/90

SIGNATURE OF INITIATOR: Jane E. Doe

DATE ORDERED: 9/8/90

DATA TO: JANE E DOE

ELECTRONIC DATA TRANSFER: YES ☒ NO ☐

CHARGE CODE: 138A03333

RESPONSIBLE PERSON AND ADDRESS TO SHIP CONTAINERS TO:

FRANK SAMPLER
BNI
259 MOUNTAIN AVE
St. Louis, MO

COMMENTS/INSTRUCTIONS:

★ FULL CLP PACKAGES REQUIRED

ANALYSES REQUIRED

ITEM	DESCRIPTION
1.1.1	VOA
1.2.1	BNAE
1.3.1	PEST/PCB
5.0	ICPAES
5.36	RARE EARTHS
2.3	As - AA
2.7	Pb - AA
2.10	Se - AA
2.12	Tl - AA

PINK: BECHTEL/WESTON LIAISON
YELLOW: INITIATOR
WHITE: WESTON

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FIGURE 4-2 COMPLETED ANALYTICAL SERVICES FORM

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WESTON

Request for Analytical Services

Bechtel Subcontr 14501-191-SC-205

WORK ORDER NUMBER:	SITE:	AREA:	DATA CODE:

PRIORITY LEVEL	TOTAL NO. SAMPLES	TOTAL NO. BOXES	SAMPLES IN THIS BOX	DATE SHIPPED	RFW LOT #	RESULTS RECEIVED

SAMPLE NUMBER	BECHTEL ID	DESCRIPTION	MATRIX	DATE COLLECTED	NUMBER OF CONTAINERS

ANALYSES REQUIRED	
ITEM	DESCRIPTION

REASON	RELINQUISHED BY	RECEIVED BY	DATE	TIME

COMMENTS/INSTRUCTIONS:

WHITE: BECHTEL/WESTON LIAISON YELLOW: SAMPLER PINK: WESTON THEN BECHTEL/WESTON LIAISON CANARY RF

FIGURE 4-3 REQUEST FORM FOR ANALYTICAL SERVICES

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Radiological samples

A strict chain-of-custody procedure was not used with the radiological samples. However, sample custody was tracked with a TMA/E sample collection form (Figure 4-4). The form was initiated when each sample was collected and followed the sample through the analytical procedures. When all sample analyses and necessary QA checks were completed in the laboratory, the unused portions of the samples and the sample containers were archived and will be retained until remedial action is complete. The independent verification contractor will archive a fraction of the samples for another five years (DOE 1986).

4.2.5 Data Reduction, Validation, and Reporting

Data reduction frequently includes computation of summary statistics and their standard errors, confidence intervals, testing of hypotheses relative to the parameters analyzed, and model validation.

Upon receipt of samples for radiological analysis (accompanied by a completed field sample collection form), chemists and/or technicians performed the analyses using approved analytical procedures, recorded the results in the parameter workbook, and detailed all procedural modifications, deviations, or problems associated with the analyses. Upon completion of an analytical procedure, all sample analysis data were subjected to a technical review by a designated representative of BNI. The analytical results were reviewed for precision, accuracy, completeness, and representativeness. Upon completion of the review, BNI either requested another measurement or approved the data for inclusion in a final data report. Upon successful completion of the QA/QC process, data were examined and evaluated by project personnel and transferred to the central database. After this process was completed, any further alteration to the data was documented. All data generated were compared with relevant and applicable standards to aid in an assessment of environmental risk.

The purpose of the chemical analytical program was to receive data at a Contract Laboratory Program (CLP) level of quality. The data report was an abbreviated version of the standard CLP report that emphasized sample results and quality control. Raw instrument data were neither requested nor received.

Exhibit B of the EPA CLP-SOW for both organics and inorganics analysis (EPA 1988a,b) was used as guidance for analytical and data reduction procedures and data reporting procedures to facilitate data validation. Analytes that are not included in the CLP (such as TOC and TOX) were reported in accordance with appropriate EPA procedures.

TMA/Eberline

FIELD SAMPLE COLLECTION FORM

SITE ACTIVITY SAMPLES

Form 4A.1

Site WBS #____________ Site Name____________________ Activity Support (Job#)________________ Sampler__________________

Sample Grid Point ID	Sample Type (1)	Sample Time	Date Sample Collected	Preserved With	Purpose (2)	Analyses Required	Remarks

Sample Type	(1)	Purpose	(2)
Surface Soil	SS	Rad Character	RC
Bias Soil	BS	Verification	VR
Profile Soil	PS	Quality Control	QC
Sediment Silt	SD	Hot Spot	SP
Other	OR	Resample	RS
Vegetation	VE	Background	BG
Ground Water	GW	Routine	RT
Surface Water	SW	Special	SP

Recorded By______________Date/Time__________________

Total Number of Samples______________________________

Shipping Carrier________________Date/Time___________

CHAIN OF CUSTODY

REASON	RELNQ. BY	RECEIVED BY	DATE	TIME

FIGURE 4-4 FIELD SAMPLE COLLECTION FORM

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Data were reported in a standard format by RFW. TCL organic compounds were reported on data summary sheets. In addition, the laboratory was required to report a maximum of 30 EPA/National Institutes of Health Mass Spectral Library searches for nonpriority pollutant compounds. These searches are conducted to tentatively identify and estimate the concentration of 10 volatile fraction peaks and 20 BNAE fraction peaks.

Each routine analytical services abbreviated data package included the following:

- General information and header information
- Organics analysis data sheets
- Surrogate recovery information
- Matrix spike/matrix spike duplicate recovery information
- Method blank summary
- Pesticide/PCB identification
- Analytical data
- Sample shipping logs

Each inorganics data package included the following:

- General information and header information
- Cover page -- inorganics analyses data package
- Inorganics analysis data sheets
- Contract-required detection limit standard for atomic absorption and inductively coupled plasma atomic emission spectrophotometry
- Blanks
- Spike sample recovery information
- Post-digest spike sample recovery
- Duplicates
- Laboratory control samples
- Instrument detection limits
- Analytical data
- Sample shipping logs

The following references were used as guidance for analytical and data reduction procedures:

Methods for Chemical Analysis of Water and Wastes, Section 200, "Metals" (EPA 1983)

"Optical Emission Spectrometric Method for Trace Element Analysis of Water and Wastes" (44 FR 69559, Appendix IV)

Handbook for Analytical Quality Control in Water and Wastewater Laboratories, Chapter 7, "Data Handling and Reporting" (EPA 1979)

Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 1982)

RFW was required to submit the data package to BNI within a prescribed time following receipt of sample, and TMA/E provided data reports and QC information within a specified time. BNI conducted a QA/QC compliance review of the data before release that consisted of technical and administrative review of each case, sample, and sample fraction for compliance with contractually required ranges on measures of precision and accuracy. The review examined data completeness and analytical results for surrogate spikes, matrix spikes, duplicate samples, blanks, and performance. Acceptability or unacceptability was determined separately for volatiles, semivolatiles, and inorganics using ranges specified in the subcontract. BNI retained all QA/QC documentation and released the actual data tabulation and, if applicable, a cover sheet explaining the reasons for rejecting the data.

The BNI database was used to store and retrieve site-specific analytical data. These data were placed in permanent storage in a central database to establish security. When these data have been reviewed by project personnel and transferred to the central database, they cannot be altered.

All evaluated data were presented to show detection limits, tabulated concentrations, and reporting qualifiers. A second set of tables was developed to show positive results only. Upon successful completion of the QA/QC process, the data packages were signed by the reviewer, indicating either that the data were acceptable for use or that restrictions were placed on the use of the data.

4.2.6 Audits

System QA audits of project activities were scheduled (usually on an annual basis) and conducted by the QA personnel to verify adherence with field and laboratory procedures and to evaluate the appropriateness and effectiveness of the procedures. Audit team leaders and auditors were trained and certified in accordance with project procedures. Technical specialists participated as auditors under the direction of the audit team leader when the nature of the activities being audited warranted.

Schedules for conducting audits were coordinated with appropriate management and were indicated on QA planning schedules. Audit reports were prepared for each audit conducted. Audit findings that required corrective action and followup were documented, tracked, and resolved, as verified by the project QA supervisor. A summary of the audit results will be provided in the RI report.

4.3 SUMMARY OF OTHER MAJOR PLANS

A CRP has been developed for the St. Louis site to ensure effective exchange of information with the general public. This plan was developed using previous DOE experience with the affected community, EPA guidance relative to community relations, and interviews conducted with key individuals in the affected community. The St. Louis site CRP summarizes background information, describes the history of community involvement, describes community relations strategies, provides a schedule of community relations activities, and lists affected and interested groups and individuals. This plan, which was tailored to the needs of the St. Louis site, provides for meaningful exchange of information on such matters as potential health impacts, environmental issues, remedial action plans, project costs, and specific site activities. The CRP for the St. Louis site is being issued as a separate document.

A sampling and analysis plan, currently being developed for the remaining data gap sampling to be conducted at the St. Louis site, consists of two individual documents, the field sampling plan and the quality assurance project plan. The field sampling plan directs the field work for all radiological and chemical remedial investigation activities. The quality assurance project plan briefly describes the protocols necessary to achieve the data quality objectives defined for the remaining sampling and provides some historical documentation of quality assurance procedures used in past characterization efforts.

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

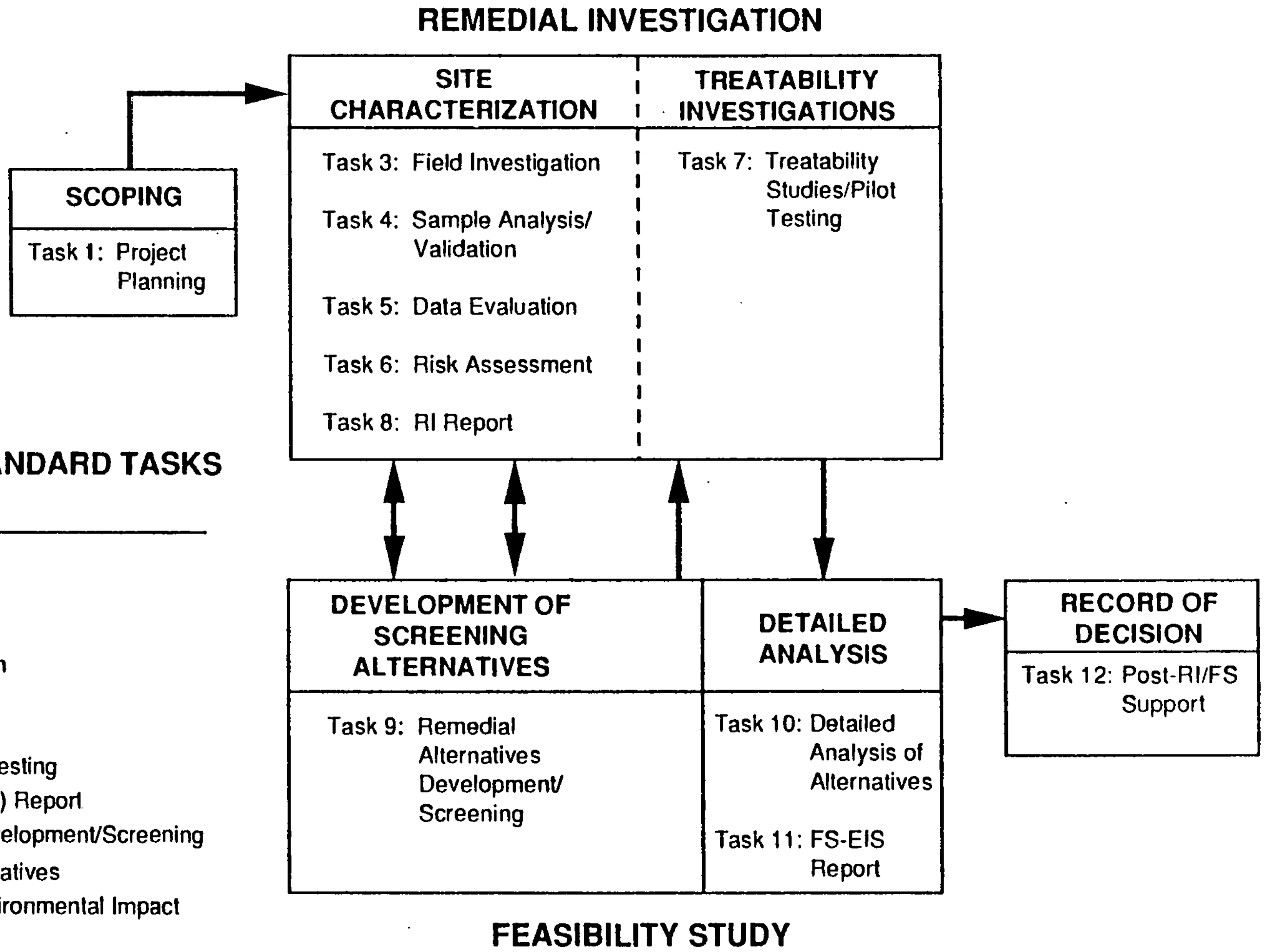
EPA has defined 14 standard tasks as composing the RI/FS process in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA 1988c). These tasks will be used in implementing the RI/FS-EIS process for the St. Louis site and should enhance coordination with EPA Region VII, MDNR, and local citizens and officials. The RI/FS tasks and the phased approach suggested by EPA are shown in Figure 5-1 and are briefly described in Subsections 5.1 through 5.14. Reference is made to other sections of this work plan or other project documents to explain the means by which these 14 tasks are being implemented for the St. Louis site.

All characterization for the St. Louis site has been completed. Some minor data gaps remain (see Subsection 3.8).

5.1 TASK 1: PROJECT PLANNING

The project planning task initiated the RI/FS-EIS process and established the project basis by:

- Collecting and documenting scoping information (Sections 1.0 and 2.0) and preparing an EIS implementation plan
- Collecting and evaluating existing data (Subsections 2.1, 2.2, and 2.3)
- Developing a site model (Subsection 3.4)
- Identifying preliminary response objectives and potential remedial action alternatives (Subsections 3.5 and 3.6)
- Identifying operable units and potential removal actions (Subsection 3.7)
- Identifying various feasibility studies to support the RI/FS-EIS process (Subsection 3.8)
- Compiling a list of potential federal ARARs (Subsection 3.9)
- Determining data needs and defining DQOs (Subsections 3.8, 4.1, and 4.2)
- Documenting RI/FS tasks (Section 5.0)
- Developing schedules for completion of major project elements (Section 6.0)
- Identifying project organization and project management (Section 7.0)



RI/FS WORK PLAN STANDARD TASKS

Task	Title
1.	Project Planning
2.	Community Relations*
3.	Field Investigation
4.	Sample Analysis/Validation
5.	Data Evaluation
6.	Risk Assessment
7.	Treatability Studies/Pilot Testing
8.	Remedial Investigation (RI) Report
9.	Remedial Alternatives Development/Screening
10.	Detailed Analysis of Alternatives
11.	Feasibility Study (FS)-Environmental Impact Statement (EIS) Report
12.	Post-RI/FS Support
13.	Enforcement Support*
14.	Miscellaneous Support*

*Tasks that can occur in any stage of the RI/FS

FIGURE 5-1 RELATIONSHIP OF RI/FS TASKS TO PHASED RI/FS APPROACH

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All of these elements are included in this work plan, which constitutes an overview of project planning for the St. Louis site RI/FS-EIS process. All project scoping required under CERCLA has been completed. The results of the NEPA scoping process, which has not yet been completed, will be summarized in an EIS implementation plan that will be appended to this work plan. The NEPA scoping process cannot be completed until a public meeting describing the proposed actions at the St. Louis site has taken place. Many elements described in this work plan are summaries of more comprehensive documents. Each of the summaries contained in this work plan reflects the current status of the respective task.

5.2 TASK 2: COMMUNITY RELATIONS

Task 2 incorporates all efforts related to preparation and implementation of the CRP. Community relations activities for the St. Louis site have been conducted since 1982, and a CRP has been prepared consistent with EPA requirements. These efforts will continue until the RI/FS process has been completed and the selected remedy is implemented. The CRP for the St. Louis site includes background information about the site, the history of community involvement, community relations strategies, a schedule of community relations activities, and a list of affected and interested groups and individuals. The CRP also addresses interviews with members of the community to determine (1) citizen concerns, (2) information needs, and (3) how and when citizens wish to be involved in the RI/FS process. The CRP describes the activities that DOE will undertake to ensure a full program of public participation.

DOE has been providing information about its remedial action activities to officials, environmental groups, and the media in the St. Louis area for several years through news releases, fact sheets, and briefings. These mechanisms will continue to be used to inform the public. Information repositories have been established at the St. Louis Public Library (1301 Olive Street, St. Louis) and at the Prairie Commons Branch, St. Louis County Library System (915 Utz Lane, Hazelwood) to provide the public with access to documentation relating to the RI/FS process, including transcripts of related public meetings.

5.3 TASK 3: FIELD INVESTIGATION

Task 3 includes all efforts related to RI field work, including procurement of field subcontractors. The task begins when any element, as outlined in the work plan, is approved and is complete when the contractors leave the field. The following activities are typically included in the task:

- Mobilization
- Media sampling
- Source testing
- Geophysical investigations
- Geological and hydrogeological investigations
- Site surveys and topographic mapping
- Field measurements and analyses
- Procurement of subcontracts
- RI waste disposal
- Task management and quality control

All major field investigations at the St. Louis site have been completed.

5.4 TASK 4: SAMPLE ANALYSIS AND VALIDATION

This task includes all efforts relating to analysis and validation of samples after they leave the field to ensure that they meet the DQOs established for the project. Control and verification of the integrity of project data were ensured through the technical specifications established for analytical subcontractors and through review of QC data. Quality control was accomplished by internal and external audits, analyses of QC samples, and participation in laboratory intercomparison tests.

Sample analyses were performed by two independent laboratories subcontracted by BNI. RFW Analytical Laboratories analyzed those samples requiring chemical analyses following the technical specifications set forth in the BNI/RFW subcontract. TMA/E performed the radiological analyses using standard industry practices and DOE-accepted methods, specifically EML-300 and EPA-600 procedures.

Efforts were made to ensure that analytical data were sufficiently accurate and precise to meet the appropriate level of data quality for a particular piece of information. The integrity of data was ensured by checking the QC data associated with the sample analysis. The quality of the data was evaluated by checking the data using information from the QC samples to ensure that the results obtained provided meaningful data that could be used in design engineering for remedial action.

Although QC data differ for each type of data generated (e.g., field gamma scan, radioisotopic analyses, volatile organic analyses, and RCRA characteristics tests), they can be used to evaluate common elements including completeness of data, acceptability of detection limits, indications of field or laboratory contamination of samples, and reproducibility of results.

5.5 TASK 5: DATA EVALUATION

Task 5 involves evaluating the data after they have been validated under Task 4. The task begins when the first set of validated data is received and ends during preparation of the RI report when it is determined that no additional data are required.

Data evaluation tasks are intended to provide the information needed to complete the RI/FS-EIS process. For example, validated groundwater data collected during the RI should complete the understanding of the groundwater system at the St. Louis site. The measured concentrations of uranium, thorium, radium, and various chemical contaminants in the aquifers--in connection with identified groundwater receptors--will enable calculation of the potential health risk to members of the public who may drink this groundwater.

Typical products of the data evaluation task for the St. Louis site include drawings delineating the boundaries of contamination for the different contaminants present, tables listing contaminant concentrations for the various media, quantification of migration pathways as appropriate, and tabulation of engineering data (such as waste volume) necessary for evaluating the remedial action alternatives. All calculations were documented in calculation logs and checked by an independent reviewer before sign-off. Where computations were performed with computer programs, either validated software was used or the calculation methods were hand-verified. Results will be provided in the RI report.

5.6 TASK 6: RISK ASSESSMENT

Task 6 consists of assessing potential risks to human health and the environment. It includes assessing baseline risks during the RI, setting preliminary performance goals for conducting the FS, and comparing risks for evaluated alternatives. Work begins during the data evaluation task and ends during the evaluation of remedial action alternatives. Efforts on Task 6 have been initiated (see schedule in Section 6.0).

Initial evaluation of currently available data (see Section 2.0) indicates chemical and radioactive contamination at SLDS. At SLAPS, HISS, Futura, and all vicinity properties, radioactive contamination is the primary concern; however, elevated levels (i.e., higher than background) of metals traceable to the original processes conducted at SLDS were found at these properties.

The baseline risk assessment being conducted for the St. Louis site will analyze, for current and future land uses, the potential adverse human health and environmental effects caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these releases. The baseline risk assessment will evaluate hazards posed by current site conditions by analyzing the environmental transport pathways to potential receptors from areas where radioactive and chemical contaminants are currently located. The results of the assessment will also assist in screening alternatives and determining acceptable levels of residual contamination (i.e., cleanup limits) for radioactive and chemical constituents.

Human health risk assessments for both chemicals and radionuclides will be conducted based on the approaches outlined in EPA's Risk Assessment Guidance for Superfund (EPA 1989). The steps in risk assessment are (1) identification of contaminants of concern, (2) assessment of exposure, (3) assessment of toxicity, and (4) characterization of risk. Contaminants to be assessed are radionuclides and those chemicals for which DOE has responsibility under the federal facilities agreement.

Pertinent pathways for the St. Louis site include inhalation of contaminants through contaminated dust particles, ingestion of contaminated soils, inhalation of radon-222 decay products, and external gamma radiation exposure.

The exposure levels of the chemicals and radionuclides at exposure points will be estimated using characterization and monitoring data as much as feasible and will be utilized to arrive at both current and future land use risk assessments. Information from the literature and earlier site studies regarding environmental chemistry and contaminant fates will be considered and incorporated, where valid and applicable, in all estimates of chemical and radionuclide exposure point concentrations.

Chemical and radiological risks will be analyzed separately to allow for a clear presentation of the source of risk, i.e., radiological or chemical. Combining the radiological and chemical risks could mask information that might aid in the selection of the appropriate remedy.

Because a major portion of the St. Louis site is in heavily industrialized areas, the species that exist at the site may be exposed to site-related contamination and other sources of contamination. The ecological assessment for the site will be at a level appropriate to current site conditions. It will be limited in scope, and it is expected to be qualitative in nature.

5.7 TASK 7: TREATABILITY STUDIES AND PILOT TESTING

Task 7 includes efforts related to the performance of pilot-scale, bench-scale, and treatability studies. It also includes any post-screening investigations. Such studies will likely be necessary for the St. Louis wastes to test volume reduction or treatment technologies that have not yet been proven reliable or effective in full-scale operation or to develop sufficient preliminary design information on which to base evaluations of remedial action alternatives in the FS. Several potential remedial action technologies that may require bench- or pilot-scale treatability studies have been identified for the St. Louis site (see Subsection 3.6). These will be performed if the results of characterization and engineering studies indicate the need for them.

5.8 TASK 8: REMEDIAL INVESTIGATION REPORT

This task involves preparation of the findings after the data have been evaluated under Tasks 5 and 6. The task covers all draft and final RI reports as well as task management and quality control. The following are typical activities:

- Preparing a preliminary site characterization summary (formatting tables, preparing graphics)
- Writing the report
- Reviewing and providing QC efforts
- Printing and distributing the report
- Holding review meetings
- Revising the report on the basis of agency comments

The proposed RI report outline format for the St. Louis site is provided in Table 5-1.

5.9 TASK 9: REMEDIAL ALTERNATIVES DEVELOPMENT AND SCREENING

Task 9 involves the initial development and evaluation of remedial action alternatives that will be fully evaluated under Task 10. The objective of the Task 9 screening process is to narrow the range of alternatives that will undergo full evaluation. The process begins with refinement of the remedial response objectives, proceeds through narrowing of the potential technologies based on

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TABLE 5-1

OUTLINE FOR THE ST. LOUIS SITE

REMEDIAL INVESTIGATION REPORT

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applicability and effectiveness, and ends with identification of a set of remedial action alternatives. Each remedial action alternative may involve application of a single technology or a combination of two or more technologies. Task 9 consists of the following activities:

- Identifying response objectives and response actions
- Listing potential remedial technologies
- Screening remedial technologies and process options based on site-specific criteria
- Assembling potential remedial action alternatives from the screened technologies and process options
- Evaluating potential remedial action alternatives based on screening criteria (i.e., effectiveness, implementability, and cost)
- Identifying candidate remedial action alternatives for detailed evaluation in Task 10

5.10 TASK 10: DETAILED ANALYSIS OF ALTERNATIVES

Task 10 involves detailed analysis and comparison of remedial alternatives. The following criteria are used to evaluate the alternatives that remain under consideration after Task 9 is complete:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost
- Acceptance by the state
- Acceptance by the community

A summary of each alternative, including the no-action alternative, is prepared using these nine criteria. The relative advantages and disadvantages are then used to compare and evaluate the remedial action alternatives. Use of these nine criteria is consistent with the new NCP.

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TABLE 5-2
(continued)

The proposed plan is a summary document (typically fewer than 10 pages) that identifies the preferred remedial action alternative and the reasons for the preference, describes the alternatives evaluated in the RI/FS, and solicits public review and comment on all screened alternatives presented in the FS. An annotated outline for the proposed plan developed from EPA guidance is shown in Table 5-3. Preparation of the responsiveness summary and ROD will be initiated following public review of the RI/FS.

5.13 TASK 13: ENFORCEMENT SUPPORT

This task includes efforts during the RI/FS process associated with enforcement aspects of the project, typically concerning potentially responsible parties. Because DOE has assumed responsibility for the St. Louis site, Task 13 is not applicable to this project.

5.14 TASK: 14 MISCELLANEOUS SUPPORT

Task 14 is used to report on work that is associated with the project but does not fall under any of the other established RI/FS tasks. Task 14 activities will vary but may include the following:

- Specific support for coordination with and review of the RI/FS by the Agency for Toxic Substances and Disease Registry
- Support for review of special state or local projects

TABLE 5-3

OUTLINE FOR THE PROPOSED PLAN

STATEMENT OF PURPOSE OF DOCUMENT

To fulfill requirements of Section 117(a) of CERCLA
To describe alternatives analyzed
To identify preferred alternative and explain rationale for preference
To serve as companion to the RI/FS
To solicit community involvement in selection of a remedy

SITE DESCRIPTION

Identify site name and location
Summarize site history and problems to be addressed
Identify lead and support agencies

SCOPE AND ROLE OF RESPONSE ACTION

Summarize scope of problem the action will address
Describe role of action within site strategy

ALTERNATIVES ANALYZED

Briefly describe alternatives evaluated in detailed analysis of FS, including estimated cost and implementation time

PREFERRED ALTERNATIVE

Identify the preferred alternative
Introduce the nine evaluation criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

Provide rationale for preferred alternative by highlighting the trade-offs among the alternatives with respect to the nine criteria

State the lead agency's belief that the preferred alternative meets statutory findings

TABLE 5-3

(continued)

ROLE OF COMMUNITY IN PROCESS

- Provide notice of public comment period (written comments are encouraged)
- Note time and place for scheduled public meeting(s) or offer opportunity for a meeting
- Identify lead and support agency contacts
- Stress importance of public input on all alternatives
- Locate administrative records and information repositories

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6.0 PROJECT SCHEDULE

The overall schedule for the environmental compliance activities planned for the St. Louis site is shown in Figure 6-1. This schedule was developed in accordance with FUSRAP budget planning as of fiscal year 1990 and shows the events projected through the point at which the ROD is issued. This schedule shows the relationships between the tasks and their projected durations. Specific dates beyond 1990 should not be considered as firmly established, however, because funding is based on an out-year budget cycle. The project schedule consists of the following major components:

- Completion of scoping and planning for the site. Scoping involves the early incorporation of public comment and concerns into the RI/FS-EIS process. This may include, for example, consideration of specific remedies for site cleanup or evaluation of various health and environmental concerns. Documentation for the St. Louis site includes a RI/FS-EIS work plan, an EIS implementation plan that will be incorporated into the work plan after completion of the public scoping meetings, and a community relations plan.

- Completion of site characterization.

- Completion of the RI/FS-EIS process and issuance of associated reports (i.e., RI, baseline risk assessment, and FS-EIS reports) for public comment.

- Incorporation of public comments on the draft RI/FS-EIS and proposed plan in the final RI/FS-EIS and the responsiveness summary, which will describe the remedy selected for the St. Louis site. The ROD is projected to be issued in 1994. Remedial design and remedial action consistent with the NCP will be initiated following issuance of the ROD.

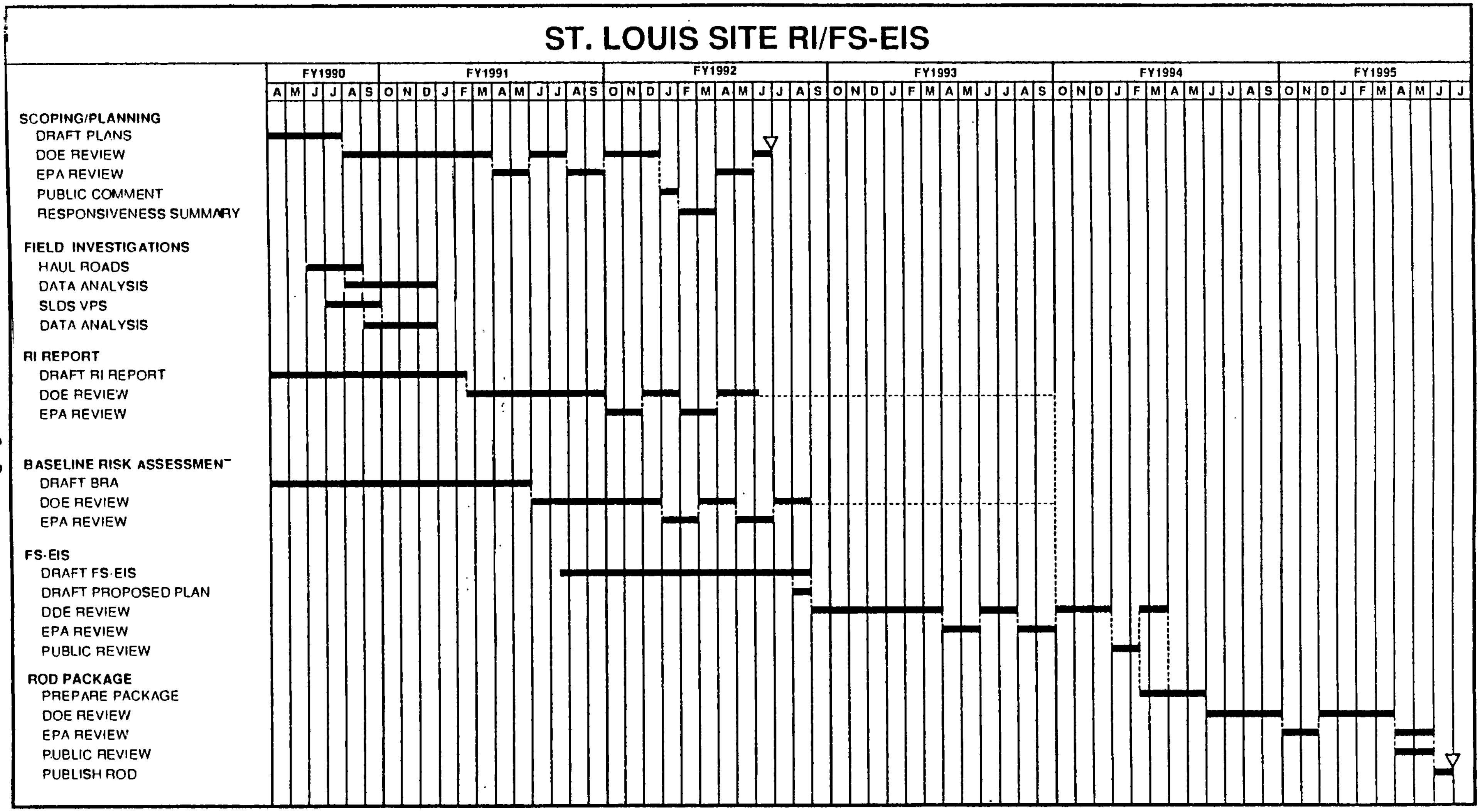

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FIGURE 6-1 SCHEDULE FOR THE ST. LOUIS SITE

7.0 PROJECT MANAGEMENT

7.1 PROJECT ORGANIZATION

Remedial action at the St. Louis site is being conducted by DOE under FUSRAP, which is administered by the Eastern Area Programs Division of the Office of Environmental Restoration (see Figure 7-1). This division is responsible for policy decisions related to conducting remedial actions at the site. Responsibility for management and technical direction of remedial action activities for FUSRAP has been delegated to the DOE Field Office, Oak Ridge (DOE-OR). The Former Sites Restoration Division of DOE-OR manages the day-to-day activities of FUSRAP. DOE-OR has functional responsibility for preparation of the environmental compliance documents, although various groups at DOE Headquarters have review and concurrence authority. The Assistant Secretary for the Environment, Safety, and Health is responsible for approving publication of the RI/FS-EIS. A phased RI/FS-EIS process is being used for this action (see Figure 7-2).

Several organizations are under contract to DOE-OR to support implementation of FUSRAP. The two organizations responsible for preparation of the St. Louis site RI/FS-EIS are BNI and Science Applications International Corporation (SAIC). BNI, the project management contractor for remedial action activities at the St. Louis site, is responsible for the collection of all necessary site characterization and environmental data required for the RI report. SAIC, the environmental studies contractor, performs an independent analysis of the environmental impacts of remedial action alternatives in the FS-EIS, using information provided by BNI and others (e.g., the RI report and requisite technical, engineering, and cost studies) to support the detailed analyses required.

7.2 PROJECT COORDINATION AND RESPONSIBILITIES

Three organizations are under contract to DOE-OR to support the implementation of remedial actions at the St. Louis site (Figure 7-1). The responsibilities of the organizations are as follows:

- Bechtel National, Inc.
  - Provides overall project management support to DOE for the St. Louis site
  - Administers procurement and QA functions
  - Performs general administrative functions

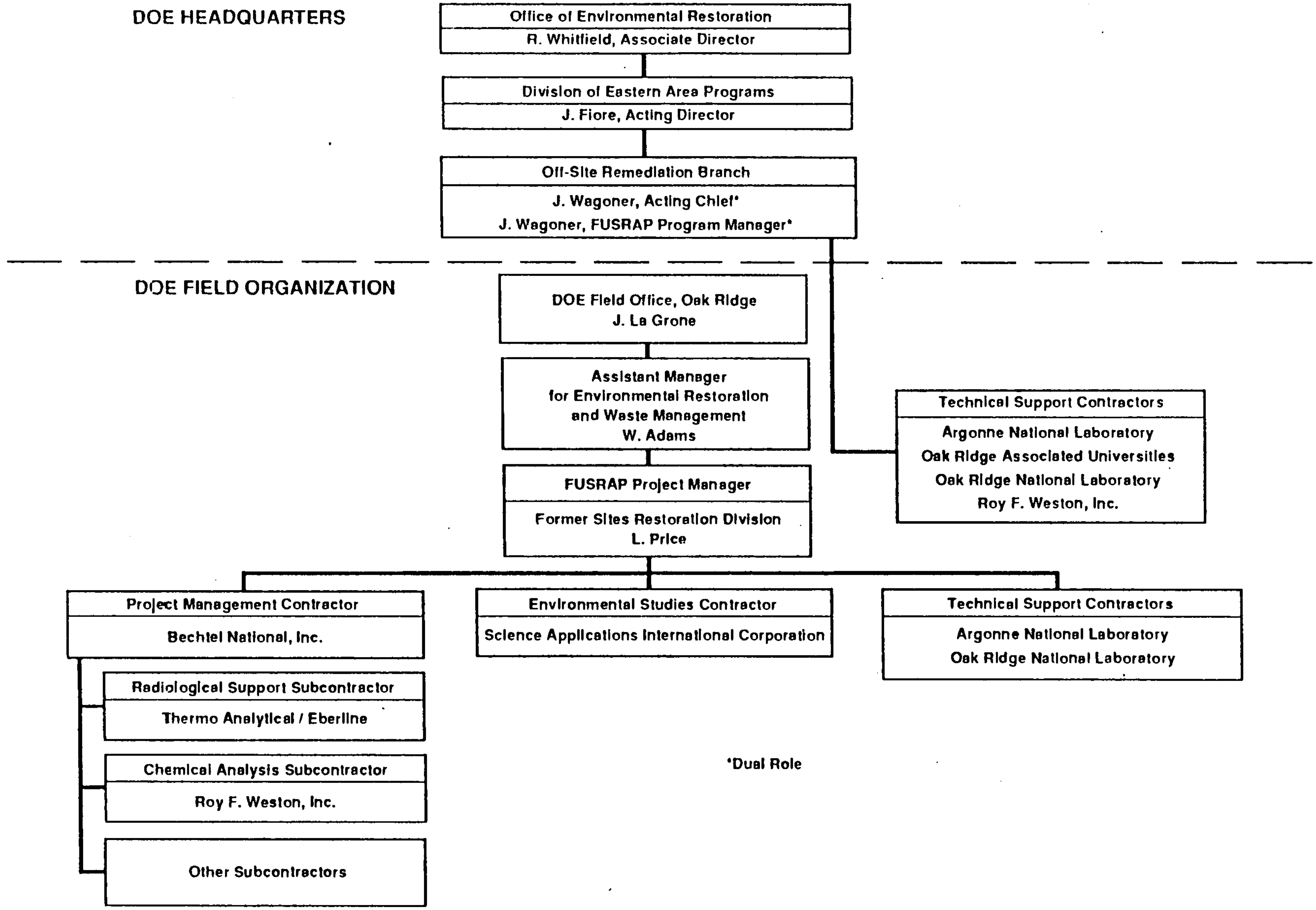

FIGURE 7-1 PROJECT ORGANIZATION

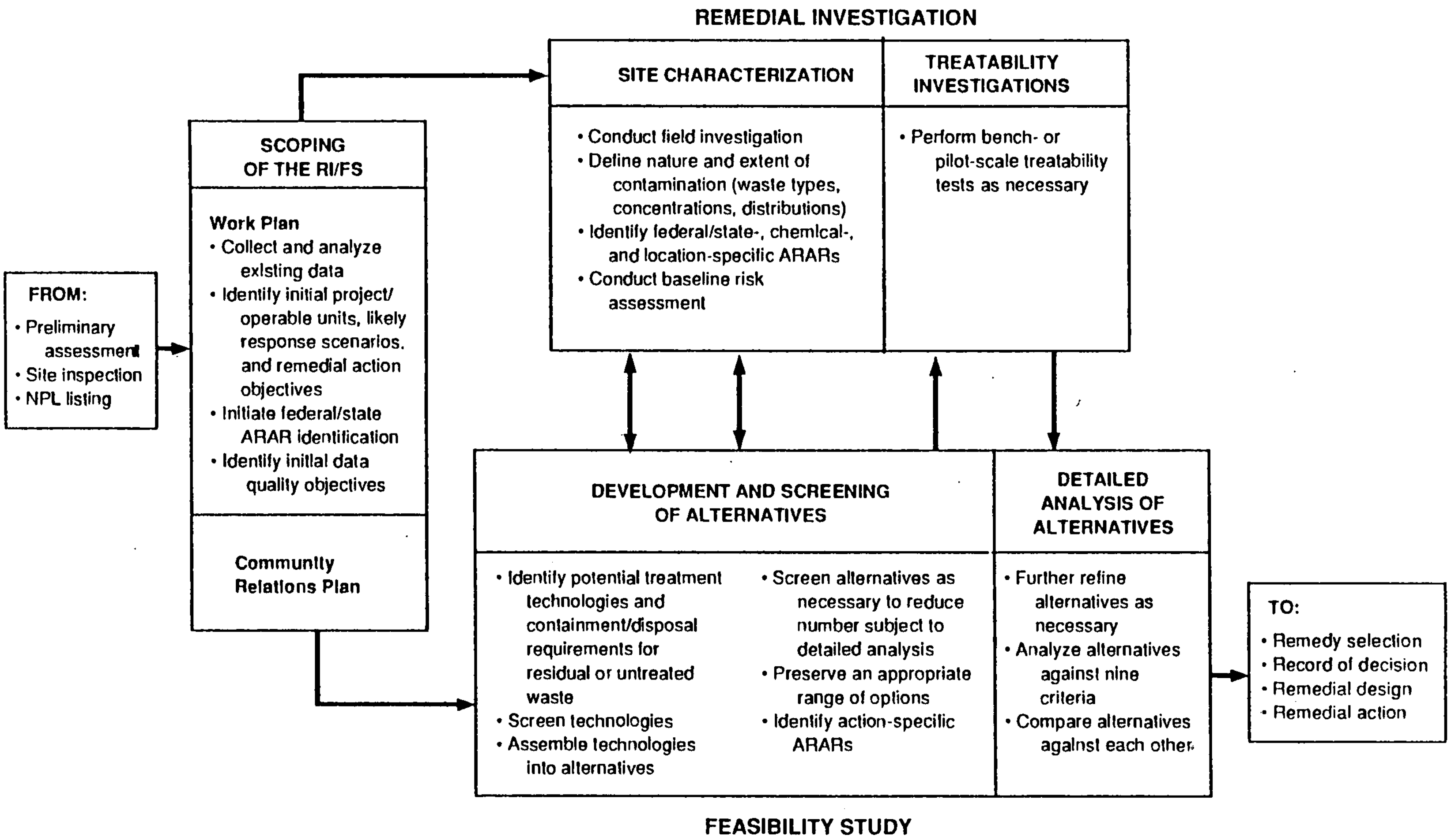

FIGURE 7-2 PHASED RI/FS PROCESS

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- Administers all environmental, safety, and health programs at the site
- Directs all engineering activities
- Provides technical input to the preparation of environmental documents
- Performs community relations duties

- Science Applications International Corporation
  - Performs health and environmental analyses for the RI/FS-EIS process
  - Provides an independent analysis of environmental studies, engineering feasibility, and cost-effectiveness of response action alternatives performed by other DOE contractors
  - Prepares additional environmental compliance documentation as needed

- Oak Ridge National Laboratory
  - Provides technical support as needed

Four organizations (ANL, ORAU, ORNL, AND RFW; see Figure 7-1) provide technical support for FUSRAP to the Division of Eastern Area Programs. These organizations carry out the following functions:

- Conduct radiological surveys to identify and aid in designation of vicinity properties that require remedial action
- Conduct post-response action radiological surveys to provide an independent verification of the adequacy of the cleanup and prepare associated verification reports
- Perform technical review of FUSRAP documents

7.3 PROJECT CONTROLS

Project controls are implemented to provide detailed planning for cost, schedule, and technical performance to maximize efforts toward achievement of project goals. Project controls are implemented for the FUSRAP project as a whole because there are 33 sites in 13 states for which costs and schedules must be tracked and controlled. BNI has established and DOE has validated a system that conforms to the criteria for cost and schedule control systems developed by the U.S. Department of Defense. This system provides a basis for assessing the quality of the cost and schedule controls used by the project participants; aids in ensuring effective planning, management, and control of project work; and provides a quick and effective means of measuring cost, schedule, and technical performance. This cost and schedule control system uses a work breakdown structure (WBS) to divide the total FUSRAP project into distinct sites and then into discrete work packages that can be effectively managed. The WBS also provides the framework for integrating budget requirements with schedule and technical performance. Finally, it establishes the management analysis and reporting structure to permit data presentation to various levels of management.

A project document control center (PDCC) is maintained at the BNI office in Oak Ridge, Tennessee, to collect, register, distribute, and retain all documents. Each document related to the St. Louis site is coded with a unique WBS number to associate the document with a particular St. Louis property. Subject codes are also assigned from predetermined categories that can be used to organize documents. The PDCC system provides for rapid identification and retrieval of all project documents by allowing documents to be searched/sorted by WBS number, subject code, author, recipient, transmittal date, a unique identification number, or any combination of the above.

All relevant information obtained during the RI/FS-EIS process for the St. Louis site is being retained by PDCC: aerial photographs, topographic maps, reports on features of the site and its surrounding area, correspondence involving the site, findings of previous surveys, and analytical data obtained during site characterization. Types of characterization data on file include radiological and chemical data based on analyses of soil, groundwater, and surface water; borehole logging data; air sampling data; and information about geological and soil properties. Well construction data and field notebooks and documentation (e.g., chain-of-custody forms) are also on file with PDCC.

Administrative Record for the Formerly Utilized Sites Remedial Action Program (FUSRAP) North St. Louis County Sites

St. Louis County, Missouri

US Army Corps of Engineers
St. Louis District

Volume 3.2a
Remedial Investigation
Sampling/Analysis Data & Plans

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Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for the St. Louis Site, Missouri

U.S. Department of Energy

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