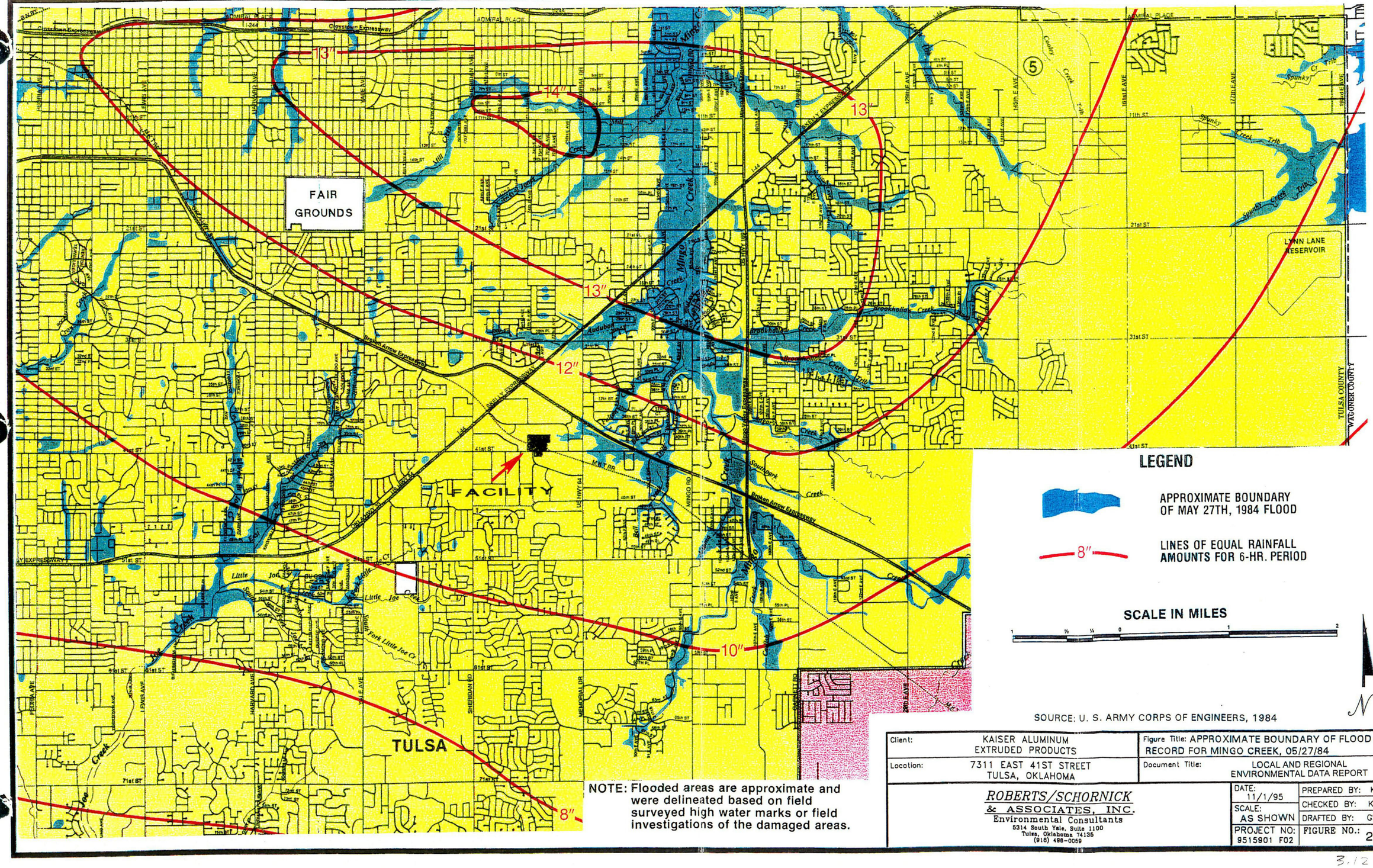
Figure 3-7



LEGEND

APPROXIMATE BOUNDARY OF MAY 27TH, 1984 FLOOD

8" LINES OF EQUAL RAINFALL AMOUNTS FOR 6-HR. PERIOD

SCALE IN MILES

1 ½ ¼ 0 1 2

N

SOURCE: U. S. ARMY CORPS OF ENGINEERS, 1984

NOTE: Flooded areas are approximate and were delineated based on field surveyed high water marks or field investigations of the damaged areas.

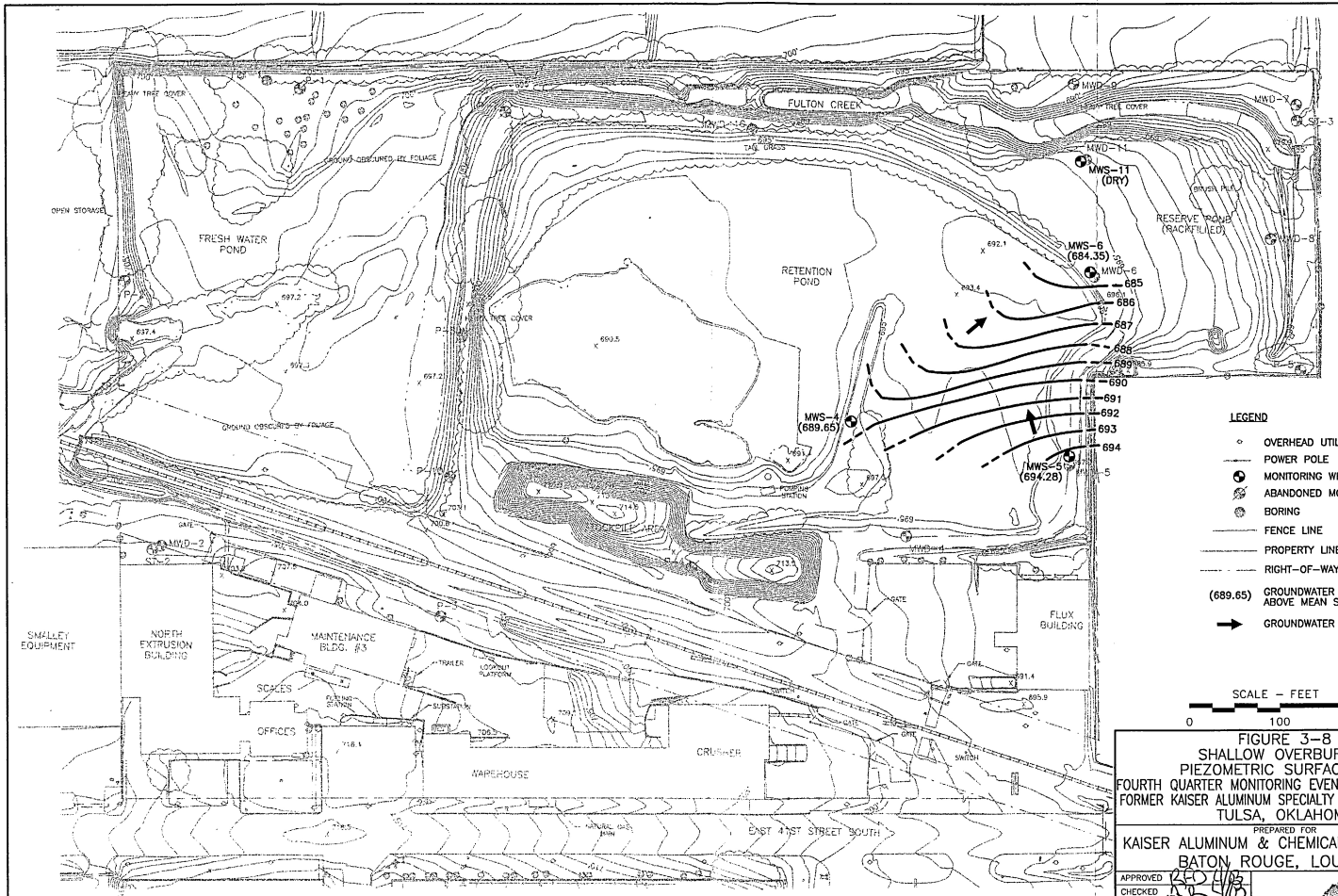
Client:	KAISER ALUMINUM EXTRUDED PRODUCTS	Figure Title:	APPROXIMATE BOUNDARY OF FLOOD OF RECORD FOR MINGO CREEK, 05/27/84
Location:	7311 EAST 41ST STREET TULSA, OKLAHOMA	Document Title:	LOCAL AND REGIONAL ENVIRONMENTAL DATA REPORT

ROBERTS/SCHORNICK & ASSOCIATES, INC.
Environmental Consultants
5314 South Yale, Suite 1100
Tulsa, Oklahoma 74135
(918) 496-0059

DATE: 11/1/95	PREPARED BY: KE		
SCALE: AS SHOWN	CHECKED BY: KE	DRAFTED BY: GS	
PROJECT NO: 9515901 F02	FIGURE NO.: 26		

3.12

C01



REFERENCES

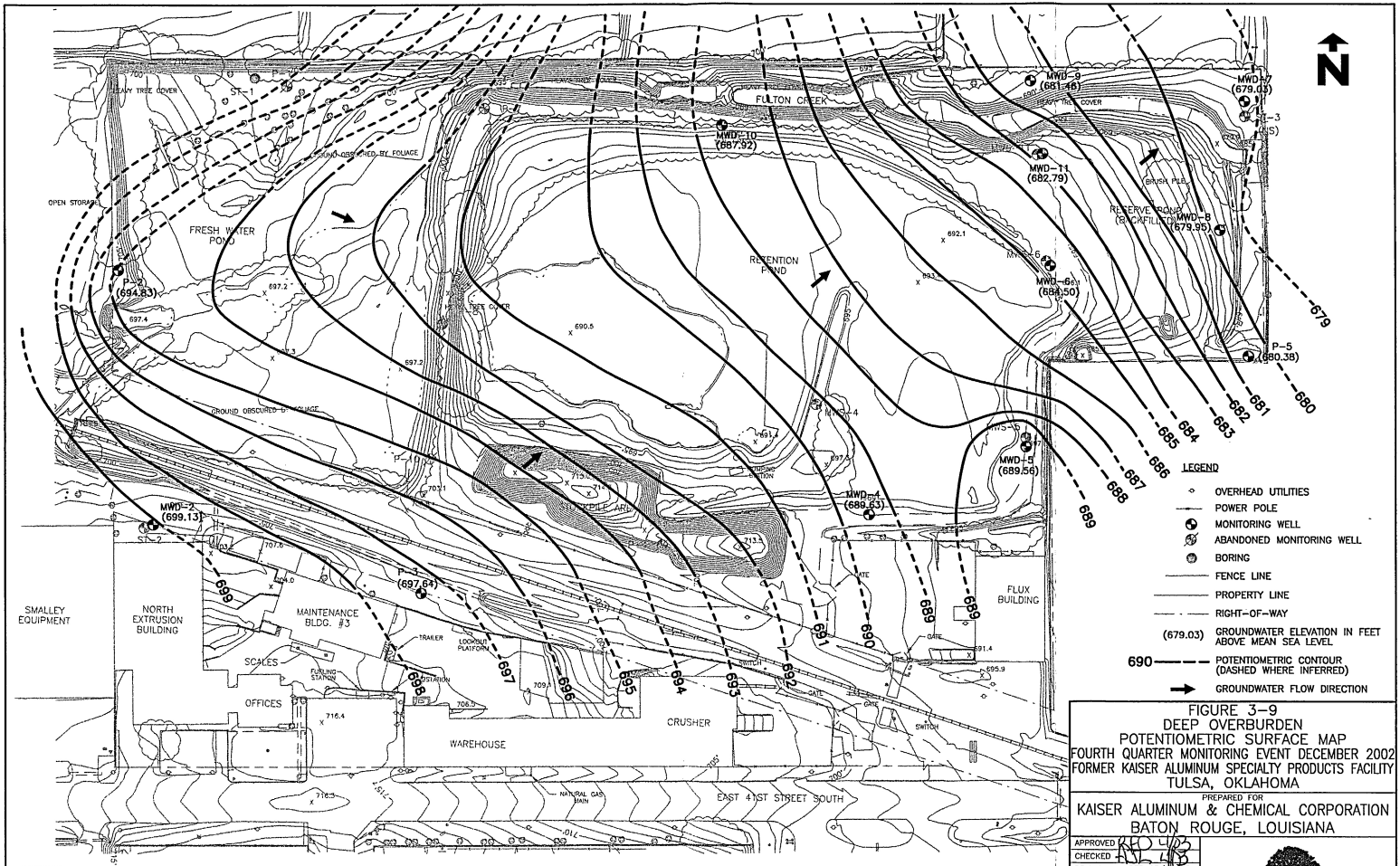
1. DIGITAL MAPPING ASSOCIATES, INC.; AUG. 16, 2001
2. THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964.

FIGURE 3-8
SHALLOW OVERBURDEN
PIEZOMETRIC SURFACE MAP
FOURTH QUARTER MONITORING EVENT DECEMBER 2002
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	
CHECKED	
DRAWN	DEB 03/05/03
DRAWING NUMBER	5427301

Earth Sciences Consultants, Inc.



REFERENCES

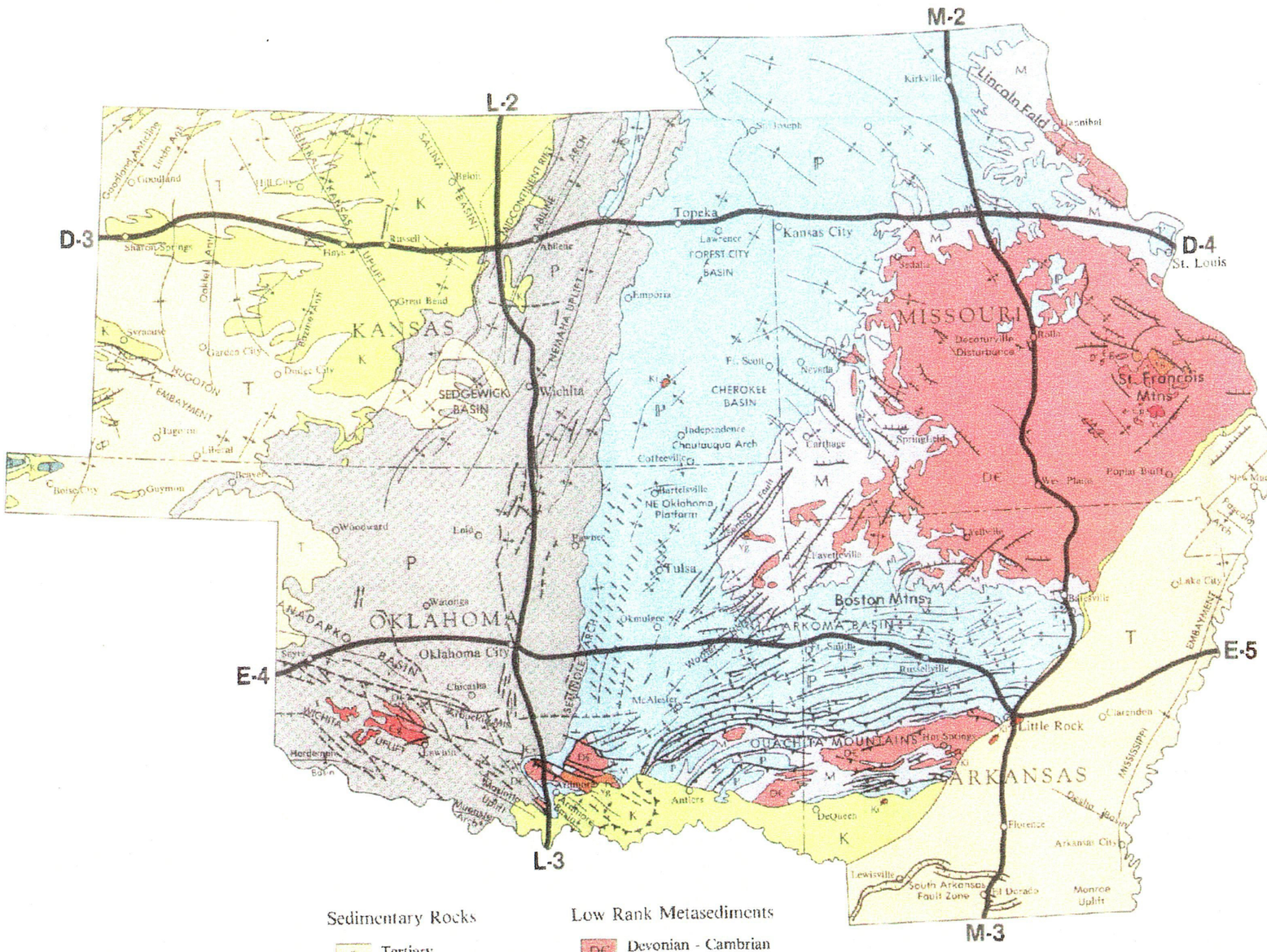
1. DIGITAL MAPPING ASSOCIATES, INC.; AUG. 16, 2001
2. THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM A PLAT PREPARED BY DENTON AND WHITE SURVEYING COMPANY ON FEBRUARY 14, 1964.

FIGURE 3-9
DEEP OVERBURDEN
POTENTIOMETRIC SURFACE MAP
FOURTH QUARTER MONITORING EVENT DECEMBER 2002
FORMER KAISER ALUMINUM SPECIALTY PRODUCTS FACILITY
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	KEO 1/03
CHECKED	KEO 1/03
DRAWN	DEB 03/01/03
DRAWING NUMBER	5427303

Earth Sciences Consultants, Inc.



REFERENCE
THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGIST, TULSA, OKLAHOMA, 1986.

FIGURE 3–10
TECTONICS MAP
MID–CONTINENT REGION

KANSAS, MISSOURI, OKLAHOMA, ARKANSAS

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	RJB 5/13
CHECKED	DEB 5/13
DRAWN	DEB 04/10/03
DRAWING NUMBER	5427306

Earth Sciences Consultants, Inc.

C02

Attachment 3-1

DEPARTMENT OF THE ARMY
U.S. ARMY, CORPS OF ENGINEERS, TULSA DISTRICT
1645 SOUTH 101ST EAST AVENUE
TULSA, OKLAHOMA 74128-4609

May 2, 2001

Planning, Environmental, and Regulatory Division
Regulatory Branch

Mr. Turgay M. Ertugrul
A & M Engineering and Environmental Services, Inc.
10010 East 16th Street
Tulsa, OK 74128-4813

Dear Mr. Ertugrul:

This reply is in reference to your letter of April 18, 2001, concerning your request to extend the verification of previously issued Regulatory Permit No. 7715. This previously authorized project consisted of the placement and/or excavation of fill material in the unnamed tributary of Mingo Creek. The project as proposed is located in the Southwest 1/4 of the Southeast 1/4 of Section 23, Township 19 North, Range 13 East, Tulsa County, Oklahoma.

This project was previously authorized by Nationwide Permit (NWP) 38 for Cleanup of Hazardous and Toxic Waste. According to your office, the project would be conducted in the same manner as originally proposed and would result in the same impacts to the aquatic environment. Consequently, this project would still fall within the scope of NWP 38.

This letter constitutes approval for the extension of the verification for 2 additional years from the date of this letter. Please retain this letter with your copy of the original permit. If we can be of further assistance, contact Mr. Allen Ryan at 918-669-7618.

Sincerely,

for David A. Manning
Chief, Regulatory Branch

A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
10010 E. 16TH STREET
TULSA, OK 74128-4813
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION
(918) 665-6575 FAX (918) 665-6576

April 18, 2001

Mr. Allen Ryan, Regulatory Specialist
Environmental Biologist
U.S. Army Corps of Engineers
1645 South 101st East Avenue
Tulsa, Oklahoma 74128-4609

RE: U. S. Corps of Engineers Permit No. 7715
Kaiser Aluminum & Chemical Corporation Property, Tulsa, Oklahoma

Dear Mr. Ryan:

In a letter dated March 27, 1997, Mr. Larry D. Hogue, P.E., Chief, Operations Division, issued Permit No. 7715 to A & M Engineering for the placement and/or excavation of fill material in the unnamed tributary to Mingo Creek (see attached copy). The proposed project is located in the Southwest ¼ of the Southeast ¼ of Section 23, Township 19 North, Range 13 East, Tulsa County, Oklahoma. The permit was valid for 2 years.

The referenced activity was never started. However, at this time, A & M Engineering is ready to begin the Privately Funded Public Improvement (PFPI) permitting process with the City of Tulsa and follow with the construction activities. Since our permit has expired, we would like to request an extension of our permit for an additional 2 years from today's date.

Thank you for your cooperation. If you have any questions, please contact Tony Mummolo or me at 665-6575.

Very truly yours,

Turgay M. Ertugrul

Turgay M. Ertugrul, P.E.
Vice President

Attachment

Cc: Bill Vinzant, P.E. - Kaiser Aluminum & Chemical Corporation

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
P. O. BOX 61
TULSA, OKLAHOMA 74121-0061

REPLY TO
ATTENTION OF:

March 27, 1997

Operations Division
Regulatory Branch

Mr. Turgay M. Ertugrul
A & M Engineering and Environmental Service, Inc.
3840 South 103rd E. Avenue
Tulsa, OK 74146-2419

Dear Mr. Ertugrul:

Please reference your letter of February 20, 1997, regarding the hydrologic investigation of a low-level, radioactive-waste site. The proposed project is located in the Southwest 1/4 of the Southeast 1/4 of Section 23, Township 19 North, Range 13 East, Tulsa County, Oklahoma.

The placement and/or excavation of fill material in the unnamed tributary to Mingo Creek associated with the proposed project falls within the scope of the Nationwide Permit for Cleanup of Hazardous and Toxic Waste, provided the conditions therein are met. This permit was issued pursuant to Section 404 of the Clean Water Act and is enclosed for your reference.

Complete and return the enclosed self-addressed, postage-paid "Permittee Construction Schedule" form. Should construction be initiated prior to 30 days from receipt of this letter, please return the completed form as soon as possible. If you prefer, you may telephone the individual listed below to inform this office regarding the construction start date.

Following completion of your proposed activity, complete and return the enclosed self-addressed, postage-paid "Compliance Certification" form. Submittal of this form is required in accordance with Nationwide Permit General Condition No. 14.

In reviewing this proposed activity, we have determined that the proposed action will have no affect on Federally-listed endangered or threatened species or habitat critical for the survival of such species.

This verification will be valid for 2 years, unless the Nationwide permit authorization is modified, reissued, or revoked. It is incumbent on you to remain informed of changes to the Nationwide permits. The U.S. Army Corps of Engineers will issue a public notice announcing the changes as they occur. Furthermore, if you commence, or are under contract to commence, this activity before the date the Nationwide permit is modified or revoked, you will have 12 months from the date of the modification or revocation to complete the activity under the present terms and conditions of this Nationwide permit.

This authorization is pursuant to Section 404 and does not preclude the need to obtain additional Federal, State, or local authorization which may be required.

Your permit has been assigned Identification Number 7715; please refer to this number during future correspondence. If you cannot comply with the conditions listed in the enclosed permit, contact Ms. Helen J. Williams at 918-669-7009.

Sincerely,

David D. Manning

Larry D. Hogue, P.E.
Chief, Operations Division

Enclosures

NATIONWIDE PERMIT FOR CLEANUP OF HAZARDOUS AND TOXIC WASTE (NWP 38)

- Specific activities required to effect the containment, stabilization, or removal of hazardous or toxic waste materials that are performed, ordered, or sponsored by a Government agency with established legal or regulatory authority provided the permittee notifies the District Engineer (DE) in accordance with the "Notification" general condition. For discharges in special aquatic sites, including wetlands, the notification must also include a delineation of affected special aquatic sites, including wetlands. Court ordered remedial action plans or related settlements are also authorized by this Nationwide permit (NWP). This NWP does not authorize the establishment of new disposal sites or the expansion of existing sites used for the disposal of hazardous or toxic waste. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act.

This NWP is authorized pursuant to Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. This NWP (33 CFR 330) became effective February 11, 1997, following publication in the Federal Register.

General Conditions: The following general conditions must be followed in order for any authorization by *this* NWP to be valid:

1. Navigation. No activity may cause more than a minimal adverse effect on navigation.

2. Proper Maintenance. Any structure or fill authorized shall be properly maintained, including maintenance to ensure public safety.

3. Erosion and Siltation Controls. Appropriate erosion and siltation controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.

4. Aquatic Life Movements. No activity may substantially disrupt the movement of those species of aquatic life indigenous to the waterbody, including those species which normally migrate through the area, unless the activity's primary purpose is to impound water.

5. Equipment. Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance.

6. Regional and Case-by-Case Conditions. The activity must comply with any regional conditions which may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the U.S. Army Corps of Engineers (Corps) or by the State or Tribe in its Section 401 water quality certification.

7. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System; or in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status; unless the appropriate Federal agency, with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely effect the Wild and Scenic River designation, or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency in the area (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service (USFWS)).

8. Tribal Rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

9. Water Quality Certification. The State of Oklahoma has denied NWP wate quality certification for components of the Oklahoma Scenic Rivers includin Illinois River, Flint Creek, Barren Fork Creek, Mountain Fork Creek, Li-le Creek, and Big Lee Creek; waters afforded special protections in Appen B the Oklahoma Water Quality Standards 1994; and those waters designated as Outstanding Resource Waters. For this NWP to be valid in the aforementione waters in Oklahoma, an individual Section 401 water quality certification m obtained or waived from the Oklahoma Department of Environmental Quality.

10. Coastal Zone Management. *Not applicable.*

11. Endangered Species.

a. No activity is authorized under any NWP which is likely to jeopardi the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Sp Act (ESA), or which is likely to destroy or adversely modify the critical ha of such species. Non-Federal permittees shall notify the DE if any listed species or critical habitat might be affected or is in the vicinity of the p ect, and shall not begin work on the activity until notified by the DE that requirements of the ESA have been satisfied and that the activity is authori

b. Authorization of an activity by a NWP does not authorize the "take" threatened or endangered species as defined under the Federal ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biologi Opinion with "incidental take" provisions, etc.) from the USFWS or the Natio Marine Fisheries Service (NMFS), both lethal and nonlethal "takes" of protec species are in violation of the ESA. Information on the location of threate and endangered species and their critical habitat can be obtained directly f the offices of the USFWS and NMFS or their world wide web pages at http:// www.fws.gov/<difference>r9endspp/endspp.html and http:// kingfish.spp.nmfs.gov/tmcintyr/prot_res.html#ES and Recovery, respectively.

12. Historic Properties. No activity which may affect historic proper s listed, or eligible for listing, in the National Register of Historic P- ces authorized, until the DE has complied with the provisions of 33 CFR Part 325 Appendix C. The prospective permittee must notify the DE if the authorized activity may affect any historic properties listed, determined to be eligibl which the prospective permittee has reason to believe may be eligible for li on the National Register of Historic Places, and shall not begin the activit until notified by the DE that the requirements of the National Historic Preservation Act have been satisfied and that the activity is authorized. Information on the location and existence of historic resources can be obtai from the State Historic Preservation Office and the National Register of His Places (see 33 CFR 330.4(g)).

13. Notification.

a. Timing: The prospective permittee must notify the DE with a Pre-Construction Notification (PCN) as early as possible and shall not begin the activity:

(1) Until notified by the DE that the activity may proceed under the with any special conditions imposed by the District or Division Engineer; or

(2) If notified by the District or Division Engineer that an individ permit is required; or

(3) Unless 30 days have passed from the DE's receipt of the notifica and the prospective permittee has not received notice from the District or Division Engineer. Subsequently, the permittee's right to proceed under the may be modified, suspended, or revoked only in accordance with the procedure forth in 33 CFR 330.5(d)(2).

b. Contents of Notification: The notification must be in writing and include the following information:

(1) Name, address, and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) Brief description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity; and

(4) The PCN must also include a delineation of affected special aquatic sites, including wetlands (see paragraph 13(f)).

c. Form of Notification: The standard individual permit application form (Form ENG 4345) may be used as the notification but must clearly indicate that it is a PCN and must include all of the information required in *Section* (b) of General Condition 13. A letter may also be used.

d. District Engineer's Decision: In reviewing the pre-construction notification for the proposed activity, the DE will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. The prospective permittee may, optionally, submit a proposed mitigation plan with the pre-construction notification to expedite the process and the DE will consider any optional mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects of the proposed work are minimal. If the DE determines that the activity complies with the terms and conditions of the NWP and that the adverse effects are minimal, the DE will notify the permittee and include any conditions the DE deems necessary.

Any mitigation proposal must be approved by the DE prior to commencing work. If the prospective permittee elects to submit a mitigation plan, the DE will expeditiously review the proposed mitigation plan, but will not commence a second 30-day notification procedure. If the net adverse effects of the project (with the mitigation proposal) are determined by the DE to be minimal, the DE will provide a timely written response to the applicant stating that the project can proceed under the terms and conditions of the NWP permit.

If the DE determines that the adverse effects of the proposed work are more than minimal, then he will notify the applicant either: (1) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit; (2) that the project is authorized under the NWP subject to the applicant's submitting a mitigation proposal that would reduce the adverse effects to the minimal level; or (3) that the project is authorized under the NWP with specific modifications or conditions.

e. Agency Coordination: The DE will consider any comments from Federal and State agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

The DE will, upon receipt of a notification, provide immediately, e.g., facsimile transmission, overnight mail or other expeditious manner, a copy to the appropriate offices of the USFWS, State natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO), and, if appropriate, the NMFS. These agencies will then have 5 calendar days from the date the material is transmitted to telephone or fax the DE notice that they intend to provide substantive, site-specific comments. If so contacted by an agency, the DE will wait an additional 10 calendar days before making a decision on the notification. The DE will fully consider agency comments received within the specified time frame, but will provide no response to the resource agency. The DE will indicate

in the administrative record associated with each notification that the resource agencies' concerns were considered. Applicants are encouraged to provide the Corps multiple copies of notifications to expedite agency notification.

f. Wetlands Delineations: Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic site. There may be some delay if the Corps does the delineation. Furthermore, the 30-day period will not start until the wetland delineation has been completed and submitted to the Corps, where appropriate.

g. Mitigation: Factors that the DE will consider when determining the acceptability of appropriate and practicable mitigation include, but are not limited to:

(i) To be practicable, the mitigation must be available and capable of being done considering costs, existing technology, and logistics in light of the overall project purposes;

(ii) To the extent appropriate, permittees should consider mitigation banking and other forms of mitigation including contributions to wetland trust funds, "in lieu fees" to organizations such as The Nature Conservancy, state or county natural resource management agencies, where such fees contribute to the restoration, creation, replacement, enhancement, or preservation of wetlands. Furthermore, examples of mitigation that may be appropriate and practicable include but are not limited to: Reducing the size of the project; establishing wetland or upland buffer zones to protect aquatic resource values; and replacing the loss of aquatic resource values by creating, restoring, and enhancing similar functions and values. In addition, mitigation must address wetland impacts, such as functions and values, and cannot be simply used to offset the acreage of wetland losses that would occur in order to meet the acreage limits of some of the NWPs.

14. Compliance Certification. Every permittee who has received a NWP verification from the Corps will submit a signed certification regarding the completed work and any required mitigation. The certification will be forwarded by the Corps with the authorization letter and will include:

a. A statement that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions;

b. A statement that any required mitigation was completed in accordance with the permit conditions;

c. The signature of the permittee certifying the completion of the work and mitigation.

15. Multiple Use of Nationwide Permits. *If this* NWP is combined with any other NWP, as part of a single and complete project, the permittee must notify the DE in accordance with paragraphs a, b, and c on the "Notification" General Condition Number 13. As provided at 33 CFR 330.6(c), two or more different NWPs can be combined to authorize a single and complete project. However, the same NWP cannot be used more than once for a single and complete project.

Section 404 Only Conditions: In addition to the General Conditions, the following conditions apply only to activities that involve the discharge of dredged or fill material into waters of the U.S., and must be followed in order for authorization by the NWPs to be valid:

1. Water Supply Intakes. No discharge of dredged or fill material may occur in the proximity of a public water supply intake except where the discharge is for repair of the public water supply intake structures or adjacent bank stabilization.

2. Shellfish Production. No discharge of dredged or fill material may occur in areas of concentrated shellfish production, unless the discharge is directly related to a shellfish harvesting activity authorized by NWP 4.

3. Suitable Material. No discharge of dredged or fill material may consist of unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.) and material discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act).

4. Mitigation. Discharges of dredged or fill material into waters of the United States must be minimized or avoided to the maximum extent practicable at the project site (i.e., on-site), unless the DE approves a compensation plan that the DE determines is more beneficial to the environment than on-site minimization or avoidance measures.

5. Spawning Areas. Discharges in spawning areas during spawning seasons must be avoided to the maximum extent practicable.

6. Obstruction of High Flows. To the maximum extent practicable, discharges must not permanently restrict or impede the passage of normal or expected high flows or cause the relocation of the water (unless the primary purpose of the fill is to impound waters).

7. Adverse Effects From Impoundments. If the discharge creates an impoundment of water, adverse effects on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow shall be minimized to the maximum extent practicable.

8. Waterfowl Breeding Areas. Discharges into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

9. Removal of Temporary Fills. Any temporary fills must be removed ir their entirety and the affected areas returned to their preexisting elevation.

For additional information concerning the NWP, please contact the Regulatory Branch, Tulsa District, U.S. Army Corps of Engineers, Post Office Box 61, Tulsa, OK 74121-0061, or telephone 918-669-7400.

4.0 Radiological Status of Facility

4.1 Contaminated Structures

The May 2002 DPA (Revised May 2003) was prepared and submitted to specifically address the approximate 3.5-acre land area of the Tulsa facility known as the former operation area. The former "operational area" of the facility is defined as the triangular parcel of land north of 41st Street and south of the Union Pacific Railroad right-of-way in which plant processes and operations occurred (May 2002 DPA [Revised May 2003] Figure 2). The former operational area currently houses several structures including the North Extrusion, Office, Maintenance, Warehouse, Crusher, and Crusher Addition buildings. The Flux Building, located to the northeast of the triangular parcel, is also included as part of the former operational area. The "land areas" of the former operational area consist mainly of land beneath concrete pavement.

An HSA was performed during late 2001 for the former operational area of the former Kaiser Aluminum Specialty Products facility (See Appendix A of the May 2002 DPA [Revised May 2003]). The HSA was conducted as the first step toward decommissioning the former operational area at the facility. The objective of the HSA was to compile as much historical information as possible for the facility and, using the MARSSIM guidelines, categorize the land areas and structures of the former operational area of the facility as either impacted or nonimpacted.

The results of the HSA were used to design radiological survey efforts for the structures and land areas of the former operational area. The recommended radiological extended scoping (nonimpacted structures) and characterization (impacted land areas) survey efforts were described in a work plan prepared by Earth Sciences (December 2001). The primary objectives of the extended scoping survey of the six structures was to verify their initial classification of "nonimpacted" during the HSA. The primary objectives of the characterization survey of the "impacted" land areas were to determine the nature and extent of residual radioactive materials within the former operational area and collect sufficient data to support evaluation of remedial alternatives and technologies for the impacted land areas of the former operational area. The radiological survey efforts were completed during the months of January and February 2002. Results of the radiological survey efforts are presented in Section 4.1 of the May 2002 DPA (Revised May 2003). Sections 4.1 through 4.3 of the May 2002 DPA (Revised May 2003) present the radiological information relative to existing site structures, site systems and equipment, and impacted land areas within the former operational area of the Tulsa facility.

4.2 Contaminated Systems and Equipment

The May 2002 DPA (Revised May 2003) presents information on the limited amount of sanitary sewer lines, subsurface piping, and culverts which exists within the former operational area of the Tulsa facility. Figure 3A-4 of the May 2002 DPA (Revised May 2003) shows a layout of the subsurface piping and the sanitary sewer for the Tulsa facility. As shown in that figure, several sections of storm drain/subsurface water piping and plant process piping (associated with the pumping station) were encountered and removed during the ALRP.

Information gathered during an HSA performed during late 2001 does not indicate the use of subsurface piping systems or the sanitary sewer for the conveyance of radioactive material. The pumping station structure identified near the Retention Pond was used to convey noncontact cooling water used in plant operations. These systems are not expected to contain radiological contamination. Their radiological status will be confirmed when they are encountered during remediation to determine the proper disposition.

4.3 Surface and Subsurface Soil Contamination

4.3.1 Retention Pond and Reserve Pond Area

In October of 1994, an extensive characterization of the Retention Pond and Reserve Pond Area was performed in accordance with the Radiological Site Characterization Plan provided to the NRC by Kaiser (September 28, 1994). The purpose of the investigation was to characterize soils and sludges containing thorium with respect to criteria used by the NRC for release of sites for unrestricted use, set forth in the NRC Branch Technical Position, Disposal or On-Site Storage of Residual Thorium or Uranium From Past Operations (1981).

Two hundred and fifty samples were systematically collected from 90 borehole locations (Figure 4-3). Samples were collected in 500-milliliter (ml) Marinelli containers, weighed to the nearest 0.1 gram, and counted for 10 minutes with a shielded 2-inch-by-2-inch NaI (Tl) scintillator detector. The instrument was a Bicron LabTech Dual Channel Analyzer.

Approximately sixty 200-ml subsamples were taken from the 250 field samples. Subsamples were analyzed using a density compensating gamma spectroscopy system (Nuclear Fuel Systems, Inc.) for U-234, U-235, U-238, and Th-232. Referred to as the At Line Solution Assay System (ALSAS), it provided density corrected pCi/g values. A correlation coefficient (r) of 0.990 relating the total counts of the field

2-inch-by-2-inch NaI (Tl) detector field count to the analytical results (pCi/g) of the same sample was completed. Linear regression was used to determine an equation to calculate pCi/g values from counts. The results of the survey were total thorium (Th-232 + Th-228) pCi/g values ranging from below the minimum detectable activity of 1 pCi/g to 425.6 pCi/g. Appendix A, Figures A-1 through A-4 present total thorium activity concentration (pCi/g) distributions by depth interval (0 to 2 feet, 2 to 4 feet, 5 to 10 feet, and 10 to 15 feet) over the Retention Pond and Reserve Pond Area. Sampling locations with respective total thorium concentrations for the particular depth interval are also presented in these figures. Two background soil samples were collected to the west and upgradient of the Retention Pond and Reserve Pond Area and analyzed by gamma spectroscopy. These two samples exhibited Total Thorium concentrations of 1.5 and 4.3 pCi/g.

Alpha spectroscopy was performed on 11 of the samples and confirmed the previously established ratio of Th-232 to Th-230 in dross of between 1:2.4 and 1:3.4. The 11 samples were selected from 60 sample results that fell in the 1 to 50 pCi/g total thorium range. The 11 samples represented 3 of the 4 main areas surveyed including the Retention Pond, the Reserve Pond, and the land area between the railroad and the Retention Pond. Two of the 11 samples represented background. The ratios calculated from these data ranged from 1:0.62 to 1:3.15.

4.3.1.1 Volume Estimates for Retention Pond and Reserve Pond Area

Earth Sciences computed affected material volumes by performing kriging calculations, using data from Appendix I of the 1995 ARS report. These data are included in Appendix A. The estimate from the kriging calculations yielded a total volume of 4,007,909 ft^3 of material greater than 10 pCi/g and a volume of 5,059,614 ft^3 of soil with Th-232 + Th-228 concentrations greater than 6 pCi/g. For off-site stockpiled soils, the 285,000 ft^3 of material that was removed during the Adjacent Land Area Remediation project has been added to the kriging estimate for a total approximate volume of 5,345,000 ft^3.

4.3.1.2 Concentration Estimates for the Retention Pond and Reserve Pond Area

Concentrations of thorium in the on-site material were estimated, using both on-site and off-site data. On-site concentrations were estimated from kriging calculations, using data generated by ARS (1995), Appendix B. The thorium concentration for on-site material ranged from approximately 2 pCi/g to 416 pCi/g for Th-232 + Th-228. The off-site thorium material ranges from less than minimum detectable activity to 728 pCi/g for Th-232 + Th-228. The average computed from the ADA reports (1999, 2000) for the adjacent area soil with Th-232 + Th-228 content over 2.2 pCi/g (background) was 39.2 pCi/g.

4.4 Surface Water

The former Freshwater Pond, Fulton Creek, and the Retention Pond dominate the site surface water, as discussed in Section 3.7 of this DP. Surface water monitoring is conducted on an annual basis for the site. Table 4-1 presents a summary of surface water analytical results for the March 2002 monitoring event. Radiological contamination in these water bodies is virtually nonexistent.

Field filtering using a dedicated disposable 0.45-micron membrane filters was incorporated beginning with the March 2000 sampling event. Samples for laboratory analysis are placed in laboratory-supplied clean containers, properly labeled, and packaged in shuttles for shipment to the analytical laboratory. Samples are chilled from the time of collection until their arrival at the analytical laboratory. Sample shipments to the analytical laboratory occur daily (same day collection and delivery).

Upon receipt of the samples, the laboratory transfers aliquots of the samples to appropriate analysis-based containers. Samples designated for metals and thorium and radium isotopic analysis are immediately acidified with nitric acid to a pH of 2.0 or less. Following preservation, samples for thorium and radium isotopic analysis are held for 16 hours prior to analysis.

The laboratory pH data provided in the Groundwater Quality Reports represent the pH of the groundwater as sampled and not the pH of the preserved groundwater samples. Samples collected for general chemistry parameters such as pH, conductivity, and alkalinity are not preserved by chemical addition prior to analysis.

4.5 Groundwater

Three different groundwater-bearing units were identified beneath the Retention Pond and Reserve Pond Area at the facility: Shallow Overburden/Dross Material, Deep Overburden, and Shallow Bedrock. They are currently being monitored as listed below:

- Shallow Overburden/Dross Material: Wells MWS-4, MWS-5, MWS-6, and MWS-11.
- Deep Overburden: Wells P-2, MWD-2, P-3, P-4, MWD-4, P-5, MWD-5, MWD-6, MWD-7, MWD-8, MWD-9, MWD-10, and MWD-11.
- Shallow Bedrock: Wells ST-2 and ST-3.

Monitoring well construction information is summarized in Table 4-3. Hydraulically upgradient (background) locations for the Tulsa facility include Wells P-1, P-2, and MWD-2 for the Deep Overburden water-bearing unit, Well ST-2 for the Shallow Bedrock water-bearing unit, and the surface water feature known as the Freshwater Pond.

The analytical parameters for the routine groundwater and surface water monitoring programs are divided into a set of field-measured parameters (water temperature, turbidity, pH, conductivity, and dissolved oxygen) and a set of laboratory-measured parameters (select metals, select inorganics, select field parameters, and select radiological constituents). The radiological constituents consists of isotopic thorium (Th-228, Th-230, and Th-232) and isotopic radium (Ra-226 and Ra-228). Gross alpha activity in the groundwater is inferred from Th and Ra isotopic analysis and is not performed as part of the routine monitoring program.

Groundwater monitoring at the Kaiser facility has been conducted over a period of 14 consecutive quarters from September 1999 to the most recent event in December 2002. During the first two events, filtering of samples was delayed until after the samples were received by the analytical laboratory. However, based on the data obtained during the third quarterly event (March 2000), it was determined that the data collected during the first two events did not accurately reflect actual groundwater quality conditions. The incorporation of field filtering into the sampling program for the third quarterly event produced analytical results that were more characteristic of actual groundwater conditions by minimizing the potential for chemical change of the samples before laboratory filtration/analysis. As a result, field filtering was continued in place of laboratory filtering during the eleven following quarterly monitoring events conducted from June 2000 through December 2002. The data for the first two events (September and December 1999) were deemed not usable for the establishment of a statistically representative groundwater quality data set for the site.

Radiological groundwater quality data collected during the third quarter (September) and fourth quarter (December) 2002 monitoring events were compared to Maximum Contaminant Levels (MCL) based on USEPA drinking water standards (Table 4-4). Specific MCLs do not exist for Th-228, Th-230, and Th-232. However, Th is an alpha emitter and would, therefore, fall under 40 CFR 141.15 regarding "Maximum Contaminant Levels for Radium-226, Radium-228, and Gross Alpha Particle Radioactivity in Community Water Systems". Specifically, the MCL for gross alpha particle activity (including Ra-226 but excluding radon and uranium) is 15 picocuries per liter. Therefore, in evaluating if the gross alpha particle activity MCL is exceeded, the combined totals for Ra-226, Th-228, Th-230, and Th-232 are

considered for each water sample. However, it should be noted that the site groundwater is not a drinking water source and there is little likelihood that it will ever be a drinking water source due to the hydrogeologic restrictions of the water-bearing unit (productivity) and the availability of a public water supply source. Analytical results from these two events indicated that the MCLs for combined Ra-226 and Ra-228 and gross alpha activity (inferred from Th and Ra isotopic analysis) were not exceeded in any of the sampled on-site monitoring well locations. In addition, reported radiological parameter concentrations at the sidegradient and downgradient monitoring wells were consistent with those reported at the upgradient locations.

A review and evaluation of the groundwater elevation and quality data obtained during the third and fourth quarter 2002 monitoring events and a perspective of historical information for the site allow for the following conclusions to be made.

- Groundwater within the Shallow Overburden/Dross Material water-bearing unit flows toward the north-northeast (Fulton Creek) away from the Retention Pond. The horizontal hydraulic gradient is approximately 0.02 foot per foot.

- Groundwater within the Deep Overburden water-bearing unit flows in an east/northeast direction following the axis of a bedrock valley located beneath the site. The average horizontal hydraulic gradient across the site is approximately 0.01 foot per foot, with steeper gradients occurring in the west and south areas along the side of the bedrock valley.

- Barium is routinely detected at concentrations above its respective primary MCL in samples collected from monitoring wells screened in the Shallow Overburden/Dross Material, Deep Overburden, and Shallow Bedrock groundwater-bearing units.

- The inorganic parameters chloride, fluoride, sulfate, and iron are sporadically detected at concentrations above their respective secondary MCLs in samples collected from monitoring wells screened in the Shallow Overburden/Dross Material, Deep Overburden, and Shallow Bedrock groundwater-bearing units.

- Analytical results for the groundwater samples collected during the two consecutive quarterly monitoring indicated that the radiological parameters of interest did not exceed their respective primary drinking water MCLs.

The groundwater and surface water monitoring program will be continued as follows:

- Groundwater sampling on a quarterly basis.
- Surface water sampling on an annual basis.
- Groundwater and surface water monitoring report preparation on a semiannual basis.

This monitoring program is subject to change through the revision of Kaiser's general procedures.

Historical groundwater elevations are summarized in Table 4-2. Tables 4-5 and 4-6 present a summary of groundwater quality data for the Deep Overburden groundwater-bearing unit obtained during the Third and Fourth Quarter 2002 monitoring events.

Field filtering using a dedicated disposable 0.45-micron membrane filters was incorporated beginning with the March 2000 sampling event. Samples for laboratory analysis are placed in laboratory-supplied clean containers, properly labeled, and packaged in shuttles for shipment to the analytical laboratory. Samples are chilled from the time of collection until their arrival at the analytical laboratory. Sample shipments to the analytical laboratory occur daily (same day collection and delivery).

Upon receipt of the samples, the laboratory transfers aliquots of the samples to appropriate analysis-based containers. Samples designated for metals and thorium and radium isotopic analysis are immediately acidified with nitric acid to a pH of 2.0 or less. Following preservation, samples for thorium and radium isotopic analysis are held for 16 hours prior to analysis.

The laboratory pH data provided in the Groundwater Quality Reports represent the pH of the groundwater as sampled and not the pH of the preserved groundwater samples. Samples collected for general chemistry parameters such as pH, conductivity, and alkalinity are not preserved by chemical addition prior to analysis.

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1. ADA Consultants, Inc., March 1999, Adjacent Land Characterization, Kaiser Aluminum Specialty Products, Appendix A, Estimate of Volume of Off-Site Contaminated Soil, Adjacent Land Characterization Report, Baton Rouge, Louisiana.

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Table 4-1
Surface Water Quality Data
First Quarter (March) 2002 Monitoring Event
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Parameter	Units	Sample Identification		
		Retention Pond Filtered	Freshwater Pond Filtered	Fulton Creek Filtered
Field Measurements:				
pH, Field	pH units	9.51	8.13	7.84
Specific Conductance @ 25°C	µmhos/cm	1000	600	600
Turbidity	NTU	12.3	17.3	7.2
Dissolved Oxygen	mg/l	12.14	15.63	11.22
Temperature	°C	9.7	9.8	17
Laboratory Analysis:				
pH, Lab	pH units	9.31	8.07	8.25
Specific Conductance @ 25°C	µmhos/cm	1300	659	830
Radium-226	pCi/l	0.378±0.161	0±0.120	0±0.139
Radium-228	pCi/l	1.44±0.045	0.804±0.078	0.518±0.046
Total Radium(1)	pCi/l	1.818	0.804	0.518
Thorium-228	pCi/l	0.033±0.095	0±0.078	0±0.096
Thorium-230	pCi/l	0.284±0.136	0.055±0.095	0±0.096
Thorium-232	pCi/l	0.092±0.099	0.057±0.101	0.004±0.01
Gross Alpha Activity(2)	pCi/l	0.787	0.112	0.004
Alkalinity	mg/l $CaCO_3$	359	326	172
Chloride	mg/l	98.5	58.0	90.5
Fluoride	mg/l	3.4	0.4	0.7
Nitrate	mg/l NO_3-N	0.3	0.7	0.4
Silica Dioxide	mg/l	<0.5	0.6	<0.5
Sulfate	mg/l	98.7	79.5	72.2
Barium	mg/l	0.194	0.112	0.273
Calcium	mg/l	10.9	65.7	68.7
Copper	mg/l	<0.007	<0.007	<0.007
Iron	mg/l	0.174	0.816	0.024
Magnesium	mg/l	146	10.6	22.7
Potassium	mg/l	41.3	6.48	22.4
Sodium	mg/l	16.4	46.1	44.5
Zinc	mg/l	0.014	0.052	0.015

(1)Total Radium consists of the summation of Radium-226 and Radium-228 activity concentrations.
(2)Gross alpha particle activity inferred from Ra-226 and Thorium isotopic analysis.

(Rev. 5/03)

Table 4-2
Groundwater Elevation Summary
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Location	Sample Date							
	9/1/99	12/1/99	3/1/00	6/1/00	9/1/00	12/22/00	3/1/01	6/1/01
P-1	698.22	699.96	700.06	699.21	697.39	699.77	699.04	697.91
P-2	698.90	699.39	699.49	701.45	699.01	698.72	697.94	698.39
P-3	699.09	700.14	699.83	699.93	697.33	699.29	697.56	698.14
P-4	692.42	694.89	696.72	694.95	691.27	694.55	Abandoned	Abandoned
P-5	679.90	681.20	678.12	680.75	678.52	681.39	680.34	680.80
P-7	691.88	692.66	692.50	692.61	698.87	692.53	692.79	692.70
P-8	691.84	692.54	692.60	693.31	690.68	692.56	692.97	693.52
P-10	696.72	697.28	697.67	697.52	696.81	696.51	696.08	695.97
MWD-2	700.57	701.23	701.26	701.60	700.79	701.97	698.66	699.28
MWS-4	691.20	692.23	691.78	692.02	687.37	691.94	691.06	692.15
MWD-4	690.07	691.30	691.09	691.24	687.06	690.99	689.35	691.44
MWS-5	690.06	691.96	690.49	691.20	687.88	694.61	695.14	696.42
MWD-5	686.05	687.34	686.51	685.60	683.77	690.62	690.29	691.26
MWS-6	684.85	686.67	685.61	685.57	682.89	685.59	685.31	688.15
MWD-6	684.83	686.59	684.87	686.05	682.89	685.71	685.45	687.97
MWD-7	678.61	679.47	680.85	681.23	679.18	680.04	678.82	678.18
MWD-8	680.45	682.15	682.27	681.64	680.35	681.73	681.13	681.60
MWD-9	681.38	681.74	682.09	681.64	680.35	682.03	681.64	681.31
MWD-10	688.54	688.74	688.45	689.03	687.13	688.67	688.96	689.75
MWS-11	683.77	-(1)	683.68	683.71	683.64	683.55	683.62	683.78
MWD-11	682.82	683.84	683.53	683.05	683.64	683.26	683.03	684.03
ST-2	663.74	-	656.47	656.26	657.03	653.97	656.28	656.90
ST-3	680.20	680.62	680.43	679.91	679.81	680.70	680.12	679.48

See footnotes at end of table.

(Rev..5/03)

Table 4-2
(Continued)

Location	Sample Date					
	9/6/01	12/3/01	3/24/02	6/14/02	9/16/02	12/17/02
P-1	699.42	698.08	698.98	699.16	Abandoned	Abandoned
P-2	695.36	697.66	697.86	698.11	696.96	694.83
P-3	697.09	697.96	698.29	698.64	697.69	697.64
P-4	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
P-5	678.70	679.95	680.65	681.63	679.44	680.38
P-7	688.45	692.00	692.18	693.35	Abandoned	Abandoned
P-8	689.01	692.14	692.19	693.56	Abandoned	Abandoned
P-10	693.46	694.99	696.09	696.74	Abandoned	Abandoned
MWD-2	697.93	699.25	699.32	699.83	698.58	699.13
MWS-4	686.83	Dry	690.62	689.49	689.53	689.65
MWD-4	687.01	689.49	690.44	691.86	689.23	689.63
MWS-5	692.82	Dry	Dry	696.45	694.65	694.28
MWD-5	687.63	689.46	690.37	691.73	689.12	689.56
MWS-6	682.64	684.35	684.85	687.80	683.99	684.35
MWD-6	683.13	684.51	685.06	687.81	684.13	684.50
MWD-7	676.67	678.53	679.00	679.83	677.22	679.03
MWD-8	679.20	680.60	681.28	679.00	680.16	679.95
MWD-9	680.16	681.31	681.51	681.66	680.77	681.46
MWD-10	686.62	688.91	688.58	689.85	688.61	687.92
MWS-11	Dry	Dry	Dry	684.31	683.68	Dry
MWD-11	681.48	682.28	682.90	684.15	682.27	682.79
ST-2	657.36	656.86	656.95	656.21	656.70	Dry
ST-3	679.28	680.08	680.23	679.58	679.33	680.18

(1)Dash denotes data not available.

(Rev. 5/03)

Table 4-3
Monitoring Well Information
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Well ID	Boring Depth (feet, bgs) [1]	Well Screen Interval (feet, bgs)	Dross Material Interval (feet, bgs)
P-1[4]	20	10-20	
P-2	28	18-28	
P-3	13	3-13	
P-4[3]	20	10-20	0-0.083
P-5	20	9-19	
P-7[4]	22	12-22	
P-8[4]	28	16.5-26.5	
P-10[4]	22	12-22	
MWD-2	15	5-15	
MWS-4	10	4-9	0-5
MWD-4	20	10-20	2-2.4
MWS-5	12	7-12	1.5-11
MWD-5	28	16-26	1.5-11
MWS-6	14.5	4.5-14.5	9.5-10 [2]
MWD-6	30	19.5-29.5	9.5-10
MWD-7	20	10-20	
MWD-8	19	9-19	
MWD-9	20.5	9-19	
MWD-10	22	10-20	
MWS-11	10	5-10	4-10
MWD-11	24.5	14-24	4-9.5
ST-2	58	38-48	
ST-3	64	38-48	

Notes:

[1] bgs = below ground surface.

[2] Well is believed to be screened in dross, but not indicated in the boring log. However, this well is right next to MWD-6 which passes through a dross layer.

[3] Well was properly abandoned in March 2001.

[4] Wells were properly abandoned in July 2002.

Table 4-4
Regulatory Limits for Groundwater
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Parameters	Units	Maximum Contaminant Level
pH	s.u.	*6.5-8.5* [1]
Specific Conductivity	umhos/cm	NA
Alkalinity	mg/l	NA
Chloride	mg/l	*250* [1]
Copper[5]	mg/l	1.3
Fluoride[2]	mg/l	4.0
Fluoride[2]	mg/l	*2* [1]
Nitrate	mg/l	10
Silica Dioxide	mg/l	NA
Sulfate	mg/l	*250* [1]
Barium	mg/l	2.0
Calcium	mg/l	NA
Iron	mg/l	*0.3* [1]
Magnesium	mg/l	NA
Potassium	mg/l	NA
Sodium	mg/l	NA
Zinc	mg/l	*5*
Radium-226	pCi/l	5 [3]
Radium-228	pCi/l	5[3]
Thorium-228	pCi/l	15[4]
Thorium-230	pCi/l	15[4]
Thorium-232	pCi/l	15[4]

Notes:

[1] *Italicized* value is a secondary MCL.

[2] Fluoride has both primary and secondary drinking water standards.

[3] MCL for Radium-226 and -228 combined is 5 pCi/l.

[4] Gross alpha particle activity (including Radium-226) is 15 pCi/l.

[5] Copper - action level of 1.3 mg/l.

Table 4-5
Groundwater Quality Data
Deep Overburden
Third Quarter (September) 2002 Monitoring Event
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

Parameter	Units	Sample Identification P-2 Filtered	P-3 Filtered	MWD-4 Filtered	P-5 Filtered	MWD-5 Filtered
Field Measurements:						
pH, Field	pH units	7.24	6.91	7.00	7.31	7.94
Specific Conductance @ 25°C	µmhos/cm	1056	2000	1417.5	1773	1195
Turbidity	NTU	12.6	181.1	54.98	10.2	5.9
Dissolved Oxygen	mg/l	0.95	1.62	0.62	0.89	1.02
Temperature	°C	20.63	23.8	22.55	22.9	22.0
Laboratory Analysis:						
pH, Lab	pH units	6.83	6.81	6.81	7.17	7.68
Specific Conductance @ 25°C	µmhos/cm	1020	2270	1550	1860	1240
Radium-226	pCi/l	0.096±0.087	0.396±0.139	0.361±0.157	0.273±0.131	0.364±0.137
Radium-228	pCi/l	0.312±0.052	ND±0.049	0.548±0.052	0.768±0.053	0.784±0.053
Total Radium(1)	pCi/l	0.408	0.396	0.909	1.041	1.148
Thorium-228	pCi/l	0.048±0.090	0.033±0.072	0.128±0.111	0±0.110	0±0.164
Thorium-230	pCi/l	0±0.141	0±0.127	0±0.159	0±0.132	0±0.246
Thorium-232	pCi/l	0.038±0.070	0±0.053	0.012±0.063	0±0.108	0±0.151
Gross Alpha Activity(2)	pCi/l	0.182	0.429	0.501	0.273	0.364
Alkalinity	mg/l $CaCO_3$	568	280	313	222	107
Chloride	mg/l	12.6	565	280	402	290
Fluoride	mg/l	0.3	0.4	0.5	0.5	1.4
Nitrate	mg/l NO_3-N	<0.2	<0.2	<0.2	0.3	<0.2
Silica Dioxide	mg/l	2.7	2.3	2.2	1.6	0.9
Sulfate	mg/l	5.2	69.3	61.6	5.6	2.2
Barium	mg/l	0.917	0.293	0.098	3.58	4.06
Calcium	mg/l	16.8	274	147	63.9	42.5
Copper	mg/l	-(3)	<0.121	-	<0.011	-
Iron	mg/l	0.076	<0.066	<0.066	0.261	0.144
Magnesium	mg/l	14.2	62.9	70.5	28.8	21.7
Potassium	mg/l	<0.660	12.2	23.6	248	138
Sodium	mg/l	2.78	60.8	42.0	39.7	25.6
Zinc	mg/l	-	<0.198	-	<0.018	-

See footnotes at end of table.

(Rev. 5/03)

Table 4-5
(Continued)

Parameter	Units	Sample Identification MWD-7 Filtered	MWD-8 Filtered	MWD-8 (Dup) Filtered	MWD-9 Filtered	MWD-10 Filtered
Field Measurements:						
pH, Field	pH units	7.02	7.53	-	6.94	7.44
Specific Conductance @ 25°C	µmhos/cm	877.5	2175	-	935	1288
Turbidity	NTU	109.45	4.1	-	93.38	84.73
Dissolved Oxygen	mg/l	1.85	0.74	-	1.39	0.75
Temperature	°C	21.65	24.05	-	24.48	22.43
Laboratory Analysis:						
pH, Lab	pH units	6.71	7.31	7.41	6.84	6.99
Specific Conductance @ 25°C	µmhos/cm	762	2470	2440	882	1260
Radium-226	pCi/l	0.275±0.109	0.240±0.162	0.410±0.168	0.134±0.106	0.413±0.137
Radium-228	pCi/l	0±0.052	3.93±0.069	2.04±0.061	ND±0.049	ND±0.046
Total Radium(1)	pCi/l	0.275	4.17	2.45	0.134	0.413
Thorium-228	pCi/l	0.123±0.073	0.192±0.147	0±0.110	0±0.191	0.186±0.103
Thorium-230	pCi/l	0±0.116	0.078±0.212	0.112±0.196	0.156±0.243	0.183±0.162
Thorium-232	pCi/l	0.043±0.066	0.184±0.155	0±0.090	0±0.0141	0±0.116
Gross Alpha Activity(2)	pCi/l	0.441	0.694	0.522	0.29	0.782
Alkalinity	mg/l $CaCO_3$	229	155	156	217	279
Chloride	mg/l	76.9	691	686	128	222
Fluoride	mg/l	0.4	1.7	1.7	0.3	0.8
Nitrate	mg/l NO_3-N	<0.2	0.2	<0.2	<0.2	<0.2
Silica Dioxide	mg/l	1.5	1.2	1.2	1.8	1.7
Sulfate	mg/l	28.7	1.3	1.1	30.0	28.2
Barium	mg/l	1.34	21.1	21.3	0.408	0.990
Calcium	mg/l	68.9	68.9	71.9	97.3	89.3
Copper	mg/l	-	-	-	-	-
Iron	mg/l	0.069	2.74	2.65	0.077	0.092
Magnesium	mg/l	12.6	131	134	28.2	47.5
Potassium	mg/l	85.2	185	188	8.99	69.2
Sodium	mg/l	14.6	30.4	30.6	23.8	27.4
Zinc	mg/l	-	-	-	-	-

(1)Total Radium consists of the summation of Radium-226 and Radium-228 activity concentrations.
(2)Gross alpha particle activity inferred from Ra-226 and Thorium isotopic analysis.
(3)Dash denotes not analyzed.

Table 4-6
Groundwater Quality Data
Deep Overburden
Fourth Quarter (December) 2002 Monitoring Event
Former Kaiser Aluminum Specialty Products Facility
Tulsa, Oklahoma
Kaiser Aluminum & Chemical Corporation

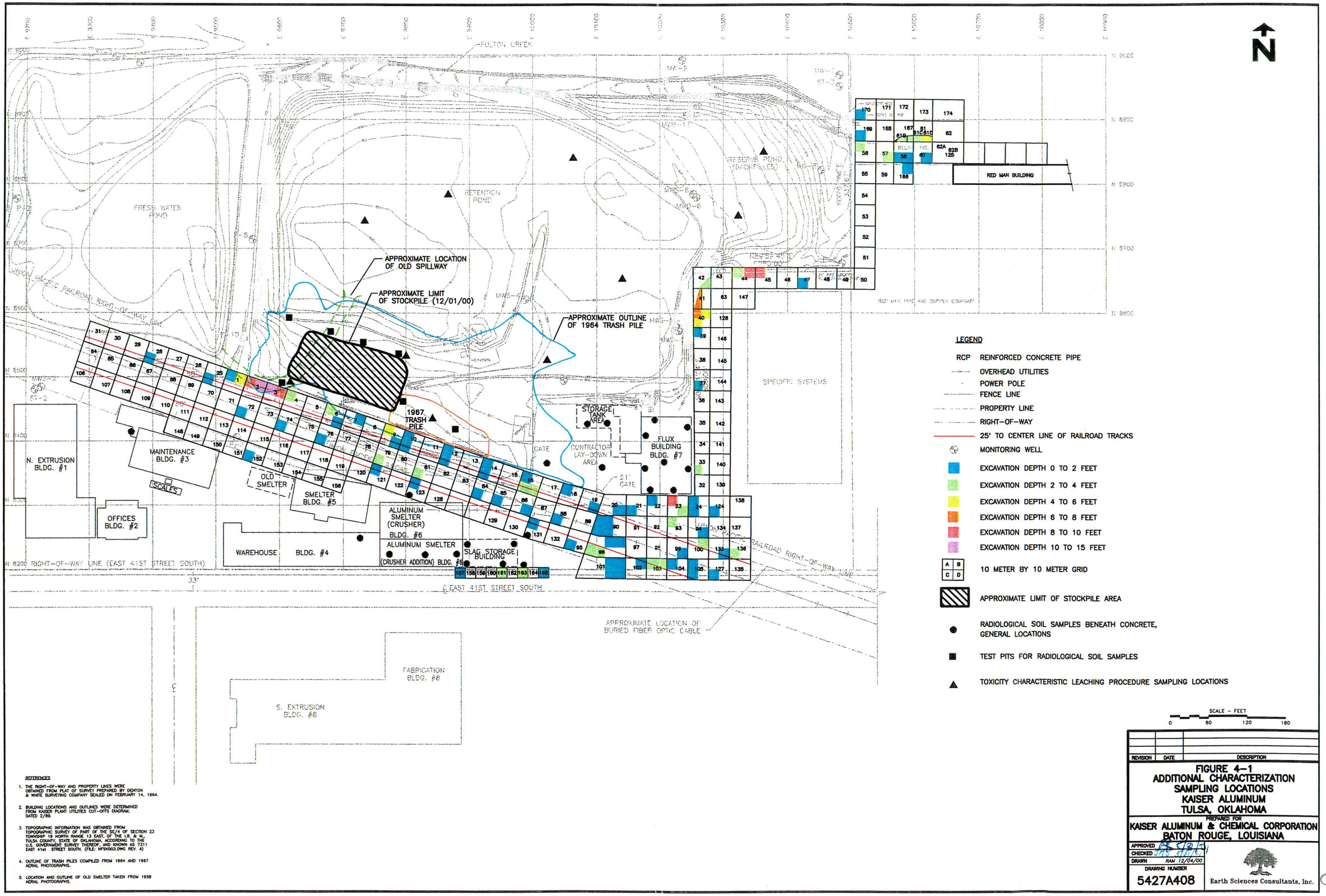
Parameter	Units	Sample Identification P-2 Filtered	P-3 Filtered	MWD-4 Filtered	P-5 Filtered	P-5 (Dup) Filtered
Field Measurements:						
pH, Field	pH units	6.79	6.93	6.74	7.35	-(1)
Specific Conductance @ 25°C	µmhos/cm	1200	2000	1875	2050	-
Turbidity	NTU	28.3	19.95	29.65	1.73	-
Dissolved Oxygen	mg/l	1.46	2.32	2.63	3.67	-
Temperature	°C	17.65	14.9	19.45	17.33	-
Laboratory Analysis:						
pH, Lab	pH units	6.83	6.91	6.80	7.28	7.30
Specific Conductance @ 25°C	µmhos/cm	1030	2110	1990	1900	1900
Radium-226	pCi/l	0.070±0.097	0.426±0.239	0.248±0.221	0.992±0.375	0.721±0.294
Radium-228	pCi/l	0±0.047	0.81±0.049	0±0	0±0.045	1.77±0.054
Total Radium(2)	mg/l	0.07	1.236	0.248	0.992	2.491
Thorium-228	pCi/l	0.064±0.076	0.244±0.131	0.101±0.094	0.046±0.090	0.118±0.132
Thorium-230	pCi/l	0.946±0.215	0.079±0.199	0±0.101	0±0.108	0.026±0.196
Thorium-232	pCi/l	0.119±0.078	0.071±0.082	0±0.053	0.031±0.095	0.212±0.175
Gross Alpha Activity(3)	pCi/l	1.199	0.82	0.349	1.069	1.077
Alkalinity	mg/l $CaCO_3$	566	254	323	221	220
Chloride	mg/l	16.0	503	416	400	403
Fluoride	mg/l	0.3	0.4	0.5	0.5	0.6
Nitrate	mg/l NO_3-N	<0.2	<0.2	<0.2	<0.2	<0.2
Silica Dioxide	mg/l	3.8	2.9	3.3	2.3	2.3
Sulfate	mg/l	4.6	47.3	64.0	4.2	4.8
Barium	mg/l	0.899	0.179	0.127	4.52	4.45
Calcium	mg/l	192	250	199	86.1	64.0
Copper	mg/l	-	0.019	-	<0.011	-
Iron	mg/l	0.055	0.069	0.035	0.202	0.287
Magnesium	mg/l	13.9	54.6	96.2	34.6	35.6
Potassium	mg/l	0.504	9.84	26.7	282	295
Sodium	mg/l	28.4	56.3	56.2	41.8	43.3
Zinc	mg/l	-	0.022	-	<0.018	-

See footnotes at end of table.

Table 4-6
(Continued)

Parameter	Units	Sample Identification MWD-5 Filtered	MWD-7 Filtered	MWD-8 Filtered	MWD-9 Filtered	MWD-10 Filtered
Field Measurements:						
pH, Field	pH units	7.80	6.83	7.53	6.89	7.06
Specific Conductance @ 25°C	µmhos/cm	1425	1050	2450	1025	1625
Turbidity	NTU	0.73	8.73	10.72	220.5	32.25
Dissolved Oxygen	mg/l	2.43	0.94	2.65	0.89	2.55
Temperature	°C	19.28	18.55	17.1	17.83	16.75
Laboratory Analysis:						
pH, Lab	pH units	7.68	6.91	7.42	6.94	7.07
Specific Conductance @ 25°C	µmhos/cm	1290	711	2530	835	1300
Radium-226	pCi/l	0.634±0.299	0.730±0.348	1.09±0.385	0.216±0.361	0±0.398
Radium-228	pCi/l	0±0.047	0±0.046	0.92±0.053	0±0.046	0±0.047
Total Radium[2]	mg/l	0.634	0.73	2.01	0.216	0
Thorium-228	pCi/l	0.050±0.170	0±0.056	0.121±0.119	0.198±0.124	0.061±0.105
Thorium-230	pCi/l	0±0.134	0.039±0.113	0.249±0.198	0±0.119	0.244±0.185
Thorium-232	pCi/l	0.025±0.120	0.021±0.083	0.144±0.134	0.198±0.113	0.034±0.090
Gross Alpha Activity[3]	pCi/l	0.709	0.79	1.604	0.612	0.339
Alkalinity	mg/l $CaCO_3$	105	188	164	212	264
Chloride	mg/l	301	87.5	673	117	239
Fluoride	mg/l	1.4	0.3	1.6	0.3	0.8
Nitrate	mg/l NO_3-N	<0.2	<0.2	<0.2	<0.2	<0.2
Silica Dioxide	mg/l	1.5	1.7	1.7	2.6	2.5
Sulfate	mg/l	<1	19.3	2.4	36.7	18.1
Barium	mg/l	4.91	1.09	23.1	0.260	1.06
Calcium	mg/l	46.3	62.4	74.1	99.2	88.8
Copper	mg/l	-	-	-	-	-
Iron	mg/l	0.520	0.666	3.61	0.068	0.048
Magnesium	mg/l	28.0	12.0	144	31.7	58.5
Potassium	mg/l	172	76.8	204	9.69	73.1
Sodium	mg/l	29.7	16.9	34.4	23.7	26.6
Zinc	mg/l	-	-	-	-	-

[1]Dash denotes not analyzed.
[2]Total Radium consists of the summation of Radium-226 and Radium-228 activity concentrations.
[3]Gross alpha particle activity inferred from Ra-226 and Thorium isotopic analysis.



REFERENCES

1. THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM PLAT OF SURVEY PREPARED BY DENTON & WHITE SURVEYING COMPANY SEALED ON FEBRUARY 14, 1964.
2. BUILDING LOCATIONS AND OUTLINES WERE DETERMINED FROM KAISER PLANT UTILITIES CUT-OFFS DIAGRAM, DATED 2/89.
3. TOPOGRAPHIC INFORMATION WAS OBTAINED FROM TOPOGRAPHIC SURVEY OF PART OF THE SE/4 OF SECTION 23 TOWNSHIP 19 NORTH RANGE 13 EAST, OF THE I.B. & M., TULSA COUNTY, STATE OF OKLAHOMA, ACCORDING TO THE U.S. GOVERNMENT SURVEY THEREOF, AND KNOWN AS 7311 EAST 41st STREET SOUTH. (FILE: NFSK003.DWG REV. A)
4. OUTLINE OF TRASH PILES COMPILED FROM 1964 AND 1967 AERIAL PHOTOGRAPHS.
5. LOCATION AND OUTLINE OF OLD SMELTER TAKEN FROM 1958 AERIAL PHOTOGRAPHS.

REVISION	DATE	DESCRIPTION

FIGURE 4-1
ADDITIONAL CHARACTERIZATION SAMPLING LOCATIONS KAISER ALUMINUM TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	
CHECKED	JAS 12/4/00
DRAWN	RAM 12/04/00
DRAWING NUMBER	5427A408

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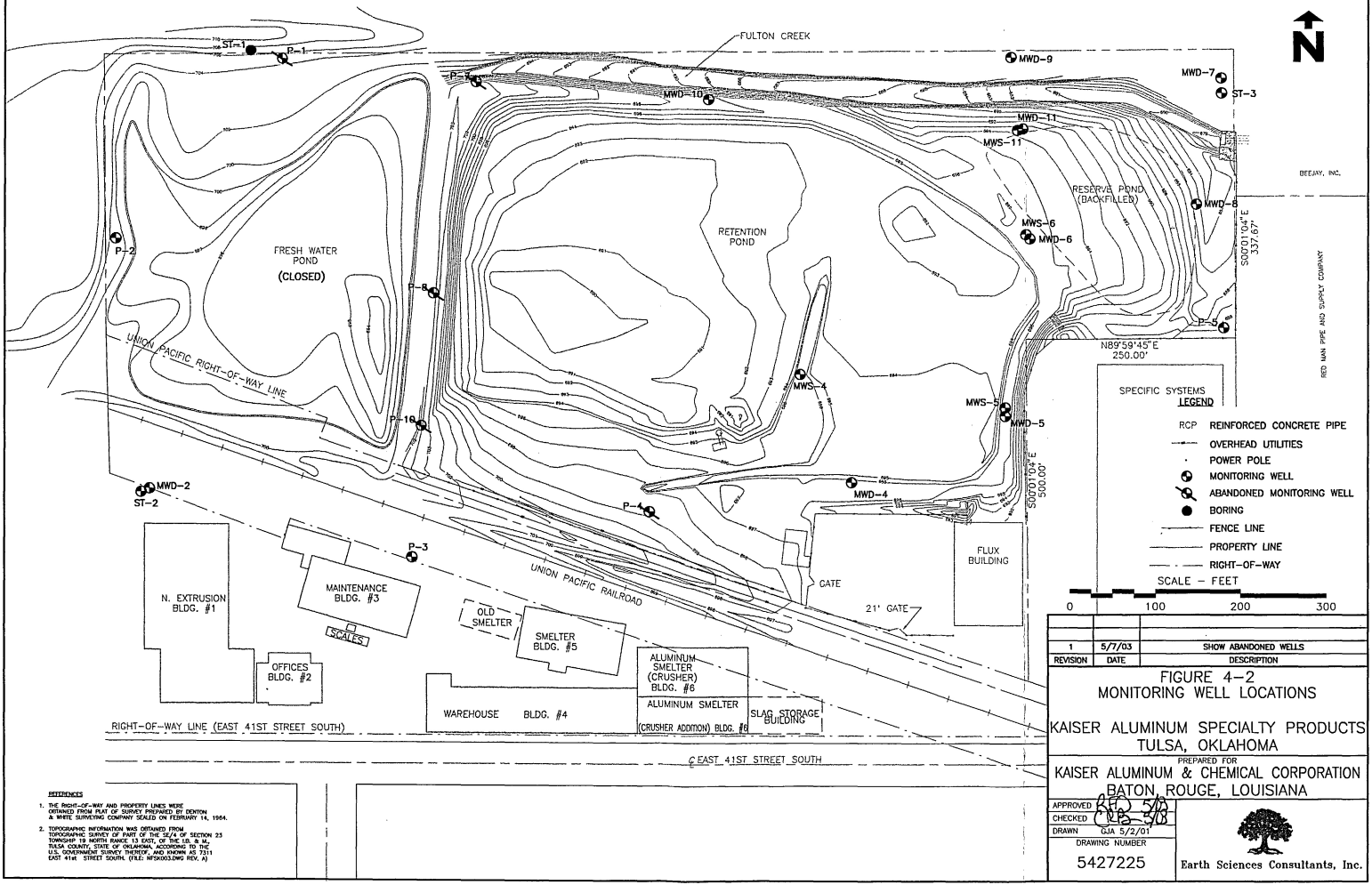

REFERENCES

1. THE RIGHT-OF-WAY AND PROPERTY LINES WERE OBTAINED FROM PLAT OF SURVEY PREPARED BY DENTON & WHITE SURVEYING COMPANY SEALED ON FEBRUARY 14, 1964.
2. TOPOGRAPHIC INFORMATION WAS OBTAINED FROM TOPOGRAPHIC SURVEY OF PART OF THE SE/4 OF SECTION 23 TOWNSHIP 19 NORTH RANGE 13 EAST, OF THE I.B. & M., TULSA COUNTY, STATE OF OKLAHOMA, ACCORDING TO THE U.S. GOVERNMENT SURVEY THEREOF, AND KNOWN AS 7311 EAST 41st STREET SOUTH. (FILE: NFSK003.DWG REV. A)

REVISION	DATE	DESCRIPTION
1	5/7/03	SHOW ABANDONED WELLS

FIGURE 4–2
MONITORING WELL LOCATIONS

KAISER ALUMINUM SPECIALTY PRODUCTS
TULSA, OKLAHOMA

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
BATON ROUGE, LOUISIANA

APPROVED	
CHECKED	
DRAWN	GJA 5/2/01
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FIGURE 4-3

"HISTORY OF SITE CHARACTERIZATION ACTIVITIES KAISER ALUMINUM, TULSA, OKLAHOMA"

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER:

5427a449

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