Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

March 15, 2006

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921-5602

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY (TVA) – MINOR PERMIT MODIFICATION – ASH LANDFILL – KINGSTON FOSSIL PLANT

As we discussed with you in a meeting on March 8, 2006, TVA requests a minor permit modification for the existing permitted landfill at our Kingston Fossil Plant. This modification will change the route of the discharge from the existing dredge cells into the ash pond. As we discussed, TVA would like to make these modifications this summer. Enclosed are three copies of the engineering drawings for this modification as well as one copy of the complete landfill drawing set, revised to reflect this change, for the pending lateral expansion request.

If you have any questions, please contact Larry C. Bowers at (423) 751-4947 in Chattanooga. Mr. Bowers is the TVA point of contact for this project.

Sincerely,

Steven C. Strunk
Manager, Permitted Programs
5D Lookout Place

Enclosures

cc: Mr. Glen Pugh
Division of Solid Waste Management
TN Department of Environment and Conservation
Fifth Floor, L&C Annex
401 Church Street
Nashville, Tennessee 37243

A60 060314 518
Env. Document Type: Solid Waste Correspondence

March 15, 2006

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921-5602

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If you have any questions, please contact Larry C. Bowers at (423) 751-4947 in Chattanooga. Mr. Bowers is the TVA point of contact for this project.

Sincerely,

Steven C. Strunk
Manager, Permitted Programs
5D Lookout Place

LCB:BFD
Enclosures
cc: Mr. Glen Pugh
Division of Solid Waste Management
TN Department of Environment and Conservation
Fifth Floor, L&C Annex
401 Church Street
Nashville, Tennessee 37243

E. L. Deskins, KFP 1A-KST (w/o Enclosures)
B. B. Walton, ET 11A-K (w/o Enclosures)
EDMS, WT CA-K (w/o Enclosures)
P:\media files\solid waste\gen\kif 3-15-06 cover letter.doc

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
PHONE (865) 594-6035 STATEWIDE 1-888-891-8332 FAX (865) 594-6105

August 19, 2005

RECEIVED
AUG 29 2005
ENVIRONMENTAL AFFAIRS
FOSSIL POWER GROUP

Mr. Gordon Park
Manager of Permitted Programs
Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402-2801

RE: Proposed modification to approved construction and operation plans- Addition of foundation material and coal yard soil from the FGD Scrubber Project to the approved waste streams for disposal in TVA Kingston Coal Ash Landfill, IDL 73-0094

Dear Mr. Park:

The revision to the operation plans for **TVA Kingston Coal Ash Landfill**, submitted by TVA Fossil Engineering Services on July 29, 2005, has been reviewed in accordance with Rule Chapter 1200-1-7, Solid Waste Processing and Disposal. This modification consists of the one time addition of a new waste stream, which will consist of foundation materials (concrete, rebar, and stone) from demolition of existing structures, and coal pile residues and associated soil, from the FGS Scrubber Project site at the Kingston plant.

We find that the revised plan meets the regulatory requirements, and we agree that this revision should be considered a minor modification. The waste material should be compatible with the coal fly ash and bottom ash which was originally approved for disposal in the site as a monofill, so long as any petroleum contaminated soil is excluded. However, since the waste is placed as a slurry which is gradually dewatered through the facility design and construction, placement of the construction rubble must be done in a manner that does not interfere with the internal drainage of the site. We are therefore approving the plan as submitted. In all aspects of construction and operation affected by the modification, this plan will replace and supercede the original plan.

An approved copy of the modified plan is enclosed for your use. If you have any questions concerning this matter, do not hesitate to contact me.

Yours truly,

Rick Brown
Environmental Engineer
Division of Solid Waste Management

Larry F. Cook
Knoxville Field Office Manager

RSB /tvakngfoundtnwastemda.doc minrmod

cc: DSWM - Nashville Central Office

TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

July 29, 2005

Ms. Paula Plont
Environmental Engineer
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921-5602

Request for Minor Permit Modification
IDL # 73-0094
Kingston Fossil Plant

Dear Ms. Plont:

TVA requests a minor modification of its solid waste permit, IDL #73-0094, to allow the disposal of construction spoils from its FGD Scrubber Project into the Kingston ash dredge cells. While this material will be primarily soil and gravel, due to its location in the coal yard area where construction spoils have been stored in the past, the material will contain some coal, concrete, asphalt, rebar, rocks, and possibly wood waste and other general construction debris. At this location, TVA has no reason to suspect that petroleum contaminated soil will be encountered. However, material removed will be inspected for odor and appearance, and if suspect material is encountered it will be isolated, covered, sampled and disposed of properly.

It should be noted that TVA plans to use much of the suitable spoil as construction fill. However, due to the volume of the spoils to be generated and the presence of coal and construction debris in some areas, we feel that onsite disposal will be necessary. At this time we suspect that in excess of 100,000 cubic yards of material will require disposal. TVA hopes to begin moving some of this material in September 2005.

If you have any questions, please contact Larry C. Bowers at (423) 751-4947 in Chattanooga.

Sincerely,

Gordon G. Park

Gordon G. Park
Manager, Permitted Programs
5D Lookout Place

Enclosures

cc: Mr. Glen Pugh
TN Division of Solid and Hazardous Waste Management
5th Floor, L&C Tower
401 Church Street
Nashville, TN 37243

Printed on recycled paper

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
PHONE (865) 594-6035 STATEWIDE 1-888-891-8332 FAX (865) 594-6105

April 29, 2005

RECEIVED
MAY 1 3 2005
ENVIRO...
FOSSIL POWER GROUP

Mr. Gordon Park
Manager of Permitted Programs
Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402-2801

RE: Proposed modification to approved construction and operation plans - New leachate breakout remediation, collection, and transfer system for the lower west and south slopes of the Kingston Power Plant Coal Ash Fill, IDL 73-0094

Dear Mr. Park:

The revised plan for TVA Kingston Power Plant Coal Ash Fill, submitted to our office by TVA Fossil Engineering Services on April 27, 2005, has been reviewed in accordance with Rule Chapter 1200-1-7, Solid Waste Processing and Disposal. This modification consists of leachate collection trench drains at the 775, 781, and 595 elevation bench levels around the west and south sides; a toe drain and improved drainage ditch around the toe of the fill on the west side; and a new collection/retention pond with force main to a channel leading to the ash pond. The plan also calls for geonet to be installed at the toe in the vicinity of the original breakout. We find that the revised plan meets the regulatory requirements, and this design is an improvement over the temporary collection/transfer system that was installed to correct the existing problem. We agree that this revision should be considered a minor modification, and we are therefore approving the plan as submitted. In all aspects of construction and operation affected by the modification, this plan will replace and supercede the original plan.

Work may begin to install the features included with this modification at any time when the weather is suitable and the necessary equipment and materials can be mobilized to the site, but work must begin no later than June 1, 2005, in accordance with your suggested schedule. Installation of the system shall be completed not later than August 31, 2005.

An approved copy of the modified plan is enclosed for your use. If you have any questions concerning this matter, do not hesitate to contact me.

Yours truly,

Rick Brown
Environmental Engineer
Division of Solid Waste Management

Larry F. Cook
Knoxville Field Office Manager

cc: DSWM, Nashville Central Office

RSB /tvaknglcsmda.doc minrmod

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
PHONE (865) 594-6035 STATEWIDE 1-888-891-8332 FAX (865) 594-6105

February 22, 2005

Mr. Gordon G. Park, Manager of Permitted Programs
Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402-2801

RE: Proposed modification to approved construction and operation plans-TVA Kingston Fossil Plant Landfill IDL 73-0094

Dear Mr. Park:

The revised plan for the Tennessee Valley Authority's Kingston Fossil Plant Landfill submitted on February 18, 2005, has been reviewed in accordance with Rule Chapter 1200-1-7, Solid Waste Processing and Disposal. This modification consists of a new outfall structure to enhance water movement from the ash pond to the stilling basin. We find that the revised plan meets the regulatory requirements, and we agree that this revision should be considered a minor modification. We are therefore approving the plan as submitted. In all aspects of construction and operation affected by the modification, this plan will replace and supercede the original plan.

An approved copy of the modified plan is enclosed for your use. If you have any questions concerning this matter, do not hesitate to contact me.

Yours truly,

Paula Plont
Environmental Protection Specialist
Division of Solid Waste Management

Larry Cook
Environmental Field Office Manager
Division of Solid Waste Mangement

PJP \TVAkingoutfall.doc

cc: DSWM, Nashville

A60 040130 500
Env. Document Type: Solid Waste Correspondence

cc: L. F. Campbell, KFP 1A-KST
EDM, WT CA-K

ENVIRONMENTAL ASSISTANCE CENTER
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
PHONE (865) 594-6035 STATEWIDE 1-888-891-8332 FAX (865) 594-6105

January 20, 2004

Ms. Janet Watts
Manager of Environmental Affairs
Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402-2801

RE: Proposed Minor Modification- Kingston Fossil Plant Landfill IDL 73-0094

Dear Ms. Watts:

The Division of Solid Waste Management has reviewed the proposed modification to the landfill's operation to allow an alternative waste placement mechanism. This modification has been reviewed in accordance with Rule Chapter 1200-1-7 Solid Waste Processing and Disposal. The request entails the addition of a dry hauling option for waste disposal into the cell at times when movement by wet slurry pumping poses some operational difficulty or is not desired. We find the revised waste movement mechanism meets the regulatory requirements, and we agree that this revision should be considered a minor modification. The Division hereby approves the request. Please retain this correspondence along with the initialed copy of your request as part of the facility's operation manual.

If you have any question concerning this correspondence, please call me at (865) 594-5474.

Yours truly,

Paula Plont

Paula Plont
Environmental Protection Specialist
Division of Solid Waste Management

RECEIVED
JAN 27 2004
ENVIRONMENTAL AFFAIRS
FOSSIL POWER GROUP

cc: Nashville Central Office—DSWM

LFC 1-13
PJP 1-13

JAN 0 8 2004

FILE COPY

MOD approved 1/15/04 PJP.

TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

January 6, 2004

Ms. Paula Plont
Division of Solid Waste
Knoxville EAC
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

TENNESSEE VALLEY AUTHORITY (TVA) – REQUEST FOR MINOR MODIFICATION – KINGSTON FOSSIL PLANT (KIF) IDL 73-0094

Dear Ms. Plont:

As you discussed with members of my staff, TVA seeks a minor modification of its Solid Waste Permit at KIF to facilitate the movement of ash into the permitted dredge when dredging is not possible. This modification would entail an additional sentence to be added to item (5) on page 6 of the closure plan originally submitted in September 1995. A revised page 6 is enclosed.

If you have questions concerning this correspondence, please call Larry C. Bowers at (423) 751-4947 in Chattanooga.

Sincerely,

Janet Watts

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

Enclosure

cc: Mr. Glen Pugh
Solid Waste Section
Division of Solid Waste Management
5th Floor, L&C Tower
401 Church Street
Nashville, Tennessee 37243-1535

(3) The sluicing water continues on through the stilling pool before it is discharged into the river. Within the stilling pool the water is treated with lime as needed to control the pH.

(4) The dredge cell dikes are constructed out of bottom ash material collected from the the bottom ash sluice channel. This ash is collected and transported by pans to the dredge cell area. Pans, dozers, backhoe/loaders, front-end loaders and dump trucks are then used to shape and construct the dikes in accordance with the drawings included with this plan.

(5) During normal operation, material is then periodically dredged from the active ash pond and is hydraulically deposited to the interior of the dredge cell dikes. However, hydraulic dredging may not be possible or desired at all times and TVA will on occasion transport material to the dredge cell by other means including dipping and hauling.

(6) The disposal process is an essentially continuous incremental procedure. No daily earth cover will be required. Intermediate cover may be placed in areas of the dredge cell dike that do not achieve final contours and vegetated during inactive phases of operation. The ash is physically stable, nonputrescible, and is not an attractant for disease or animal vectors.

(7) The dredge cell side-slopes will continue at 3:1 with intermediate benches for erosion control and surface water drainage.

(8) Dust is controlled by utilizing a water tank truck as required on the haul roads and dikes.

(9) The ash disposal area dikes are formally inspected each spring.

2. <u>Drainage System</u>

The surface water drainage system will be operated with the same concepts as have proven to be historically successful during the operation of other TVA ash facilities.

The potential run-on from surrounding areas will continue to be intercepted in the existing diversion ditching network. The handling of this extraneous water assists in stormwater management and erosion control within the ash pond area.

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Solid Waste Management
5th Floor, L & C Tower
401 Church Street
Nashville, Tennessee 37243-1535
615-532-0780

January 15, 2004

Mr. Larry C. Bowers
Senior Solid Waste Specialist
Tennessee Valley Authority
1101 Market Street, LP 5D
Chattanooga, TN 37402-2801

RE: Kingston Fossil Plant Part 1 Application and Lateral Expansion
IDL 73-0094, Roane County

Dear Larry:

The Division has reviewed the request from TVA dated January 6, 2004 to construct a new dredge cell within the existing ash pond at Kingston Fossil Plant. We have also received a Part I Application from TVA for a Class II landfill which includes this same area. We hereby approve construction/operation to commence on the new dredge cell with the understanding that a complete Part II application for this area will be submitted by June 1, 2004.

If I can be of further service, please give me a call at 615-532-0818.

Sincerely,

Glen Pugh
Program Manager

cc: Larry Cook, Knoxville EAC

Bowers, Larry C

From: Glen Pugh [Glen.Pugh@state.tn.us]
Sent: Wednesday, January 14, 2004 12:07 PM
To: Bowers, Larry C
Cc: Mike Apple
Subject: Re: TVA Kingston emergency dredge cell

Larry,
The Division has reviewed the request from TVA dated January 6, 2004 to construct a new dredge cell within the existing ash pond at Kingston Fossil Plant. We have also received a Part I application from TVA for a Class II landfill which includes this same area. We hereby approve construction/operation to commence on the new dredge cell with the understanding that a complete Part II application for this area will be submitted by June 1, 2004.
Glen

Larry B.

A60 040106 501
Env. Document Type: Solid Waste Correspondence

January 6, 2004

Ms. Paula Plont
Division of Solid Waste
Knoxville EAC
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

TENNESSEE VALLEY AUTHORITY (TVA) – REQUEST FOR MINOR MODIFICATION – KINGSTON FOSSIL PLANT (KIF) IDL 73-0094

Dear Ms. Plont:

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If you have questions concerning this correspondence, please call Larry C. Bowers at (423) 751-4947 in Chattanooga.

Sincerely,

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

GGP:LCB:SMF
Enclosure
cc: Mr. Glen Pugh
Solid Waste Section
Division of Solid Waste Management
5th Floor, L&C Tower
401 Church Street
Nashville, Tennessee 37243-1535

EDMS, WT CA-K

Q:\media files\sldwaste\general\Request for minor modifications\KIF lcb.doc

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Larry B.

A60 040106 500
Env. Document Type: Solid Waste Correspondence

January 6, 2004

Mr. Glen Pugh, Manager
Solid Waste Section
Division of Solid Waste Management
5th Floor, L&C Tower
401 Church Street
Nashville, Tennessee 37243-1535

TENNESSEE VALLEY AUTHORITY (TVA) - REQUEST APPROVAL FOR NEW DREDGE CELL – KINGSTON FOSSIL PLANT (KIF)

Dear Mr. Pugh:

Thank you for meeting with members of my staff on December 30, 2003. As discussed in this meeting, TVA wishes to construct a new dredge cell within the confines of the existing ash pond at the KIF. TVA would like to begin construction of this cell by mid-January 2004 and begin using the cell by mid-February 2004. This dredge cell will be adjacent to the existing dredge cells permitted by IDL 73-0094 and will contain approximately 1,000,000 cubic yards of ash. Plans for this proposed dredge cell are enclosed. It should be noted that the area where this dredge cell will be constructed is within the boundary of a permit modification request for a lateral expansion which TVA will submit to the Division no later than June 1, 2004.

Also discussed in the above referenced meeting, the need for this new cell is due to a localized dike failure of the existing dredge cell dike. Rather than proceed with a "quick fix" of this failure, TVA would like more time to study the issues associated with the use of elevated dredge cells before resuming dredging into the existing cells. The construction of this new cell is the only cost effective way to delay the repair and reopening of the existing cells while maintaining NPDES compliance.

Your expedited response to this request would be greatly appreciated. Please contact Larry C. Bowers at (423)751-4947 in Chattanooga, if you have questions concerning this correspondence.

Sincerely,

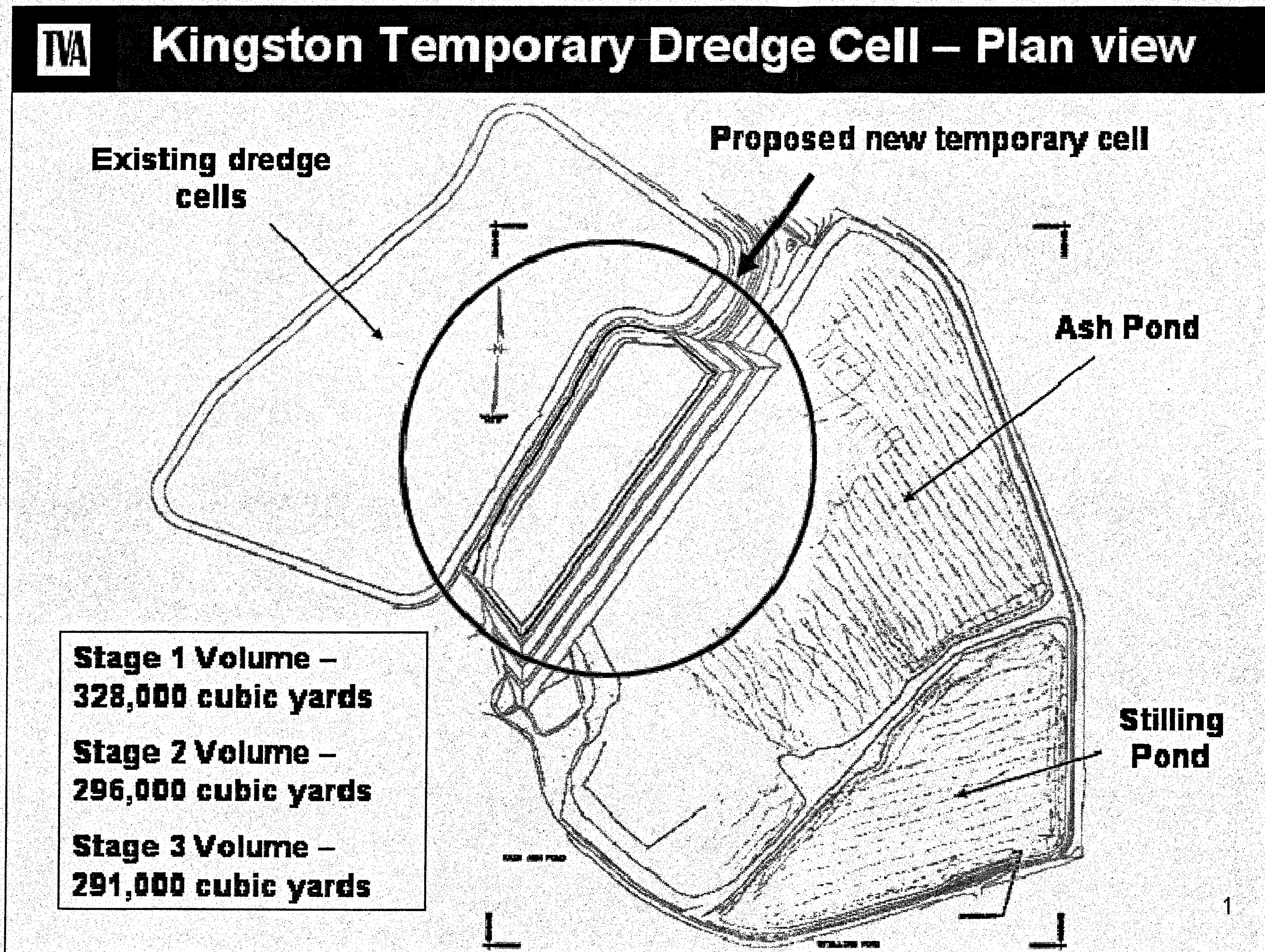
Janet K Watts
Manager of Environmental Affairs
5D Lookout place

Enclosures

GGP:LCB:SMF
cc (Enclosures):
Ms. Paula Plont
Division of Solid Waste
Knoxville EAC
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

L. F. Campbell, KFP 1A-KST
EDMS, WT CA-K

Q:\media files\sldwaste\general\KIF dredge cell ltr lcb.doc



SCALE: NONE EXCEPT AS NOTED

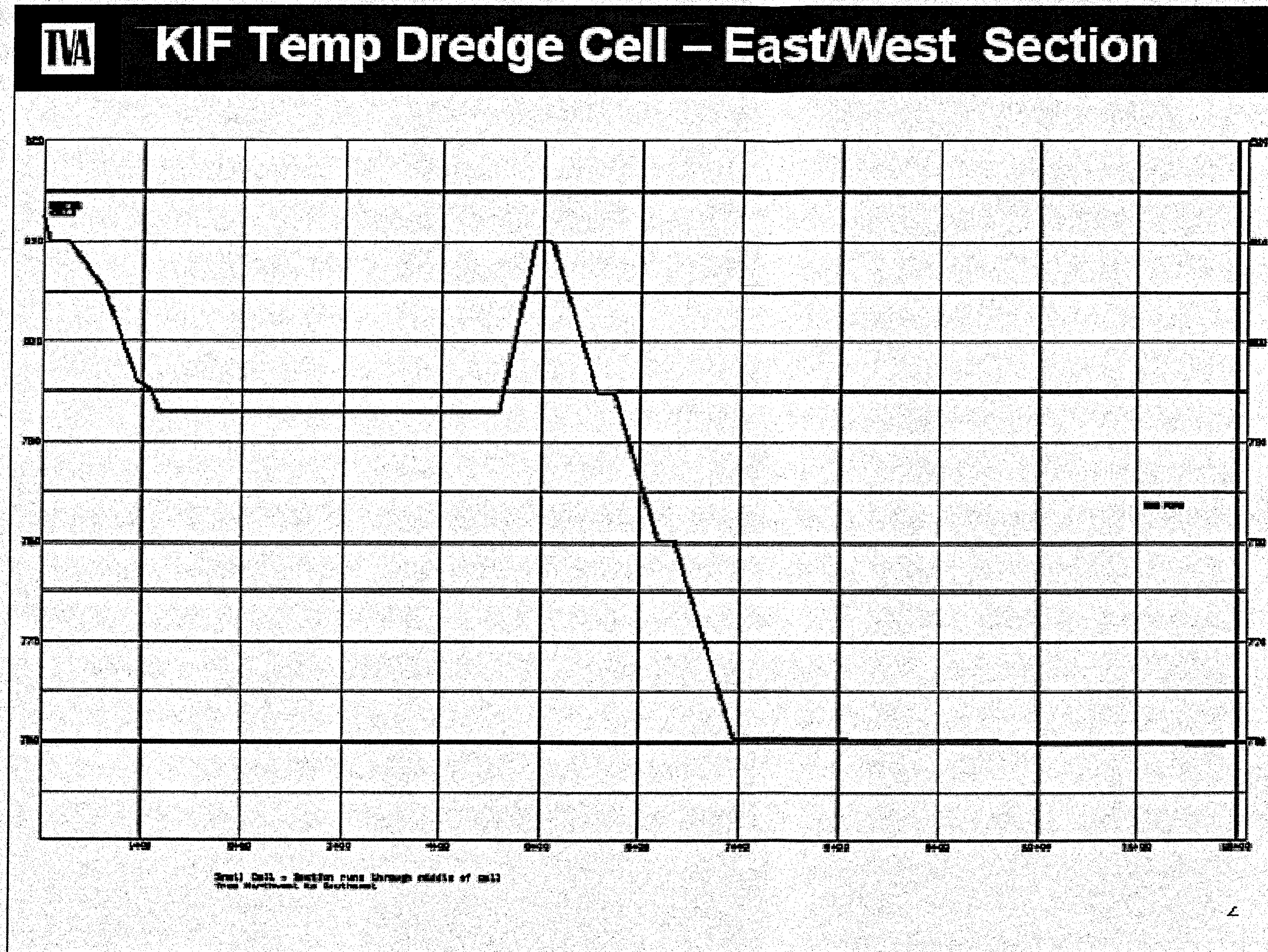
YARD

TEMPORARY DREDGE CELL

KINGSON FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2K | 36 | C | Attachment A | R 0

PLOT FACTOR:1:1 C.A.D. DRAWING



SCALE: NONE EXCEPT AS NOTED

YARD

TEMPORARY DREDGE CELL

KINGSON FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

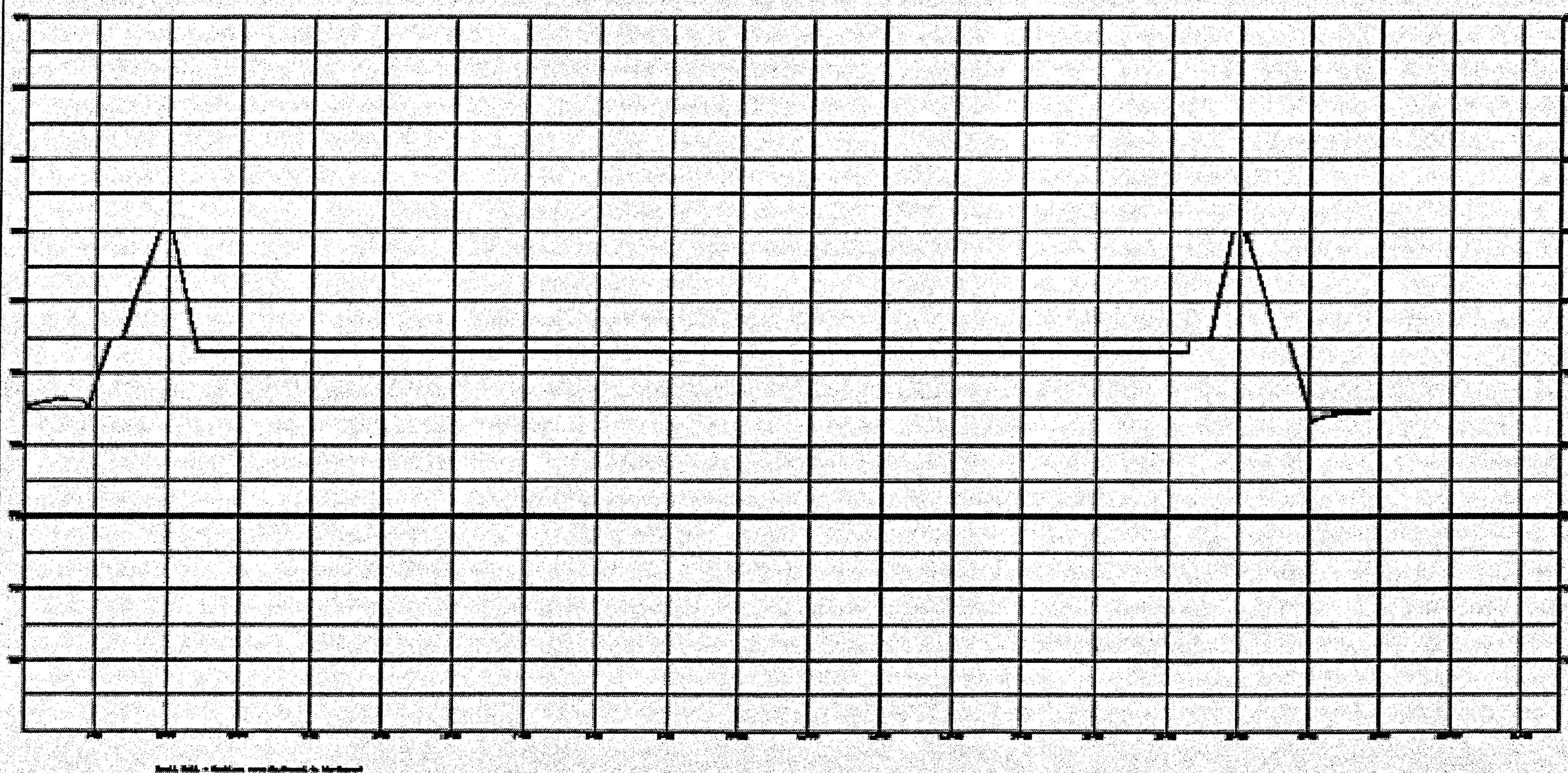
AUTOCAD R 2K | 36 | C | Attachment B | R 0

PLOT FACTOR:1:1
B_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

TASK COMPLETED BY: | REV NO.

KIF Temporary Cell – North/South Section



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REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CO

SCALE: NONE EXCEPT AS NOTED

YARD

TEMPORARY DREDGE CELL

KINGSON FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2K | 36 | C | Attachment C R 0

PLOT FACTOR:1:1

C.A.D. DRAWING DO NOT ALTER MANUALLY

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Solid Waste Management
5th Floor, L & C Tower
401 Church Street
Nashville, Tennessee 37243-1535
615-532-0780

September 26, 2000

Mr. Joseph R. Bynum, Vice President
Fossil Power Group
Tennessee Valley Authority – Kingston Fossil Plant
714 Swan Road
Harriman, TN 37748

RE: Kingston Fossil Plant – TVA IDL 73-0094

Dear Mr. Bynum:

The Tennessee Department of Environment and Conservation has approved the modification to permit number IDL 73-0094 for a vertical expansion.

I appreciate your interest in complying with state statutes and look forward to working with you again.

Sincerely,

J M Apple

Mike Apple,
Director

JMA/DBM/mjs PER9

Enclosure

cc: Jack Crabtree, DSWM, Knoxville Environmental Assistance Center

State of Tennessee
Department of Environment
and Conservation
Division of Solid Waste Management

Solid Waste Management Program
401 Church Street
5th Floor L & C Tower
Nashville, Tennessee 37243-1535
615-532-0780

REGISTRATION AUTHORIZING SOLID WASTE DISPOSAL ACTIVITIES IN TENNESSEE

Registration Number: IDL 73-0094

Date Issued: September 26, 2000

Issued to: Issued to TVA, Kingston Fossil Plant (KIF) for a facility located at the base of a peninsula formed by the Clinch and Emory River embayments of Watt's Bar Lake about 2.7 miles above the confluence of the Clinch and Tennessee River in Roane County.

Activities Authorized: Disposal of fly ash and bottom ash generated from burning coal from the TVA's Kingston Steam Plant in a Class II Landfill.

By my signature this registration is issued in compliance with the provisions of the Tennessee Solid Waste Disposal Act (Tennessee Code Annotated, Section 68-211-101, et seq.), and applicable regulations developed pursuant to this law and in effect; and in accordance with the conditions and other terms set forth in this registration document and attached Registration Conditions.

Mike Apple, Director
Division of Solid Waste Management

JMA/DBM/mjs PER1

Registration Number ____IDL 73-0094____

PERMIT TERMS AND CONDITIONS

1. Recertification by Permittee for Facilities Whose Initial Operation is Delayed - If the facility does not initiate construction and/or operation within one year of the date of this permit, the permittee must recertify the application in accordance with Rule 1200-1-7-.02(2)(e).

2. Duty to Comply - The permittee must comply with all conditions of this permit, unless otherwise authorized by the Department. Any permit noncompliance, except as otherwise authorized by the Department, constitutes a violation of the Act and is grounds for enforcement action, or for permit termination, revocation and reissuance, or modification.

3. Need to Halt or Reduce Activity Not a Defense - It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

4. Duty to Mitigate - In the event of noncompliance with the permit, the permittee shall take all reasonable steps to minimize releases to the environment, and shall carry out such measures as are reasonable to prevent adverse impacts on human health or the environment.

5. Proper Operation and Maintenance - The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

6. Permit Actions - This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any existing permit condition.

7. Property Rights - This permit does not convey any property rights of any sort, or any exclusive privilege.

8. Duty to Provide Information - The permittee shall furnish to the Commissioner, within a reasonable time, any relevant information which the Commissioner may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Commissioner, upon request, copies required to be kept by this permit.

9. Inspection and Entry - The permittee shall allow the Commissioner, or an authorized representative, to:

   (i) Enter at any reasonable time the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

(ii) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

(iii) Inspect at any reasonable time any facilities, equipment (including monitoring and control equipment), practices or operations regulated or required under this permit (Note: If requested by the permittee at the time or sampling, the Commissioner shall split with the permittee any samples taken.);

(iv) Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Act any substances or parameters at any location; and

(v) Make photographs for the purpose of documenting items of compliance or noncompliance at waste management units, or where appropriate to protect legitimate proprietary interests, require the permittee to make such photos for the Commissioner.

10. Monitoring and Records

(i) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

(ii) The permittee shall retain records of all required monitoring information. The permittee shall maintain records for all ground-water monitoring wells and associated ground-water surface elevations, for the active life of the facility, and for the post-closure care period as well. This period may be extended by request of the Commissioner at any time.

(iii) Records of monitoring information shall include:

(I) The date, exact place, and time of sampling or measurements;

(II) The individual(s) who performed the sampling or measurements;

(III) The date(s) analyses were performed;

(IV) The individual(s) who performed the analyses;

(V) The analytical techniques or methods used (including equipment used); and

(VI) The results of such analyses.

11. Reporting Requirements

(i) The permittee shall give notice to the Commissioner as soon as possible of any planned physical alterations or additions to the permitted facility.

(ii) Monitoring results shall be reported at the intervals specified elsewhere in this permit.

(iii) The permittee shall report orally within 24 hours from the time the permittee becomes aware of the circumstances of any release, discharge, fire, or explosion from the permitted solid waste facility which could threaten the environment or human health outside the facility. Such report shall be made to the Tennessee Emergency Management Agency, using 24-hour toll-free number 1-800-262-3300.

(iv) Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Commissioner, it shall promptly submit such facts or information.

12. Periodic Survey

(i) Within 60 days of his receipt of the written request of the Commissioner to do so, the permittee shall cause to be conducted a survey of active and/or closed portions of his facility in order to determine if operations (e.g., cut and fill boundaries, grades) are being conducted in accordance with the approved design and operational plans. The permittee must report the results of such survey to the Commissioner within 90 days of his receipt of the Commissioner's request.

(ii) The Commissioner may request such a survey:

(I) If he has reason to believe that operations are being conducted in a manner that significantly deviates from the approved plans; and/or

(II) As a periodic verification (but no more than annually) that operations are being conducted in accordance with the approved plans.

(iii) Any survey performed pursuant to this part must be performed by a qualified land surveyor duly authorized under Tennessee law to conduct such activities.

13. Duration of Permits - This permit shall be effective for the operating life of the facility.

14. Effect of Permit - The issuance of this permit does not authorize the permittee to injure persons or property or to invade other private rights, or to violate any local law or regulations.

15. Transfer, Modification, Revocation and Reissuance, and Termination of Permits - This permit may be transferred, modified, revocated or reissued, or terminated as set forth in 1200-1-7-.02(5)3(b).

16. Applicable Standards - All applicable facility standards of Rule Chapter 1200-1-7, Solid Waste Processing and Disposal Amendments shall be considered conditions of this registration.

17. Penalties - Any violation of the conditions or other terms of this registration may subject the registrant to the penalties set forth in Tennessee Code Annotated Section 68-211-114 and 68-211-117.

18. Hazardous Waste Restriction - No hazardous waste, as regulated by the Tennessee Hazardous Waste Management Act (TCA Section 68-212-101, et seq.), and the Rules adopted pursuant to that Act, shall be accepted at this facility.

19. Construction and Operation - The permittee shall construct and operate the facility in accordance with the approved engineering plans and operations manual which becomes a condition of this permit in Attachment I.

20. Financial Assurance - Prior to beginning operation, the permittee must file a Financial Assurance Instrument in accordance with Rule 1200-1-7-.03(1).

21. Special Waste - Except as specifically provided for in the Facility-Specific Conditions of this permit, the permittee may not accept for disposal any special waste unless approved to do so in writing by this Department.

22. Automobile Batteries - This facility is specifically prohibited from accepting automobile batteries for disposal.

PER2

Registration Number IDL 73-0094

VARIANCES AND WAIVERS

The following variances or waivers from standards or requirements in Rule 1200-1-7, Solid Waste Processing and Disposal Amendments, are hereby granted in accordance with Rule 1200-1-7-.01(5):

1. No geologic buffer between the fill material and the ash pond will be required. Rule 1200-1-7-.04(4)(b)
2. No leachate migration control system will be required. Rule 1200-1-7.04(4)
3. No gas migration control system will be required. Rule 1200-1-7-.04(5)
4. No random inspection program will be required. Rule 1200-1-7-.04(2)(s)
5. No daily or intermediate cover will be required for the ash fill area. Rule 1200-1-7-.04(6)

Registration Number **IDL 73-0094**

FACILITY-SPECIFIC PERMIT CONDITIONS

The following conditions of this permit are established pursuant to Rule 1200-1-7-.02(4)(b):

1. During the post closure period, but no later than three years after final closure, TVA must submit a report to the Division characterizing the nature of ground water mounding beneath the ash disposal area.

2. The permittee shall close the facility in accordance with the approved closure and post closure plan which becomes a condition of this permit.

C:permits/73-0094 idl.doc

JUL 07 1999

SOLID WASTE PART I APPLICATION

Tennessee Department of Environment and Conservation
Division of Solid Waste Management

Group No. ______ File No. ______

ID No. ______

1. a. Facility's full, legal name Tennessee Valley Authority Kingston Fossil Plant	Official use only IDL-73-0094		
b. Mailing address 714 Swan Pond Road	City Harriman	State TN	Zip Code 37748
2. a. Physical location or address of facility 714 Swan Pond Road	County Roane		
b. Latitude (degrees, minutes, and seconds) 35 deg. 54 min. 40 sec.	Longitude (degrees, minutes, and seconds) 84 deg. 30 min. 42 sec.		
3. Responsible official's name Joseph R. Bynum	Phone number with area code (423) 751-2601		
4. Manager's or Operator's name Nathan W. Burris	Phone number with area code (423) 717-2500		
5. a. Landowner's name Tennessee Valley Authority	Phone number with area code (423) 751-2601		
b. Mailing address 1101 Market Street LP-3K	City Chattanooga	State TN	Zip Code 37402
6. a. Zoning authority's name Roane Count Zoning Officer	Current zoning status 1-3 Heavy Industrial	Phone number with area code (423) 376-5578	
b. Mailing address P.O. Box 643	City Kingston	State TN	Zip Code 37763

7. Type of facility:
☐ Class I X Class II ☐ Class III ☐ Class IV ☐ Class V ☐ Class VI

8. Site acreage 255.5 Approved by County (Jackson Bill) N/A
Fill acreage 122.5 Approved by Solid Waste Planning Chairman N/A

9. Type(s) of waste handled:
☐ Municipal X Industrial ☐ Commercial ☐ Demolition ☐ Medical ☐ Yard waste
☐ Other Coal Ash

10. Amount of waste handled:
Weight 813 tons/day Volume 744 cubic yards/day

11. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information.

Date 6/29/99 Signature of Responsible Official [signature]

Official Title Exec. Vice President, Fossil Power Group

Signature of Notary Cherry P. Griffith

(Notary Seal) Date Commission Expires September 21, 1999

12. Date ______ Signature of Landowner ______

CN-1036 (continued on reverse) RDA 2202

-10-098464 / 7-8-99 / # 6,000.00 / 4712-2013-7039

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Solid Waste Management
5th Floor, L & C Tower
401 Church Street
Nashville, Tennessee 37243-1535
615-532-0780

June 19, 2000

Mr. Joseph R. Bynum, Vice President
Fossil Power Group
Tennessee Valley Authority – Kingston Fossil Plant
714 Swan Road
Harriman, TN 37748

RE: Proposed TVA – Kingston Facility, IDL 73-0094

Enclosed for your information is a copy of the Public Notice on the referenced facility.

We have also requested the Notice be published on June 23, 2000, in The Roane County News and in the June 27, 2000, edition of The Harriman Record and The Rockwood Times.

If you have any questions or comments concerning the conditions, please contact our Division of Solid Waste Management, Knoxville Environmental Assistance Center, 2700 Middlebrook Pike, Suite 220, Knoxville, TN 37921-5602; telephone: 865-594-6035.

Thank you very much for your cooperation.

Sincerely,

David Moses

David Moses, Chief
Permit Administration
Division of Solid Waste Management

DBM/mjs PUB8

Enclosure

cc: Jack Crabtree, DSWM, Knoxville Environmental Assistance Center

FACT SHEET
Tennessee Valley Authority
Kingston Fossil Plant
Ash Pond Area
Vertical Expansion

The Tennessee Valley Authority (TVA) Fossil Fuel Plant located in Kingston, Tennessee, submitted a closure/post-closure plan for its ash pond area in September of 1995. The facility is located at the base of a peninsula formed by the Clinch and Emory River embayments of Watts Bar Lake about 2.7 miles above the confluence of the Clinch and Tennessee Rivers in Roane County, Tennessee (Latitude =35° 50' 32" North, Longitude = 84° 30' 40" West). The area consists of approximately 250 acres and is accessed by a private road from the TVA site.

The Tennessee Valley Authority (Kingston) Fossil Fuel Plant submitted a closure/post-closure plan for the area in September of 1995, which included a projected closure date of 2015. Currently, TVA is seeking approval for a vertical expansion over its current footprint.

OPERATION RESPONSIBILITY

The Tennessee Valley Authority operates this facility.

Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, TN 37763
(423) 945-7212

The plant manager is the responsible official, and is the primary contact for all inquiries conceming site.

DRAFT

State of Tennessee
Department of Environment
and Conservation
Division of Solid Waste Management

Solid Waste Management Program
401 Church Street
5th Floor L & C Tower
Nashville, Tennessee 37243-1535
615-532-0780

REGISTRATION AUTHORIZING SOLID WASTE DISPOSAL ACTIVITIES IN TENNESSEE

Registration Number: IDL 73-0094

Date Issued: ______________________

Issued to: Issued to TVA, Kingston Fossil Plant (KIF) for a facility located at the base of a peninsula formed by the Clinch and Emory River embayments of Watt's Bar Lake about 2.7 miles above the confluence of the Clinch and Tennessee River in Roane County.

Activities Authorized: Disposal of fly ash and bottom ash generated from burning coal from the TVA's Kingston Steam Plant in a Class II Landfill.

By my signature this registration is issued in compliance with the provisions of the Tennessee Solid Waste Disposal Act (Tennessee Code Annotated, Section 68-211-101, et seq.), and applicable regulations developed pursuant to this law and in effect; and in accordance with the conditions and other terms set forth in this registration document and attached Registration Conditions.

____
Mike Apple, Director
Division of Solid Waste Management

JMA/DBM/mjs PER1

DRAFT

Registration Number IDL 73-0094

PERMIT TERMS AND CONDITIONS

1. Recertification by Permittee for Facilities Whose Initial Operation is Delayed - If the facility does not initiate construction and/or operation within one year of the date of this permit, the permittee must recertify the application in accordance with Rule 1200-1-7-.02(2)(e).

2. Duty to Comply - The permittee must comply with all conditions of this permit, unless otherwise authorized by the Department. Any permit noncompliance, except as otherwise authorized by the Department, constitutes a violation of the Act and is grounds for enforcement action, or for permit termination, revocation and reissuance, or modification.

3. Need to Halt or Reduce Activity Not a Defense - It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

4. Duty to Mitigate - In the event of noncompliance with the permit, the permittee shall take all reasonable steps to minimize releases to the environment, and shall carry out such measures as are reasonable to prevent adverse impacts on human health or the environment.

5. Proper Operation and Maintenance - The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

6. Permit Actions - This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any existing permit condition.

7. Property Rights - This permit does not convey any property rights of any sort, or any exclusive privilege.

8. Duty to Provide Information - The permittee shall furnish to the Commissioner, within a reasonable time, any relevant information which the Commissioner may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Commissioner, upon request, copies required to be kept by this permit.

9. Inspection and Entry - The permittee shall allow the Commissioner, or an authorized representative, to:

   (i) Enter at any reasonable time the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

(ii) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

(iii) Inspect at any reasonable time any facilities, equipment (including monitoring and control equipment), practices or operations regulated or required under this permit (Note: If requested by the permittee at the time or sampling, the Commissioner shall split with the permittee any samples taken.);

(iv) Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Act any substances or parameters at any location; and

(v) Make photographs for the purpose of documenting items of compliance or noncompliance at waste management units, or where appropriate to protect legitimate proprietary interests, require the permittee to make such photos for the Commissioner.

10. Monitoring and Records

(i) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

(ii) The permittee shall retain records of all required monitoring information. The permittee shall maintain records for all ground-water monitoring wells and associated ground-water surface elevations, for the active life of the facility, and for the post-closure care period as well. This period may be extended by request of the Commissioner at any time.

(iii) Records of monitoring information shall include:

(I) The date, exact place, and time of sampling or measurements;

(II) The individual(s) who performed the sampling or measurements;

(III) The date(s) analyses were performed;

(IV) The individual(s) who performed the analyses;

(V) The analytical techniques or methods used (including equipment used); and

(VI) The results of such analyses.

11. Reporting Requirements

(i) The permittee shall give notice to the Commissioner as soon as possible of any planned physical alterations or additions to the permitted facility.

DRAFT

(ii) Monitoring results shall be reported at the intervals specified elsewhere in this permit.

(iii) The permittee shall report orally within 24 hours from the time the permittee becomes aware of the circumstances of any release, discharge, fire, or explosion from the permitted solid waste facility which could threaten the environment or human health outside the facility. Such report shall be made to the Tennessee Emergency Management Agency, using 24-hour toll-free number 1-800-262-3300.

(iv) Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Commissioner, it shall promptly submit such facts or information.

12. Periodic Survey

(i) Within 60 days of his receipt of the written request of the Commissioner to do so, the permittee shall cause to be conducted a survey of active and/or closed portions of his facility in order to determine if operations (e.g., cut and fill boundaries, grades) are being conducted in accordance with the approved design and operational plans. The permittee must report the results of such survey to the Commissioner within 90 days of his receipt of the Commissioner's request.

(ii) The Commissioner may request such a survey:

(I) If he has reason to believe that operations are being conducted in a manner that significantly deviates from the approved plans; and/or

(II) As a periodic verification (but no more than annually) that operations are being conducted in accordance with the approved plans.

(iii) Any survey performed pursuant to this part must be performed by a qualified land surveyor duly authorized under Tennessee law to conduct such activities.

13. Duration of Permits - This permit shall be effective for the operating life of the facility.

14. Effect of Permit - The issuance of this permit does not authorize the permittee to injure persons or property or to invade other private rights, or to violate any local law or regulations.

15. Transfer, Modification, Revocation and Reissuance, and Termination of Permits - This permit may be transferred, modified, revocated or reissued, or terminated as set forth in 1200-1-7-.02(5)3(b).

16. Applicable Standards - All applicable facility standards of Rule Chapter 1200-1-7, Solid Waste Processing and Disposal Amendments shall be considered conditions of this registration.

DRAFT

17. Penalties - Any violation of the conditions or other terms of this registration may subject the registrant to the penalties set forth in Tennessee Code Annotated Section 68-211-114 and 68-211-117.

18. Hazardous Waste Restriction - No hazardous waste, as regulated by the Tennessee Hazardous Waste Management Act (TCA Section 68-212-101, et seq.), and the Rules adopted pursuant to that Act, shall be accepted at this facility.

19. Construction and Operation - The permittee shall construct and operate the facility in accordance with the approved engineering plans and operations manual which becomes a condition of this permit in Attachment I.

20. Financial Assurance - Prior to beginning operation, the permittee must file a Financial Assurance Instrument in accordance with Rule 1200-1-7-.03(1).

21. Special Waste - Except as specifically provided for in the Facility-Specific Conditions of this permit, the permittee may not accept for disposal any special waste unless approved to do so in writing by this Department.

22. Automobile Batteries - This facility is specifically prohibited from accepting automobile batteries for disposal.

PER2

DRAFT

Registration Number IDL 73-0094

VARIANCES AND WAIVERS

The following variances or waivers from standards or requirements in Rule 1200-1-7, Solid Waste Processing and Disposal Amendments, are hereby granted in accordance with Rule 1200-1-7-.01(5):

1. No geologic buffer between the fill material and the ash pond will be required. Rule 1200-1-7-.04(4)(b)

2. No leachate migration control system will be required. Rule 1200-1-7.04(4)

3. No gas migration control system will be required. Rule 1200-1-7-.04(5)

4. No random inspection program will be required. Rule 1200-1-7-.04(2)(s)

5. No daily or intermediate cover will be required for the ash fill area. Rule 1200-1-7-.04(6)

DRAFT

Registration Number IDL 73-0094

FACILITY-SPECIFIC PERMIT CONDITIONS

The following conditions of this permit are established pursuant to Rule 1200-1-7-.02(4)(b):

1. During the post closure period, but no later than three years after final closure, TVA must submit a report to the Division characterizing the nature of ground water mounding beneath the ash disposal area.

2. The permittee shall close the facility in accordance with the approved closure and post closure plan which becomes a condition of this permit.

C:permits/73-0094 idl.doc

Tennessee: Sounds Good To Me

TDEC

Department of Environment and Conservation

NOTICE OF RECEIPT OF A PERMIT APPLICATION FOR A SOLID WASTE DISPOSAL FACILITY

Mr. Joseph R. Bynum, Executive Vice President, Fossil Power Group, Tennessee Valley Authority (TVA), has applied to the Tennessee Department of Environment and Conservation's Division of Solid Waste Management (DSWM) for a solid waste disposal facility permit to construct and operate a Class II landfill. The facility would be located at 714 Swan Pond Road. The type of waste material that would be accepted would include fly ash and bottom ash generated from burning coal and would also serve as closure for the existing ash pond.

Under State law, TVA must obtain a permit before it can begin operating the facility. DSWM has received a Part I Permit Application indicating the applicant's desire to operate a Class II landfill facility at the described location.

A complete permit application consists of both a Part I and a Part II as described in Regulations Governing Solid Waste Processing and Disposal Facilities in Tennessee (Rule 1200-1-7-.02(2)(d)). Upon receipt of a complete Part I and Part II application, DSWM will do an in-depth review to determine if the application meets the technical standards of the Regulations (Rule Chapter 1200-1-7-.02(2)(d), Solid Waste Processing and Disposal). Once the technical review is finished, DSWM will then make a tentative decision to either grant or deny the permit and issue a public notice of such decision. This second notice will provide the public at least 45 days to submit written comments on the proposed action and to request a public hearing (a public hearing may be announced in this second notice if there is already significant public interest). If there is a significant degree of public interest found following the publication of this second notice, a public hearing will be scheduled, and a public notice issued at least 15 days before the hearing. After considering all comments received, the DSWM Director shall issue a final permit decision and a response to comments.

Further information on this matter may be obtained by contacting the Division of Solid Waste Management, Knoxville Environmental Assistance Center, 2700 Middlebrook Pike, Suite 220, Knoxville, TN 37921-5602, telephone: 423-594-6035 or Mr. Joseph R. Bynum, Executive Vice President, Fossil Power Group, telephone: 423-751-2601. Hearing impaired callers may use the Tennessee Relay Service (1-800-848-0298).

The Tennessee Department of Environment and Conservation is committed to principles of equal opportunity equal access, and affirmative action. Contact the Tennessee Department of Environment and Conservation EEO/AA Coordinator, 615-532-0103 or the ADA Coordinator, Isaac Okoreeh-Baah, 615-532-0059, for further information.

Persons who wish to be on DSWM's mailing list should request a Mailing List Request form by calling or writing: Public Participation Officer; Division of Solid Waste Management; Tennessee Department of Environment and Conservation; 5th Floor, L & C Tower; 401 Church Street; Nashville, TN 37243-1535, telephone: 615-532-0780.

NOTICE ISSUED: August 9, 1999

Updated July 30, 1999; Send comments to Department of Environment and Conservation.

Tennessee Home | TDEC Home | Service Index | Search | Guest Book dwn

June 29, 1999

Mr. Tom Tiesler , Director
Division of Solid Waste Management
5th Floor L&C Tower
401 Church Street
Nashville, Tennessee 37243

Dear Mr. Tiesler:

TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - PART I APPLICATION AND REVIEW FEE PAYMENT

Enclosed are an original and two copies of the Part 1 application and a check for $6000 for the review fee for a Class II disposal facility at KIF. TVA originally submitted a Closure/Post Closure Plan for the facility. After a review by the Division of Solid Waste Management's central office, it was determined that the facility needs a Class II permit. The division also determined that the Hyro-Geo submitted for the Closure/Post Closure would "suffice in lieu of a formal hydrogeologic report" and that the closure plan "may also suffice for the construction and operation plans."

If you have any questions or need additional information please call Dave Robinson at (423) 751-2502 or John Myers at (423) 751-8855.

Janet K Watts
Manager of Environmental Affairs
5D Lookout Place

JWM:DWR:AJH
Enclosures
cc: (Enclosures):

Mr. Jack Crabtree
Knoxville Field Operations
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

N. W. Burris, Kingston
J. M. Loney, WT 8C-K
R. L. Pope, Kingston
B. B. Walton, ET 10A-K (w/o Enclosures)
EDMS, WR 4Q-C

Q:\ENVAFF\SLDWASTE\GENERAL\KIF PART 1 APPLICATION AND REVIEW FEE.DOC

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

June 29, 1999

Mr. Tom Tiesler , Director
Division of Solid Waste Management
5th Floor L&C Tower
401 Church Street
Nashville, Tennessee 37243

Dear Mr. Tiesler:
TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - PART I APPLICATION AND REVIEW FEE PAYMENT

Enclosed are an original and two copies of the Part 1 application and a check for $6000 for the review fee for a Class II disposal facility at KIF. TVA originally submitted a Closure/Post Closure Plan for the facility. After a review by the Division of Solid Waste Management's central office, it was determined that the facility needs a Class II permit. The division also determined that the Hyro-Geo submitted for the Closure/Post Closure would "suffice in lieu of a formal hydrogeologic report" and that the closure plan "may also suffice for the construction and operation plans."

If you have any questions or need additional information please call Dave Robinson at (423) 751-2502 or John Myers at (423) 751-8855.

John W Myers for
Janet K Watts
Manager of Environmental Affairs
5D Lookout Place

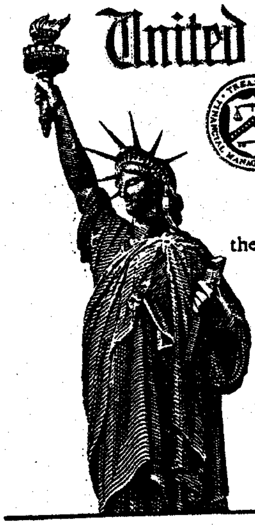
Enclosures
cc: (Enclosures):
Mr. Jack Crabtree
Knoxville Field Operations
Division of Solid Waste Management
Tennessee Department of Environment and Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Review/Concurrence Sheet

Subject: PART 1 - SOLID WASTE APPLICATION FOR KINGSTON FOSSIL PLANT			
Originating Organization	Environmental Affairs		
Document Prepared By	Dave Robinson		
RIMS No.(Optional)		Date 6/23/99	CTS Number
File No.		DUE DATE:	

CONCURRENCES		
Name	Signature - Comment	Date
Dave Robinson	[signature]	6-23-99
John W. Myers	John W Myers	6/24/99
Janet K. Watts	John W Myers for	6/24/99

concur.doc



United States Treasury 15-51/000

TENNESSEE VALLEY AUTHORITY
KNOXVILLE, TN

4912-80137039
Check No.

06/15/99

$6,000AND000/100

Pay to the order of

TREASURER, STATE OF TENNESSEE
XX
KNOXVILLE TN 37901

$*******6000*00

VOID AFTER ONE YEAR

TENNESSEE VALLEY AUTHORITY
TVA [signature] TVA
DISBURSING OFFICER

⑈49126⑈ ⑆000000518⑆ 80137039⑈

INQUIRY SHOULD INCLUDE COPY OF THIS FORM

TVA 8262 (FD-6-82)

REMITTANCE INFORMATION FROM TENNESSEE VALLEY AUTHORITY TO:

VENDOR: TREASURER, STATE OF TENNESSEE
XX
KNOXVILLE TN 37901

DATE 06/15/99
TVA CONTRACT NO. 0000000000
TVA D.O. NO.
TVA VO. NO. 00080137039
AMOUNT REMITTED 6000.00

INVOICE NUMBER	INVOICE DATE	INVOICE AMOUNT	DISCOUNT	REFERENCE	ADJUSTMENT
PO NUMBER: PD MSC 0367061199 SOLID WASTE ANNUAL PERMIT FEE KINGSTON F P		REL: 6000.00	0.00	*	0.00
*NOTE - THIS INVOICE HAS AN EXTERNAL ATTACHMENT ***********					

* Discount Taken

SOLID WASTE PART I APPLICATION

Tennessee Department of Environment and Conservation
Division of Solid Waste Management

1. a. Facility's full, legal name: Tennessee Valley Authority Kingston Fossil Plant | Official use only

b. Mailing address	City	State	Zip Code
714 Swan Pond Road	Harriman	TN	37748

2. a. Physical location or address of facility	County
714 Swan Pond Road	Roane

b. Latitude (degrees, minutes, and seconds)	Longitude (degrees, minutes, and seconds)
35 deg. 54 min. 40 sec.	84 deg. 30 min. 42 sec.

3. Responsible official's name	Phone number with area code
Joseph R. Bynum	(423) 751-2601

4. Manager's or Operator's name	Phone number with area code
Nathan W. Burris	(423) 717-2500

5. a. Landowner's name	Phone number with area code
Tennessee Valley Authority	(423) 751-2601

b. Mailing address	City	State	Zip Code
1101 Market Street LP-3K	Chattanooga	TN	37402

6. a. Zoning authority's name	Current zoning status	Phone number with area code
Roane Count Zoning Officer	1-3 Heavy Industrial	(423) 376-5578

b. Mailing address	City	State	Zip Code
P.O. Box 643	Kingston	TN	37763

7. Type of facility:
☐ Class I X Class II ☐ Class III ☐ Class IV ☐ Class V ☐ Class VI

8. Site acreage 255.5 Approved by County (Jackson Bill) N/A
Fill acreage 122.5 Approved by Solid Waste Planning Chairman N/A

9. Type(s) of waste handled:
☐ Municipal X Industrial ☐ Commercial ☐ Demolition ☐ Medical ☐ Yard waste

☐ Other Coal Ash

10. Amount of waste handled:
Weight 813 tons/day Volume 744 cubic yards/day

11. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information.

Date 6/29/99 Signature of Responsible Official Joseph R Bynum

Official Title Exec. Vice President, Fossil Power Group

Signature of Notary Cherry P. Griffith

(Notary Seal) Date Commission Expires September 21, 1999

12. Date ______ Signature of Landowner ______

CN-1036 (continued on reverse) RDA 2202

KIF ASH DREDGE CELL DISPOSAL AREA ACTIVITY OBJECTIVES

The Tennessee Division of Solid Waste Management (DSWM)suggested that TVA should file a Closure/Post Closure Plan for the dredge cells operations at KIF. This type of plan is in accordance with the division regulations for the operation of a class VI disposal facility (surface impoundment's used for disposal of solid waste) where the ash pond is regulated under a National Pollution Discharge Elimination System (NPDES) Permit.

After technical approval of the plan by the Knoxville Field Office (KFO) the Closure/Post Closure plan was submitted by the KFO to the DSWM Central Office for final approval. During the final approval process the Central Office determined that the site should have a Class II facility permit rather than a Closure/Post Closure Plan for a class VI facility. The KFO responds to TVA that we need to submit a Part 1 Application and a check for the review of the application. They made a determination that the Closure/Post Closure contains sufficient information for a permit for the facility.

TVA does not wish to argue the point that this facility should be classified as a class VI facility because of the nature of the dredging could be construed as a solid waste activity and certainly the shape of the dredged cells look as if they are a disposal facility. After completion of the permitting at KIF then a permit will be applied for BRF pond 2A. The nature of handling bottom ash with track hoes and truck is defiantly with in the realm of solid waste activities and a class II permit will be applied for.

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

September 14, 1998

Mr. Nathan Burris, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

RE: Permitting requirements for TVA Kingston Fossil Plant Ash Pond Area

Dear Mr. Burris:

The closure and post-closure plans for this facility, as submitted to our office by Ms. Janet Watts of TVA's Technology and Regulatory Integration Section in Chattanooga, on August 10, 1998, were reviewed by the Permit Review Committee of the Division of Solid Waste Management's Nashville Central Office on September 3, 1998. The Permit Review Committee agreed that the closure/post-closure plan is satisfactory, but they also determined that since the facility is being constructed by raising dikes above grade and placing dredged material there, it is actually a landfill and requires a permit as such.

Existing hydrogeologic information was reviewed by geologist Larry Cook of this office and it was determined that the existing information will suffice in lieu of a formal hydrogeologic report.

You will need to file a "Part I" permit application with the review fee of $6000.00 in order to initiate the permitting process. Since the closure plan describes the operation and the stages of construction, it may also suffice for the construction and operation plans.

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SEP 17 1998
Environmental Affairs

If you should have any questions concerning this matter, do not hesitate to contact me.

Yours truly,

Rick Brown
Environmental Engineer
Division of Solid Waste Management

RSB a:\tvaknpr.doc

cc: Nashville Office - Division of Solid Waste Management
Ms. Janet K. Watts, Tennessee Valley Authority

9/18/98--JKW
cc: N. W. Burris, Kingston
J. M. Loney, WT 8C-K

dwr

August 28, 1998

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Department of Environment and Conservation
700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - CLOSURE/POST CLOSURE PLAN FOR ASH POND DISPOSAL AREA - ADDITIONAL COPIES OF PLANS AND VEGETATION CLARIFICATION

Enclosed are the two requested additional complete copies of the above-mentioned plan. The question raised concerning the propagation of Sericea lespedeza was previously addressed in Notes 6 and 12 on Drawing 10W425-2. These notes refer to seed mixtures in Appendix A, which designates seed mixtures Type 6 Mixture 9 (page 580-5) for spring applications and Type 8 Mixture 3 (page 580-6) for fall applications. Neither of these mixtures include Sericea lespedeza.

If you have any questions or concerns please call Dave Robinson at (423) 751-2502 or John Myers at (423) 751-8855.

Janet K. Watts
Manager of Advanced Production
Technology and Regulatory Integration
5D Lookout Place

JWM:DWR:SGC
Enclosures
cc (Enclosure):

N. W. Burris, KFP 1A-KST
J. M. Loney, WT 8C-K
B. B. Walton, ET 10A-K (w/o Enclosure)
EDMS, WR 4Q-C (enclosure on file in APT&RI)

Q:\ENVAFF\SLDWASTE\GENERAL\DWR\KIFCLOSPLAN 8-28-8

TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2881

August 28, 1998

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Department of Environment and Conservation
700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - CLOSURE/POST CLOSURE PLAN FOR ASH POND DISPOSAL AREA - ADDITIONAL COPIES OF PLANS AND VEGETATION CLARIFICATION

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John W. Myers for

Janet K. Watts
Manager of Advanced Production
Technology and Regulatory Integration
5D Lookout Place

Enclosures

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

from
RAH
DWR

August 12, 1998

Mr. Nathan Burris, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

RE: Closure and post-closure plans for TVA Kingston Fossil Plant Ash Pond Area (not permitted)

Dear Mr. Burris:

The revised closure and post-closure plans for this facility, as submitted to our office by Ms. Janet Watts of TVA's Technology and Regulatory Integration Section in Chattanooga, on August 10, 1998, have been reviewed in accordance with Rule Chapter 1200-1-7, Solid Waste Processing and Disposal. Specifically this review is based on the closure/post-closure plan content requirements of Rule 1200-1-7-.03(2)(c), and the closure and post-closure standards of Rule 1200-1-7-.04(8). This plan is basically in accordance with our previous recommendations. However, one item which we thought was agreed upon previously is the removal of sericea lespedeza from the vegetation specifications. We request that the page which addresses "vegetative cover" be amended to clarify this matter. Otherwise, this plan meets the regulatory requirements and is tentatively approved by the Knoxville Office.

We also need two(2) binders with the appencices which were not affected by this resubmittal, because we only have one binder and one copy of the original material. When we receive the additional binders, we will make two more complete sets of these plans so that the additional copies

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AUG 14 1998
Environmental Affairs

can be sent to our Nashville Office for their review. If they agree that the plan is complete, they will return one approved copy to you with the final approval letter.

If you should have any questions concerning this review, do not hesitate to contact me.

Yours truly,

Rick Brown
Environmental Engineer
Division of Solid Waste Management

RSB a:\tvakcla.doc

cc: Nashville Office - Division of Solid Waste Management
[illegible] Janet K. Watts, Tennessee Valley Authority

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

September 14, 1998

Mr. Nathan Burris, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

RE: Permitting requirements for TVA Kingston Fossil Plant
Ash Pond Area

Dear Mr. Burris:

The closure and post-closure plans for this facility, as submitted to our office by Ms. Janet Watts of TVA's Technology and Regulatory Integration Section in Chattanooga, on August 10, 1998, were reviewed by the Permit Review Committee of the Division of Solid Waste Management's Nashville Central Office on September 3, 1998. The Permit Review Committee agreed that the closure/post-closure plan is satisfactory, but they also determined that since the facility is being constructed by raising dikes above grade and placing dredged material there, it is actually a landfill and requires a permit as such.

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You will need to file a "Part I" permit application with the review fee of $6000.00 in order to initiate the permitting process. Since the closure plan describes the operation and the stages of construction, it may also suffice for the construction and operation plans.

RECEIVED
SEP 17 1998
Environmental Affairs

dwr

August 28, 1998

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Department of Environment and Conservation
700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - CLOSURE/POST CLOSURE PLAN FOR ASH POND DISPOAL AREA - ADDITIONAL COPIES OF PLANS AND VEGETATION CLAIRFICATION

Enclosed are the two requested additional complete copies of the above-mentioned plan. The question raised concerning the propagation of Sericea lespedeza was previously addressed in Notes 6 and 12 on Drawing 10W425-2. These notes refer to seed mixtures in Appendix A, which designates seed mixtures Type 6 Mixture 9 (page 580-5) for spring applications and Type 8 Mixture 3 (page 580-6) for fall applications. Neither of these mixtures include Sericea lespedeza.

If you have any questions or concerns please call Dave Robinson at (423) 751-2502 or John Myers at (423) 751-8855.

Janet K. Watts
Manager of Advanced Production
Technology and Regulatory Integration
5D Lookout Place

JWM:DWR:SGC
Enclosures
cc (Enclosure):

N. W. Burris, KFP 1A-KST
J. M. Loney, WT 8C-K
B. B. Walton, ET 10A-K (w/o Enclosure)
EDMS, WR 4Q-C

Q:\ENVAFF\SLDWASTE\GENERAL\DWR\KIFCLOSPLAN 8-28-8

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2881

August 28, 1998

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Department of Environment and Conservation
700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - CLOSURE/POST CLOSURE PLAN FOR ASH POND DISPOAL AREA - ADDITIONAL COPIES OF PLANS AND VEGETATION CLAIRFICATION

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John W Myers for

Janet K. Watts
Manager of Advanced Production
Technology and Regulatory Integration
5D Lookout Place

Enclosures

FILE COPY

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

September 12, 1997

Mr. Randy M. Cole, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

RE: Closure/Post-Closure Plan for ash pond disposal area

Dear Mr. Cole:

We have reviewed the letter from Ms. Janet K. Watts of TVA's Chattanooga Office concerning the November 18, 1996, revisions to the closure-post closure plan for the ash pond disposal area at Kingston Fossil Plant, in which she defends using a single GCL membrane cap over a fly ash base, which we previously rejected.

Some of her arguments have merit. We agree that fly ash would probably have few if any large, sharp pieces which would damage a GCL. However, the likelihood of material and/or installation imperfections still dictates that the cap should not solely rely on a single fabric.

Also, we agree that ash which was originally wet-sluiced as it has been at Kingston would likely have a high enough moisture content so that dessication of the GCL would not be a concern. (We think it would be a concern with dry-stacked ash).

However, we disagree that the ash itself has a sufficiently low permeability to be considered a cap component. The permeability in the 10^{-5} range agrees with other reports that we have seen for compacted ash. However, we have never suggested in any previous correspondence that $1x10^{-5}$ cm/sec would be an acceptable permeability for the cap. Our guidance for new coal ash fills does not specify the permeability of the cap, but the permeability of the natural or constructed 3-foot soil buffer is specified at 1×10^{-6} cm/sec. The permeability of the cap should not be greater than that of the underlying soil buffer. In this situation where the existing fill was placed without a permit on existing soils with unknown characteristics, the cap should meet current standards because this is the only environmental improvement that can be made at this stage of the site development.

To summarize, we stand by our original recommendation that at least 1 foot of clay compacted to a maximum permeability of 1×10^{-6} cm/sec be placed below a GCL membrane. If you wish to discuss this matter further, do not hesitate to contact me.

Yours truly,

Rick Brown

Rick Brown
Environmental Engineeer
Division of Solid Waste Management

RSB a:\tvaknc3.doc

cc: DSWM-Nashville Central Office

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
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September 12, 1997

Mr. Randy M. Cole, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

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Rick Brown

Rick Brown
Environmental Engineeer
Division of Solid Waste Management

RSB a:\tvaknc3.doc

cc: DSWM-Nashville Central Office

DWR

A60 970902 051

September 8, 1997

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Department of Environment and Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - CLOSURE/POST-CLOSURE PLAN FOR ASH POND DISPOSAL AREA - SECOND ALTERNATIVE FOR CAP

This letter is in response to your letter concerning the use of a bentonite-impregnated fabric without a soil component in the cap.

We recognize the need for a "cushion" underneath a geosynthetic clay liner (GCL) cap component in a typical waste landfill where there is a high probability that random shards of waste material would puncture the membrane. In our facility at KIF, the enclosed material is made up uniformly of coal ash with almost no debris that could puncture a GCL material placed directly on the ash fill. We see the probability of such a puncture as very unlikely.

Your letter expressed concerns that placement of a GCL directly in contact with the ash material could cause the bentonite to dry out and desiccate rendering it less effective. We do not anticipate that happening. The vast majority of the material placed within the disposal area is fly ash. Field experiments and analyses conducted by TVA indicate that fly ash exhibits an ability to store water. Moreover, when there is a barrier placed that blocks the vertical evaporation of water, there is a tendency to redistribute the moisture within the stack consistent with its particle size distribution (silt).

Furthermore, during placement of the final layer of ash, roller compaction will be employed in the same manner as construction control for soil with testing for both density and moisture content, thus it will have no more ability to desiccate than soil. In the consideration of such a low probability of a failure in the GCL, we believe the underlying clay liner component of a synthetic cap is not necessary in this application.

Enclosed are copies of laboratory test results on fly ash at KIF. These test show that when compacted to maximum dry density the hydraulic conductivity very nearly approaches your standard requirement of 1 E-5. If rolled fly ash can meet the manufacturer's specification for surface preparation, then there is minimal benefit to importing clay to place under the synthetic cap. We see this as an excellent use of coal combustion by-products in an environmental application.

We would be happy to discuss this issue further. There may be other economic and innovative possibilities that we could jointly explore. For more information, questions, or comments, please call Dave Robinson at (423) 751-2502 or John Myers at (423) 751-8855.

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

JWM:DWR:SGC
Enclosures
cc (Enclosures):
N. W. Burris, Kingston
J. M. Loney, WT 8C-K
B. B. Walton, ET 10A-K (w/o Enclosure)
RIMS, WR 4Q-C

Q:\ENVAFF\SLIDWSTLE\DWR\KIF CP-CPLAN 9-2

HYDRAULIC CONDUCTIVITY

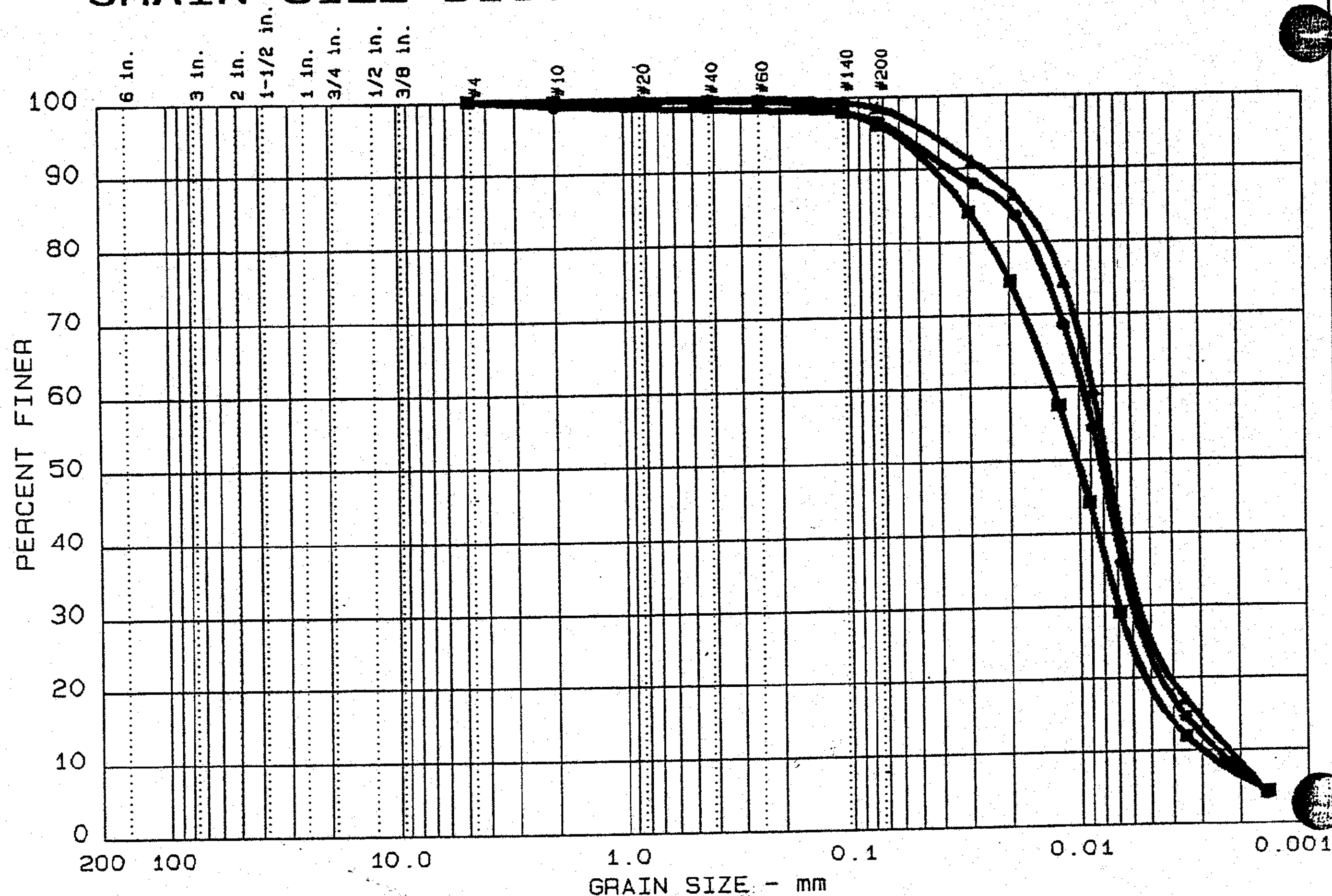
LAW ENGINEERING

Project No.	*5810860101*	Tested By	*HEJ*
Project Name	*TVA - Kingston*	Test Date	*06/12/95*
Material (Source)	*Ponded Fly Ash (Cell III)*	Reviewed By	*RLB*
		Review Date	*09/06/95*

ASTM D5084 - Falling Head

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*24.1*
Wet Unit Weight, pcf:	*94.6*
Dry Unit Weight, pcf:	*76.2*
Compaction, %:	*94.1*
Hydraulic Conductivity, cm/sec. @20 °C:	***3.4E-05***

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	15	0.0	0.0	3.5	73.9	22.6
▲	16	0.0	0.0	1.7	73.3	25.0
■	17	0.0	0.0	3.9	77.7	18.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP			0.01	0.006	0.0036	0.0025	1.48	3.8
▲	NL	NP			0.01	0.006	0.0031	0.0022	1.65	3.9
■	NL	NP			0.01	0.007	0.0042	0.0030	1.25	4.4

MATERIAL DESCRIPTION	USCS	AASHTO
● Cell III	ML	A-4(0.0)
▲ Cell III	ML	A-4(0.0)
■ Cell III	ML	A-4(0.0)

Project No.: 5810860101
Project: TVA - Kingston
● Location: Ponded Fly Ash A & B
▲ Location: Ponded Fly Ash C & D
■ Location: Ponded Fly Ash E & F
Date: July 18, 1995

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Remarks:
Tested by: JCR
Reviewed by: NS

Figure No.

HYDRAULIC CONDUCTIVITY

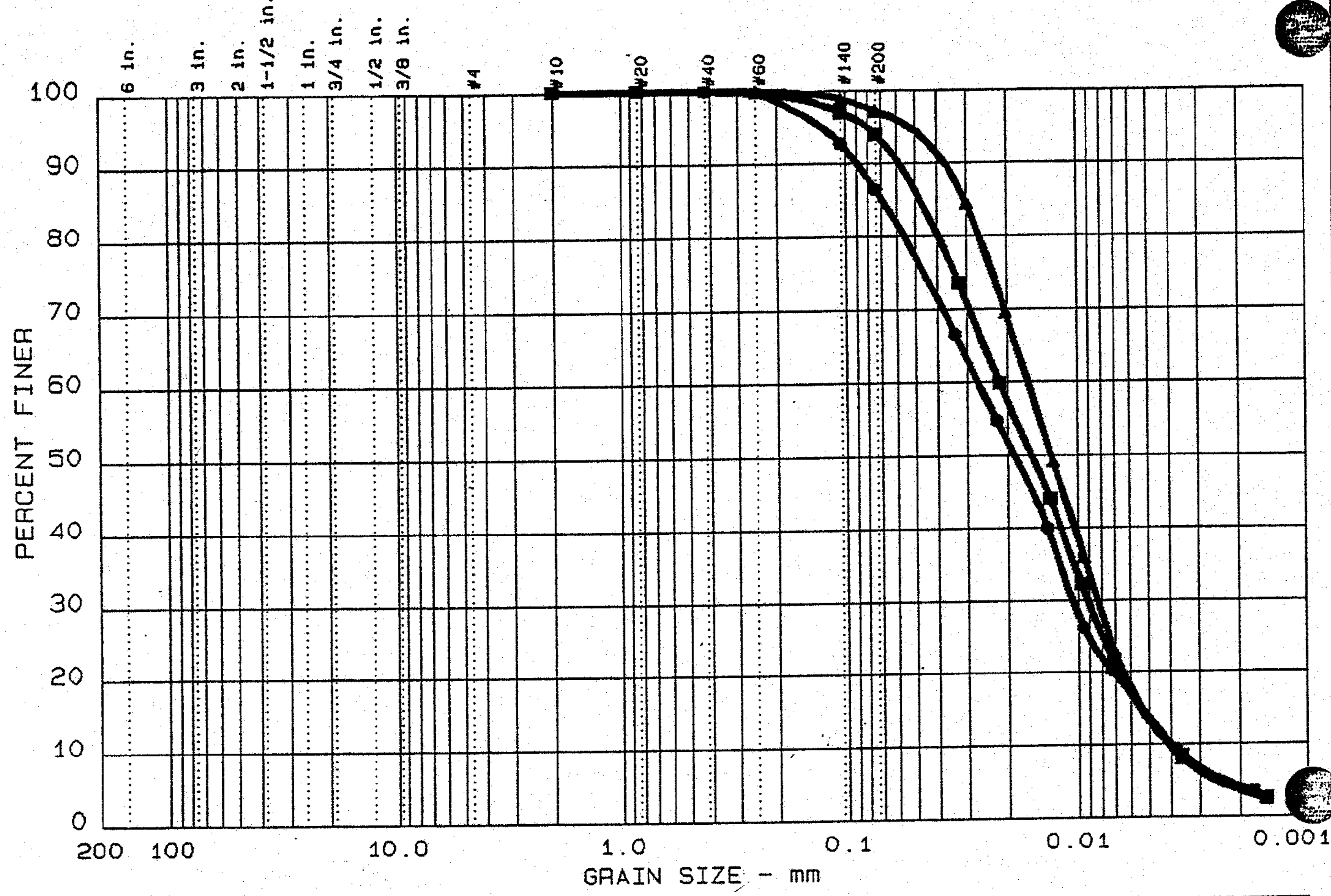
LAW ENGINEERING

Project No.	*5810860101*	Tested By	*HEJ*
Project Name	*TVA - Kingston*	Test Date	*06/12/95*
Material (Source)	*Ponded Fly Ash (Cell I)*	Reviewed By	*RLB*
		Review Date	*09/06/95*

ASTM D5084 - Falling Head

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*23.2*
Wet Unit Weight, pcf:	*95.8*
Dry Unit Weight, pcf:	*77.8*
Compaction, %:	*96.0*
Hydraulic Conductivity, cm/sec. @20 °C:	***8.3E-05***

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	0.0	13.6	72.8	13.6
▲	13	0.0	0.0	2.9	83.9	13.2
■	14	0.0	0.0	6.0	80.9	13.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP			0.02	0.011	0.0054	0.0040	1.07	6.8
▲	NL	NP			0.01	0.008	0.0054	0.0042	1.01	3.9
■	NL	NP			0.02	0.009	0.0055	0.0041	0.95	5.3

MATERIAL DESCRIPTION	USCS	AASHTO
● Cell I	ML	A-4 (0.0)
▲ Cell I	ML	A-4 (0.0)
■ Cell I	ML	A-4 (0.0)

Project No.: 5810860101
Project: TVA - Kingston
● Location: Ponded Fly Ash A & B
▲ Location: Ponded Fly Ash C & D
■ Location: Ponded Fly Ash E & F
Date: July 18, 1995

Remarks:
Tested by: JCR
Reviewed by: HD

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

September 8, 1997

Mr. Rick Brown
Environmental Engineer
Division of Solid Waste Management
Department of Environment and Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY (TVA) - KINGSTON FOSSIL PLANT (KIF) - CLOSURE/POST-CLOSURE PLAN FOR ASH POND DISPOSAL AREA - SECOND ALTERNATIVE FOR CAP

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Your letter expressed concerns that placement of a GCL directly in contact with the ash material could cause the bentonite to dry out and desiccate rendering it less effective. We do not anticipate that happening. The vast majority of the material placed within the disposal area is fly ash. Field experiments and analyses conducted by TVA indicate that fly ash exhibits an ability to store water. Moreover, when there is a barrier placed that blocks the vertical evaporation of water, there is a tendency to redistribute the moisture within the stack consistent with its particle size distribution (silt).

Furthermore, during placement of the final layer of ash, roller compaction will be employed in the same manner as construction control for soil with testing for both density and moisture content, thus it will have no more ability to desiccate than soil. In the consideration of such a low probability of a failure in the GCL, we believe the underlying clay liner component of a synthetic cap is not necessary in this application.

Enclosed are copies of laboratory test results on fly ash at KIF. These test show that when compacted to maximum dry density the hydraulic conductivity very nearly approaches your standard requirement of 1 E-5. If rolled fly ash can meet the manufacturer's specification for surface preparation, then there is minimal benefit to importing clay to place under the synthetic cap. We see this as an excellent use of coal combustion by-products in an environmental application.

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John W Myers for

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

Enclosures

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

November 21, 1996

Mr. Randy M. Cole, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

RE: Closure/Post-Closure Plan for ash pond disposal area

Dear Mr. Cole:

The revisions to the closure-post closure plan for the ash pond disposal area at Kingston Fossil Plant, as prepared by Tennessee Valley Authority, Site and Environmental Engineering Section, and submitted to our office on November 18, 1996, have been reviewed in accordance with Rule Chapter 1200-1-7, Solid Waste Processing and Disposal. The revisions have satisfactorily addressed most of our previous comments; however, the following deficiency remains uncorrected:

The second alternative for the final cap has only a bentonite-impregnated fabric product over the final ash surface, with no soil component in the cap. This is unacceptable; if the cap consists of only a membrane, there will be no cap at all at any point where there is a puncture, tear, or defect. Also, having the dry ash material in contact with the bentonite fabric could cause the bentonite to dry out and dessicate once it has been hydrated, which may render it less effective. Bentonite-impregnated fabrics are only approved in combination with soil liners, although a higher permeability would be allowed for the soil component if a GCL material is also used. It has been noted in the revision that there is a soil component; however, this is a vegetative layer over the bentonite fabric. There must also be a low-permeability clay layer under the fabric (over the ash) to assure that there will be uniform, continuous cap over all of the waste.

Please prepare and submit revisions to the closure/post closure plan to address these items. If you should have any questions concerning this review, do not hesitate to contact me.

Yours truly,

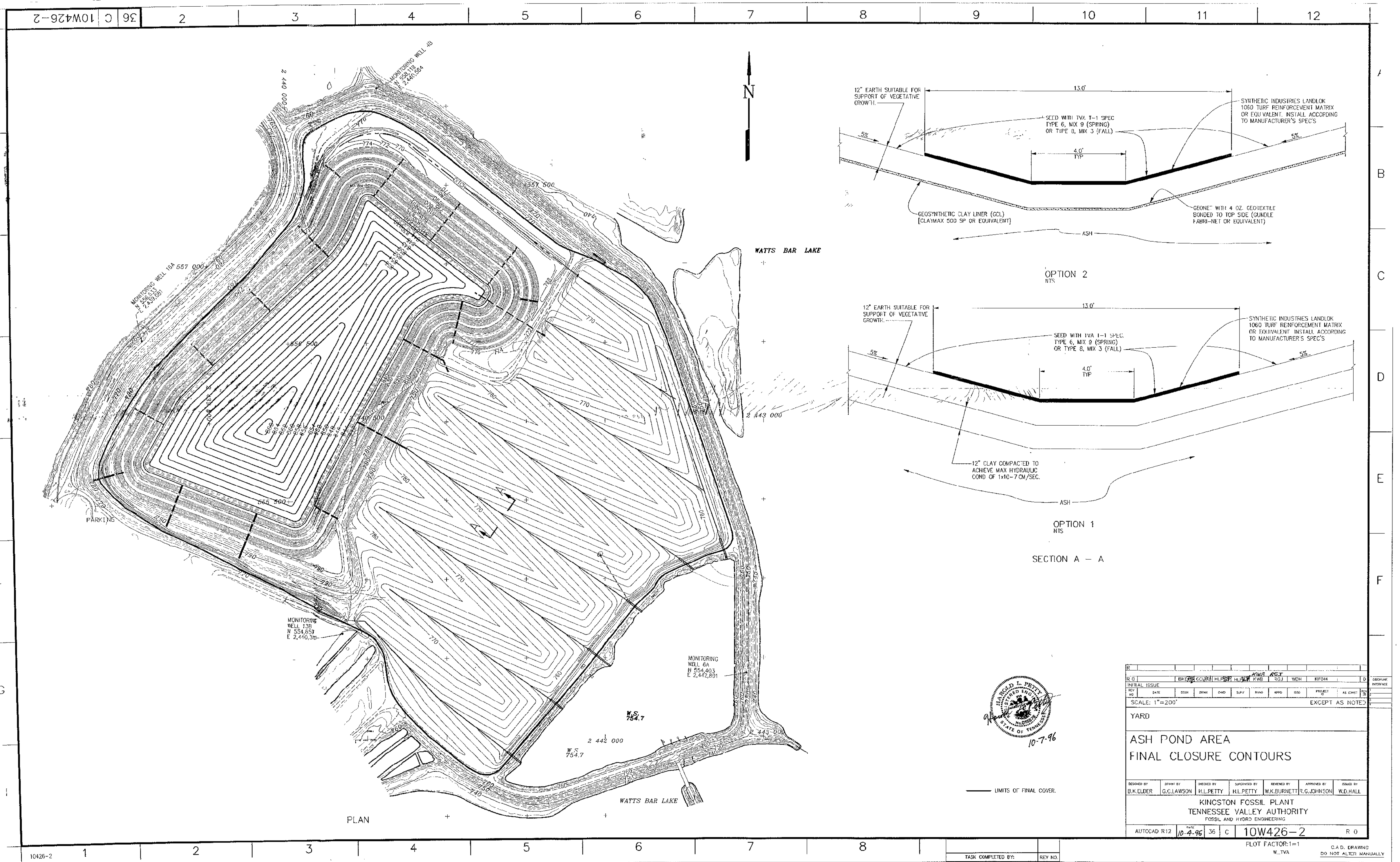
Rick Brown

Rick Brown
Environmental Engineeer
Division of Solid Waste Management

RSB a:\tvaknc2.doc

cc: DSWM-Nashville Central Office

TOTAL P.03



N
PLAN
WATTS BAR LAKE
W.S. 754.7
2 442 000
2 443 000
2 440 000
557 000
2 445 000
PARKING
MONITORING WELL 4B N 558,118 E 2,440,564
MONITORING WELL 18A 557 000 N 556,133 E 2,440,061
MONITORING WELL 13B N 554,657 E 2,440,318
MONITORING WELL 6A N 554,403 E 2,442,801
12" EARTH SUITABLE FOR SUPPORT OF VEGETATIVE GROWTH.
13.0'
4.0' TYP
5%
SEED WITH TVA T-1 SPEC TYPE 6, MIX 9 (SPRING) OR TYPE 8, MIX 3 (FALL)
SYNTHETIC INDUSTRIES LANDLOK 1060 TURF REINFORCEMENT MATRIX OR EQUIVALENT. INSTALL ACCORDING TO MANUFACTURER'S SPEC'S
GEOSYNTHETIC CLAY LINER (GCL) [CLAYMAX 500 SP OR EQUIVALENT]
GEONET WITH 4 OZ. GEOTEXTILE BONDED TO TOP SIDE (GUNDLE FABRI-NET OR EQUIVALENT)
ASH
OPTION 2
NTS
12" CLAY COMPACTED TO ACHIEVE MAX HYDRAULIC COND OF 1x10-7 CM/SEC.
OPTION 1
NTS
SECTION A – A
LIMITS OF FINAL COVER.
10-7-96
INITIAL ISSUE
SCALE: 1"=200'
EXCEPT AS NOTED
YARD
ASH POND AREA
FINAL CLOSURE CONTOURS
B.K.ELDER
G.C.LAWSON
H.L.PETTY
H.L.PETTY
W.K.BURNETT
R.G.JOHNSON
W.D.HALL
KINGSTON FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING
AUTOCAD R12
10-4-96
36
C
10W426-2
R 0
PLOT FACTOR:1=1
W_TVA
C.A.D. DRAWING DO NOT ALTER MANUALLY
TASK COMPLETED BY:
REV NO.
10426-2
36 C 10W426-2

dwr

A60 961029 054

November 13, 1996

Mr. Rick Brown
Department of Environment and Conservation
Division of Solid Waste Management
Knoxville Environmental Field Office
270 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

Dear Mr. Brown:

TENNESSEE VALLEY AUTHORITY - RESPONSE TO COMMENTS ON CLOSURE/POST-CLOSURE PLAN FOR ASH POND DISPOSAL AREA AT KINGSTON FOSSIL PLANT

Enclosed are three copies of our response, for enclosure in our original submittal, to your letter dated August 13 concerning the above-mentioned facility. Specifically, our response includes the following information:

A geosynthetic turf reinforcement matrix will be used in the drainage channels across the former ash pond area. The configuration for this material can be seen on Section A-A which has been added to Drawing 10W426-2.

A soil component was previously specified for cover Option 2. It consists of a 12-inch layer of soil suitable to support vegetative growth. This can be seen on Drawing 10W425-13, Detail A13.

No grasses with root systems deeper than the one foot of earth cover has been specified for this project. Only Mixture 6, Type 9, and Mixture 8, Type 3 from the TVA T-1 specification are in the drawing notes on Sheet 10W425-2. Both types consist of rebel fescue, hard fescue, and white clove only. These two mixes have been highlighted on pages 580-5 and 580-6 of Appendix A of the Closure Plan to emphasize this point.

If you have any question or comments, please call Dave Robinson in Chattanooga at (423) 751-2502.

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

JWM:DWR:SGC
Enclosures
cc (Enclosure):
R. M. Cole, Kingston (w/o Enclosure)
J. M. Loney, WT 8C-K
R. L. Pope, Kingston
B. B. Walton, ET 10A-K (w/o Enclosure)
RIMS, WR 4Q-C

Q:\MSWORD\SANDRA\DWR\CPCKIF.DOC

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

November 13, 1996

Mr. Rick Brown
Department of Environment and Conservation
Division of Solid Waste Management
Knoxville Environmental Field Office
270 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

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If you have any question or comments, please call Dave Robinson in Chattanooga at (423) 751-2502.

John W Myers for

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

Enclosures

CLOSURE/POST CLOSURE PLAN
ASH POND AREA

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

SEPTEMBER 1995

(Revised October 1996)

Prepared By:

Tennessee Valley Authority
Site and Environmental Engineering Section

580.2 -- Materials (Continued)

c. Channel Banks, Cuts, Fill Slopes, Waste Areas, and Other Disturbed Areas

Type 6: Spring seeding only (Plant between March 15 and May 15).

Mixture:

(1) Kentucky 31 Fescue................60 pounds per acre

(2) Bermuda Grass (hulled)..........40 pounds per acre

(3) Creeping Red Fescue ....80 pounds per acre
(Shaded slopes only)

(4) Weeping Lovegrass.................15 pounds per acre
Korean Lespedeza
(scarified)...............................10 pounds per acre
Total mixture ....25 pounds per acre

(5) Sericea Lespedeza
(scarified)...............................30 pounds per acre
Kentucky 31 Fescue................30 pounds per acre
Total mixture ....60 pounds per acre

(6) Interstate Sericea
Lespedeza (scarified)..............30 pounds per acre
Rebel Fescue..........................30 pounds per acre
Total mixture ....60 pounds per acre

(7) Crownvetch (scarified
and inoculated)........................30 pounds per acre
Kentucky 31 Fescue................30 pounds per acre
Total mixture ....60 pounds per acre

(8) Bahia Grass ....40 pounds per acre
Bermuda Grass........................20 pounds per acre
Switch Grass ....10 pounds per acre
Total mixture ....70 pounds per acre

[redacted]

580.2 -- Materials (Continued)

c. Channel Banks, Cuts, Fill Slopes, Waste Areas, and Other Disturbed Areas (Continued)

Type 7: Summer seeding (Plant between May 15 and July 15).

Mixture:

(1) Bermuda Grass (hulled) ....40 pounds per acre
Korean Lespedeza
(scarified) ....10 pounds per acre
Total mixture ......50 pounds per acre

(2) Buffalo Grass ....40 pounds per acre
Korean Lespedeza
(scarified) ....10 pounds per acre
Total mixture ......50 pounds per acre

Type 8: Fall seeding (Plant between August 15 and October 15).

(1) Kentucky 31 Fescue..........60 pounds per acre
White Clover.....................15 pounds per acre
Total mixture ......75 pounds per acre

(2) Hard Fescue ....10 pounds per acre
Rebel Fescue ....40 pounds per acre
White Clover..................... 5 pounds per acre
Total mixture ......55 pounds per acre

[redacted]

d. Highway Shoulders

The planting dates and seed mixtures for each type listed here are described above.

Type 6: Spring seeding [Mixture (1), (2), (3) or (9)]

Type 7: Summer seeding [Mixture (1) or (3)]

Type 8: Fall seeding [Mixture (2)]

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

DWQ
KEN BRUNETT

RECEIVED
AUG 15 '96

August 13, 1996

Mr. Randy M. Cole, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

RE: Closure/Post-Closure Plan for ash pond disposal area

Dear Mr. Cole:

The closure-post closure plan for the ash pond disposal area at Kingston Fossil Plant, as prepared by Tennessee valley Authority, Site and Environmental Engineering Section, and submitted to our office on July 19, 1996, has been reviewed in accordance with Rule Chapter 1200-1-7, Solid Waste Processing and Disposal. This unit is presently a series of impoundments in which sluiced and dredged ash is ponded, with dikes raised in the dredge ponds as previously deposited ash settles. However, the site will be closed as a landfill when the area is filled to maximum capacity. Therefore the standards for closure of a coal ash monofill are being applied to the closure of this site. We find that the following additional information or revisions are necessary if the plan is to be approved:

(1) We cannot tell from the plans how the surface drainage channels across the former ash pond area are to be stabilized against erosion. This needs to be clarified.

(2) The second alternative for the final cap has only a bentonite-impregnated fabric product over the final ash surface, with no soil component in the cap. This is unacceptable; if the cap consists of only a membrane, there will be no cap at all at any point where there is a puncture, tear, or defect. Bentonite-impregnated fabrics are only approved in combination with soil liners, although a higher permeability (i.e., 1×10^{-6} cm/sec.) would be allowed for the soil component if a GCL material is also used.

(3) Only grasses which can develop their root system within the 1-foot loose soil/topsoil zone should be planted. Deep rooted species such as sericea lespedeza should not be used.

Please prepare and submit revisions to the closure/post closure plan to address these items. If you should have any questions concerning this review, do not hesitate to contact me.

Yours truly,

Rick Brown

Rick Brown
Environmental Engineeer
Division of Solid Waste Management

RSB a:\tvakncl.doc

cc: DSWM- Nashville Central Office

ALO 960814002

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

Jtom
dsh.
XC: Rems

August 9, 1996

CERTIFIED MAIL
Return Receipt Requested
#Z 367 996 392

Ms. Janet K. Watts
Manager of Environmental Affairs
Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402-2801

RE: Review of TVA's Kingston Fossil Plant Hydrogeological Evaluation - Ash Pond Closure

Dear Ms. Watts:

In accordance with Rule 1200-1-7-.07(6)(a), the Division of Solid Waste Management has reviewed the resubmitted Hydrogeologic Report submitted to this office on July 19, 1996 for the Ash Pond Closure at TVA's Kingston Fossil Plant.

Upon review, the Division has determined that the report meets the regulatory requirement of Rule 1200-1-7-.04(9)(a), for assessing hydrogeologic characteristics under Part II Permit Application for a Class II Disposal Facility.

The next step in the permitting process for this Ash Pond Closure will be the review of the Engineering Plans and Operations Manual.

If you should have any questions, please feel free to contact me at (423) 594-5459.

Sincerely,

Larry F. Cook

Larry F. Cook, Jr.
Solid Waste Field Supervisor
Division of Solid Waste Management

RECEIVED
AUG 14 1996
Environmental Affairs

LFC/bmh

cc: DSWM - Nashville Attention: Alan Spear
Rick Brown - DSWM/KFO

DWR

A60 960614 055

June 14, 1996

Mr. Larry F. Cook, Jr
Solid Waste Field Supervisor
Division of Solid Waste Management
Department of Environment
and Conservation
2700 Middlebrook Pike
Knoxville, Tennessee 37921

Dear Mr. Cook:

RESPONSE TO NOTICE OF DEFICIENCY - TENNESSEE VALLEY AUTHORITY - KINGSTON FOSSIL PLANT - HYDROGEOLOGIC EVALUATION ASH POND CLOSURE

This submittal has been prepared in response to your February 9 letter concerning your review of the subject report. We apologize for the delay in our response.

Response to Comment 1 - Pursuant to Rule 1200-17-7-.04(9)(a)3(i)(III) & (IV)

The soil hydraulic conductivity data presented in Table 2-1 of the Hydrogeologic Evaluation of Ash Pond Area, which is Appendix D to the "Closure/Post Closure Plan Ash Pond Area" September 1996, do not include data for remolded samples of cover and cap soil materials. The source of the cover and cap soil material has not as yet been identified. Prior to actual closure of the ash pond facility, TVA will solicit bids for cover/cap materials having specified geotechnical properties. Geotechnical specifications will include a requirement that the soil cover/cap materials be recompacted in accordance with ASTM D-698 and that hydraulic conductivity be measured in a test fill in accordance with ASTM D-5084. Hydraulic conductivities equal to or less than the design value will be required of all soils used for cap material. Testing results will be presented to the division.

Response to Comment 2. - Pursuant to Rule 1200-1-7-.04(9)(a)4 and 5

The laboratory permeameter test data presented in Table 2-1 of the Hydrogeologic Evaluation of the Ash Pond Area are for undisturbed soil samples collected in thin-walled Shelby tubes during an EPA-sponsored investigation conducted in March/April 1976. The results of this investigation are presented in an EPA report entitled, *"Effects of Coal-Ash Leachate on Ground Water Quality," by J. D. Milligan and R. J. Ruane, EPA-600/7-80-066, March 1980.* Whether recognized sample collection and testing methods were followed is not evident from the report. However, the sample collection procedures are described on page 17 of the report as follows:

> "The undisturbed samples were collected by hydraulically pushing a cylindrical tube (a Shelby tube) having a length of 76 cm and a diameter of 8.9 cm through the desired sampling area. The Shelby tube, with sample, was then extracted from the well hole and both ends sealed with paraffin wax to prevent moisture loss."

The method of measuring the hydraulic conductivities of these samples is given in Appendix A, page 100, of the report and is described as follows:

> "Vertical and horizontal permeabilities of the soil samples were determined by encasing soil specimens 3.5 cm in diameter and approximately 7.6 cm long in a rubber membrane and placing in a triaxial chamber. Back pressure to 70,310 kg/m^2 (100 psi) was applied to assure specimen saturation. The average coefficient of permeability was then determined under a constant head test method by measuring the quantity of water flowing through the specimen in a given time."

Note that the hydraulic conductivity data for the undisturbed soil cores presented in the hydrogeological report were intended to show the range of conductivities for soils underlying the site and not the expected range of hydraulic conductivities for the cover and cap materials.

Response to Comment 3.--Pursuant to Rule 1200-1-7-.04(9)(a)3(ii)

A tabulation of the water table data used to prepare the water table contour map presented in Figure 2-5 of the Hydrogeologic Evaluation of the Ash Pond Area are given in Table 1 (enclosed). These data represent measurements made on December 5, 1994.

We do not have water levels for all well borings at the time of drilling. However, periodic water level measurements from 1988 through 1994 are available for 24 piezometers located in the ash pond vicinity. These data are presented as hydrographs in Figure 2-6 of the hydrogeological report and are tabulated in Table 2 (enclosed). As discussed Section 2 (page 10) of the report, seasonal trends are not evident in the groundwater level data. Groundwater levels are strongly affected by artificial hydrologic controls, e.g., the reservoir, the ash pond, and the dredge cells. In the absence of true seasonality in the data, the historical maximum water level for each piezometer given in Table 2 can be considered the seasonal high water table for the piezometer's locality.

TVA understands the difficulty of reviewing the hydrogologic data of this existing site. We have only provided your office with one copy of the subject report. If you have additional questions or concerns after review of these responses to your initial review comments, TVA would propose that we meet with you to discuss the project prior to publication of the three copies required for final approval.

If you have any questions, please call John Myers at (423) 751-8855 in Chattanooga.

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

JWM:SGC
Enclosures
cc (Enclosures):
J. M. Boggs, LAB 1A-N
K. W. Burnett, LP 2G-C
R. M. Cole, Kingston
J. M. Loney, WT 8C-K
B. B. Walton, ET 10A-K
RIMS, CST 13B-C (Re: A60 960214 001)

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TABLE 1. Water Level Data Used in Constructing Figure 2-5				
			12/03/94	
			Water Level	
	Well		(ft-MSL)	
	2		756.40	
	4A		740.49	
	4B		740.49	
	5		741.01	
	5A		741.01	
	5B		741.01	
	6A		744.33	
	6B		744.33	
	8		763.78	
	9A		756.50	
	9B		756.50	
	10		753.55	
	10A		753.55	
	10B		753.55	
	11B		759.03	
	12A		761.98	
	12B		761.98	
	13A		758.70	
	13B		758.70	
	15A		788.33	
	15B		788.33	
	16A		762.41	
	16B		762.41	

~ATT007F.XLS
3/28/96

TABLE 2. Ground Water Level Data for Kingston Plant Site

																				Historical Maximum Water Level (ft)
			Well No.	2																
Date	89/01/11	89/03/30	89/06/29	89/09/14	89/11/29	90/03/07	90/06/05	90/09/05	90/12/04	90/12/04	91/03/20	91/06/04	91/09/10	91/12/17	92/06/02	92/12/07	93/12/06	93/12/09	93/12/09	
Time	1405	1013	1044	950	1223	1103	1243	1520	1040	1041	1017	1023	1328	1423	1103	1411	1131	1007	1343	
G.W. Ele (ft-msl)	757.55	757.98	758.83	757.65	751.18	757.98	757.65	757.12	757.39	757.39	758.67	758.37	757.62	759.75	759.45	759.52	759.26	759.35	759.35	
Well Depth (ft)	49.71	49.71	49.71	49.71	0.00	49.51	49.71	49.61	49.51	49.51	49.51	49.61	44.69	49.71	49.71	49.61	49.64	49.64	49.64	
Depth to Water (ft)	10.30	9.84	9.02	10.20	16.67	9.84	10.17	10.70	10.47	10.47	9.19	9.45	10.24	8.16	8.40	8.33	8.60	8.50	8.50	
Calc. ref pt (ft-msl)	767.85	767.82	767.85	767.85	767.85	767.82	767.82	767.82	767.85	767.85	767.85	767.82	767.85	767.85	767.85	767.85	767.85	767.85	767.85	767.85
			Well No.	4A																
Date	89/01/11	89/03/29	89/06/28	89/09/13	89/11/29	90/03/06	90/06/05	90/09/05	90/12/04	91/03/20	91/12/17	92/03/03	92/06/02	92/09/01	92/12/07	93/06/08	93/12/06	93/12/09	94/06/13	
Time	940	1159	1047	1227	941	1327	1342	1150	1144	1051	1005	909	1009	954	1215	1006	1231	1226	1059	
G.W. Ele (ft-msl)	739.87	739.34	743.24	742.72	734.71	741.47	743.24	747.77	740.19	739.70	741.28	739.93	742.42	737.50	739.27	740.78	741.24	740.03	742.82	
Well Depth (ft)	26.41	26.41	26.41	26.41	0.00	26.31	26.51	26.41	26.41	26.31	26.61	26.61	26.41	26.51	26.51	26.61	26.51	26.51	26.48	
Depth to Water (ft)	15.36	15.88	11.98	12.50	20.51	13.75	12.01	7.45	15.06	15.52	13.94	15.29	12.80	17.72	15.95	14.44	13.98	15.19	12.40	
Calc. ref pt (ft-msl)	755.22	755.22	755.22	755.22	755.22	755.22	755.25	755.22	755.25	755.22	755.22	755.22	755.22	755.22	755.22	755.22	755.22	755.22	755.22	755.25
			Well No.	4B																
Date	89/01/11	89/03/29	89/06/28	89/09/13	89/11/29	90/03/06	90/06/05	90/09/05	90/12/04	91/03/20	91/06/04	91/09/10	91/12/17	92/03/03	92/06/02	92/09/01	92/12/07	93/06/08	93/12/06	
Time	930	1210	1008	1254	1009	1134	1327	1217	1125	1107	946	1112	1104	933	1030	939	1254	950	1233	
G.W. Ele (ft-msl)	743.41	743.44	735.24	737.83	732.91	741.31	734.81	735.04	745.74	743.70	742.79	734.45	747.71	748.59	743.47	720.93	746.07	729.66	744.69	
Well Depth (ft)	38.91	38.81	38.81	39.90	0.00	38.72	38.91	38.81	38.81	38.72	38.91	38.91	38.91	38.91	38.91	38.91	38.91	38.85	38.88	
Depth to Water (ft)	10.53	10.47	18.70	16.11	21.00	12.63	19.13	18.90	8.20	10.24	11.16	19.49	6.23	5.35	10.47	33.01	7.87	24.28	9.25	
Calc. ref pt (ft-msl)	753.94	753.91	753.94	753.94	753.91	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94	753.94
			Well No.	5 (Recased on 6/1/92)																
Date	89/01/11	89/03/29	89/06/28	89/09/13	89/11/29	90/03/06	90/06/05	90/09/05	90/12/04	91/03/20	91/12/17	92/03/03	92/06/03	92/06/30	92/09/01	93/12/06	94/12/05			
Time	1000	1230	1203	1412	1040	1415	1452	1348	1248	1128	1216	1045	1023	1644	1036	1311	4.69183			
G.W. Ele (ft-msl)	739.44	739.01	742.39	742.23	735.53	739.18	742.26	741.80	739.47	739.41	740.88	739.41	747.94	748.17	740.19	751.05	751.35			
Well Depth (ft)	27.10	27.00	27.10	27.10	0.00	27.10	26.90	26.90	26.90	26.90	27.00	27.00	24.71	24.90	24.61	24.44	0.00			
Depth to Water (ft)	16.60	17.03	13.65	13.81	20.51	16.86	13.75	14.24	16.54	16.63	15.16	16.63	8.10	7.87	15.85	4.99	4.69			
Calc. ref pt (ft-msl)	756.04	756.04	756.04	756.04	756.04	756.04	756.01	756.04	756.01	756.04	756.04	756.04	756.04	756.04	756.04	756.04	756.04			756.04
			Well No.	5A (Recased on 6/2/92)																
Date	89/03/28	90/03/07	90/06/07	90/09/06	90/12/05	91/03/21	91/12/17	92/06/30	92/08/20	93/12/06	94/12/06									
Time	1245	1337	1050	1206	1015	1227	1622	1556	1332	1307										
G.W. Ele (ft-msl)	739.05	724.87	726.68	726.28	724.84	725.40	740.36	740.23	740.85	743.34	741.47									
Well Depth (ft)	39.70	39.60	40.00	39.70	39.60	39.50	39.60	20.41	20.31	20.16	0.00									
Depth to Water (ft)	14.08	28.25	26.48	26.87	26.51	27.76	12.80	12.93	12.30	9.81	11.68									
Calc. ref pt (ft-msl)	753.12	753.12	753.15	753.15	753.15	753.15	753.15	753.15	753.15	753.15	753.15									753.15
			Well No.	5B (Recased on 6/1/92)																
Date	89/01/11	89/03/29	89/06/28	89/09/13	89/11/29	90/03/06	90/06/05	90/09/05	90/12/04	91/03/20	91/03/20	91/12/17	92/03/03	92/06/03	92/06/30	92/09/01	93/12/06	94/12/05		
Time	950	1300	1145	1431	1101	1428	1428	1415	1238	1143	1144	1151	1025	1055	1620	1052	1309			
G.W. Ele (ft-msl)	741.05	740.65	744.29	743.74	733.86	740.75	744.75	743.34	741.11	741.01	741.01	742.62	741.31	741.47	741.47	739.21	746.66	740.55		
Well Depth (ft)	40.00	40.00	40.00	40.00	0.00	39.70	39.60	39.90	39.90	39.80	39.80	40.00	40.00	36.72	39.21	39.11	37.73	0.00		
Depth to Water (ft)	12.70	13.09	9.45	10.01	19.88	12.99	8.99	10.40	12.63	12.73	12.73	11.12	12.43	12.27	12.27	14.53	7.09	13.19		
Calc. ref pt (ft-msl)	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74	753.74		753.74

			Well No.	6A																						
Date	89/01/11	89/03/29	89/06/28	89/09/13	89/11/29	90/03/07	90/06/05	90/09/05	90/12/04	91/03/20	91/12/17	92/06/02	92/12/07	93/06/08	93/12/08	93/12/09	94/06/13	94/12/05	94/12/08							
Time	1045	1310	1241	1550	1134	1027	1523	1443	1306	1227	1336	927	1344	1044	1319	1618	1240		1526							
G.W. Ele (ft-msl)	740.92	740.49	744.75	743.90	733.04	740.36	743.67	743.44	741.21	740.49	741.97	743.57	741.01	742.39	742.39	741.97	743.80	738.72	738.72							
Well Depth (ft)	26.81	26.81	26.81	26.81	0.00	29.69	29.79	26.71	26.71	26.71	26.81	29.89	23.59	26.84	26.87	26.87	26.87	0.00	29.20							
Depth to Water (ft)	11.32	11.75	7.48	8.33	19.19	11.88	8.56	8.79	11.02	11.75	10.27	8.66	11.22	9.84	9.84	10.27	8.43	13.52	13.52							
Calc. ref pt (ft-msl)	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23	752.23							752.23
			Well No.	8																						
Date	89/01/11	89/03/30	89/06/28	89/09/14	89/11/29	90/03/07	90/06/07	90/09/06	90/12/05	91/03/21	91/06/04	91/09/10	91/12/17	92/06/02	92/12/08	93/06/08	93/12/08	93/12/08	94/06/14	94/12/05	94/12/08					
Time	1130	1046	1528	935	1148	1135	1016	1029	1049	1256	1313	1413	1535	1257	1426	1112	1115	1642	922		1111					
G.W. Ele (ft-msl)	750.89	764.05	764.08	762.87	748.04	762.05	762.01	761.22	758.93	757.58	752.76	755.19	763.52	762.93	763.52	754.86	764.01	763.88	763.69	763.78	763.78					
Well Depth (ft)	33.11	33.50	33.11	33.11	0.00	33.01	33.11	33.01	33.01	33.01	33.01	33.11	33.11	33.11	33.11	33.06	33.07	33.07	33.07	0.00	33.14					
Depth to Water (ft)	20.05	6.89	6.86	8.07	22.90	8.89	8.92	9.71	12.01	13.35	18.18	15.75	7.42	8.01	7.42	16.08	6.92	7.05	7.25	7.15	7.15					
Calc. ref pt (ft-msl)	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94	770.94					770.94
			Well No.	9A																						
Date	89/01/05	89/03/28	89/06/29	89/09/14	89/12/04	90/03/13	90/06/12	90/09/12	90/12/10	91/03/25	91/06/06	91/09/11	91/12/18	92/06/03	92/12/09	93/12/06	93/12/08	93/12/08	94/12/05	94/12/08						
Time	1105	1713	1213	1127	1530	1326	1507	1023	1122	1200	1401	1401	1149	1609	1117	1141	1440	1441		1109						
G.W. Ele (ft-msl)	754.20	754.43	755.35	754.70	749.81	754.99	755.09	755.22	755.22	755.91	755.52	756.47	757.09	756.60	756.40	757.65	757.45	757.45	756.43	756.43						
Well Depth (ft)	71.59	71.59	71.69	71.59	0.00	71.49	71.59	71.49	71.49	71.49	71.39	71.59	71.59	71.59	71.49	71.62	71.62	71.62	0.00	71.62						
Depth to Water (ft)	18.31	18.08	17.16	17.85	22.74	17.55	17.45	17.32	17.32	16.63	17.00	16.08	15.45	15.95	16.14	14.90	15.09	15.09	16.11	16.11						
Calc. ref pt (ft-msl)	772.51	772.51	772.51	772.54	772.54	772.54	772.54	772.54	772.54	772.54	772.51	772.54	772.54	772.54	772.54	772.54	772.54	772.54	772.54	772.54						772.54
			Well No.	9B																						
Date	89/01/05	89/03/28	89/06/29	89/09/14	89/12/04	90/03/13	90/06/12	90/09/12	90/12/10	91/03/25	91/06/06	91/09/11	91/12/18	92/06/03	92/12/09	93/12/06	93/12/08	93/12/08	94/12/05	94/12/08						
Time	1200	1611	1137	1047	1627	1424	1627	1107	1048	1118	1329	1446	1311	1536	1035	1142	1511	1604		1031						
G.W. Ele (ft-msl)	753.22	754.47	755.38	754.70	753.71	754.76	754.63	754.07	755.22	755.94	756.04	755.71	756.60	757.09	756.70	757.68	772.45	757.68	756.53	756.47						
Well Depth (ft)	85.01	85.01	85.21	85.01	0.00	84.91	85.01	84.91	84.91	84.91	84.81	85.01	85.01	85.01	85.01	84.98	84.98	84.98	0.00	85.01						
Depth to Water (ft)	19.23	17.98	17.06	17.75	18.73	17.66	17.82	18.34	17.19	16.50	16.41	16.73	15.81	15.36	15.75	14.76	0.00	14.76	15.91	15.98						
Calc. ref pt (ft-msl)	772.45	772.45	772.45	772.45	772.45	772.45	772.45	772.41	772.41	772.45	772.45	772.45	772.41	772.45	772.45	772.45	772.45	772.45	772.45	772.45						772.45
			Well No.	10																						
Date	89/01/04	89/03/28	89/07/05	89/09/14	89/11/30	90/03/13	90/06/06	90/09/11	90/12/10	91/03/20	91/06/04	91/09/10	91/12/18	92/03/03	92/06/03	92/09/01	92/12/08	93/06/08	93/12/06	93/12/08	94/06/13	94/12/05	94/12/07			
Time	1450	1414	1502	1407	1206	1020	1232	1036	1238	1354	1059	1155	1440	1303	1236	1135	1053	1244	1336	1010	1435		936			
G.W. Ele (ft-msl)	750.76	751.02	751.25	751.22	751.18	751.25	751.38	751.51	752.30	752.37	752.53	755.94	756.63	756.37	756.47	755.94	756.50	755.84	756.83	756.83	756.47	755.81	755.75			
Well Depth (ft)	17.29	17.29	17.29	17.29	0.00	17.09	17.09	17.19	17.19	17.09	17.09	17.19	17.29	17.29	17.29	17.19	17.19	17.23	17.13	17.13	17.19	0.00	17.09			
Depth to Water (ft)	6.07	5.81	5.61	5.61	5.64	5.58	5.45	5.32	4.53	4.46	4.30	0.89	0.20	0.46	0.36	0.89	0.33	0.98	0.00	0.00	0.36	1.02	1.08			
Calc. ref pt (ft-msl)	756.83	756.83	756.86	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83			756.86
			Well No.	10A																						
Date	89/01/04	89/03/28	89/07/05	89/09/14	89/11/30	90/03/13	90/06/06	90/09/11	90/12/10	91/03/20	91/06/04	91/09/10	91/12/18	92/03/03	92/06/03	92/09/01	92/12/08	93/06/08	93/12/06	93/12/08	94/06/13	94/12/05	94/12/07			
Time	1406	1517	1439	1333	1309	1031	1129	1134	1356	1311	1144	1257	1548	1253	1255	1225	1035	1322	1333	1040	1519		1007			
G.W. Ele (ft-msl)	747.05	747.16	748.95	749.22	744.03	747.41	748.59	749.74	747.61	748.26	749.38	752.04	751.84	751.02	752.33	742.33	750.50	752.07	752.27	752.27	752.33	750.46	750.66			
Well Depth (ft)	23.59	32.71	23.59	23.59	0.00	32.19	31.99	32.09	31.99	32.09	32.19	32.19	32.19	32.19	32.32	52.10	32.09	32.15	0.00	32.15	32.15	0.00	32.15			
Depth to Water (ft)	9.29	9.15	7.38	7.12	12.30	8.92	7.74	6.59	8.73	8.07	6.96	4.30	4.49	5.32	4.00	14.01	5.84	4.27	4.07	4.07	4.00	5.87	5.68			
Calc. ref pt (ft-msl)	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34	756.34			756.34

			Well No.	10B																						
Date	89/01/04	89/03/28	89/07/05	89/09/14	89/11/30	90/03/13	90/06/06	90/09/11	90/12/10	91/03/20	91/12/23	92/12/08	93/12/06	93/12/08	94/12/05	94/12/07										
Time	1420	1446	1422	1356	1246	1132	1158	1046	1338	1340	1333	1106	1334	1022		953										
G.W. Ele (ft-msl)	749.74	749.35	751.94	751.94	746.66	749.97	751.15	750.92	750.14	750.53	751.32	751.45	752.89	752.83	754.43	751.45										
Well Depth (ft)	52.10	52.10	52.10	52.10	0.00	52.10	52.10	52.00	52.00	51.91	52.10	52.10	52.07	52.07	0.00	52.04										
Depth to Water (ft)	6.69	7.09	4.49	4.49	7.78	6.50	5.28	5.51	6.30	5.91	5.12	4.99	3.54	3.61	2.00	4.99										
Calc. ref pt (ft-msl)	756.43	756.43	756.43	756.43	756.43	756.47	756.43	756.43	756.43	756.43	756.43	756.43	756.43	756.43	756.43	756.43										756.47
			Well No.	11B																						
Date	89/01/04	89/01/04	89/03/28	89/06/28	89/09/14	89/11/30	90/03/07	90/06/06	90/09/11	90/12/10	91/03/20	91/12/23	92/12/08	93/12/06	93/12/06	94/12/05	94/12/06									
Time	1300	1301	1613	1451	1430	1507	1429	1359	1010	1434	1424	1250	942	1340	1247		1234									
G.W. Ele (ft-msl)	761.36	761.36	761.66	762.54	757.42	755.22	761.72	757.68	757.12	759.81	762.47	761.03	759.58	761.82	761.59	759.03	758.96									
Well Depth (ft)	35.01	35.01	35.01	35.01	35.01	0.00	34.91	35.01	34.91	34.91	34.81	35.01	35.01	35.01	35.01	0.00	35.01									
Depth to Water (ft)	7.78	7.78	7.25	6.59	11.71	13.91	7.42	11.48	12.01	9.32	6.66	8.10	9.55	7.32	7.55	10.11	10.17									
Calc. ref pt (ft-msl)	769.13	769.13	769.13	769.13	769.13	769.13	769.13	769.16	769.13	769.13	769.13	769.13	769.13	769.13	769.13	769.13	769.13									769.16
			Well No.	12A																						
Date	89/01/04	89/03/29	89/06/28	89/06/28	89/09/18	90/03/14	90/06/14	90/09/10	90/12/06	91/03/14	91/03/21	91/12/19	92/05/27	92/06/03	92/12/06	92/12/09	93/06/07	93/12/06	93/12/06	94/12/05	94/12/06					
Time	1050	1245	1617	1618	1112	1244	1311	1100	1113		1328	1307		1634	1408	1408		1057	1319		1430					
G.W. Ele (ft-msl)	761.49	762.14	762.14	761.09	761.55	761.72	760.96	760.14	761.72	762.24	762.05	762.14	761.03	761.19	761.82	761.82	761.82	763.00	762.60	762.54	762.57					
Well Depth (ft)	27.30	27.20	27.30	27.30	27.30	27.10	27.10	27.00	27.00	0.00	27.10	27.20	0.00	27.20	0.00	27.20	0.00	27.07	27.07	0.00	27.07					
Depth to Water (ft)	5.84	6.56	6.23	6.23	5.77	5.61	6.37	7.19	5.61	0.00	5.32	5.18	0.00	6.14	0.00	5.51	5.51	4.33	4.72	4.79	4.76					
Calc. ref pt (ft-msl)	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33	767.33					767.33
			Well No.	12B																						
Date	89/01/04	89/03/29	89/06/28	89/09/18	89/12/05	90/03/12	90/06/06	90/09/10	90/12/06	91/03/14	91/03/21	91/12/19	92/05/27	92/06/03	92/12/09	92/12/19	93/06/07	93/12/06	93/12/06	94/12/05	94/12/06					
Time	1115	1315	1707	1151	1326	1329	1440	1136	1050		1402	1254		1651	1356	1356		1059	1335		1349					
G.W. Ele (ft-msl)	760.80	760.83	761.49	760.70	755.15	761.13	760.21	759.75	761.03	761.78	761.32	761.39	760.40	760.47	760.93	760.93	760.90	762.01	761.88	761.39	761.45					
Well Depth (ft)	56.01	56.01	55.91	56.01	0.00	56.01	56.01	55.91	55.91	0.00	55.81	56.01	0.00	55.91	55.91	0.00	0.00	55.94	55.94	0.00	55.91					
Depth to Water (ft)	6.37	6.30	5.64	6.43	11.98	6.00	6.92	7.42	6.10	0.00	5.81	5.74	0.00	6.66	6.20	0.00	6.23	5.12	5.25	5.74	5.68					
Calc. ref pt (ft-msl)	767.16	767.13	767.13	767.13	767.13	767.13	767.13	767.16	767.13	767.13	767.13	767.13	767.13	767.13	767.13	767.13	767.13	767.13	767.13	767.13	767.13					767.16
			Well No.	13A																						
Date	89/01/11	89/03/29	89/07/05	89/12/06	90/03/14	90/06/14	90/09/10	90/12/06	91/03/21	91/06/06	91/09/11	91/12/19	92/03/04	92/06/03	92/09/01	92/12/08	93/06/08	93/12/06	93/12/08	94/08/14	94/12/05	94/12/07				
Time	1303	1135	1328	1107	1100	1220	1425	1210	1146	1126	1210	1143	1038	1436	1405	1220	1452	1203	1156	1030		1132				
G.W. Ele (ft-msl)	757.94	758.30	759.06	753.02	758.57	758.21	757.39	758.17	758.93	762.73	758.50	759.39	759.56	759.35	756.27	759.39	758.73	759.39	759.39	759.49	758.90	758.90				
Well Depth (ft)	66.70	66.60	66.70	0.00	66.51	66.51	66.41	66.41	66.41	66.31	66.51	66.51	66.51	66.51	66.51	66.41	66.41	66.44	66.44	66.24	0.00	66.44				
Depth to Water (ft)	11.29	10.93	10.20	16.21	10.70	11.02	11.84	11.06	10.30	6.50	10.73	9.84	9.65	9.88	12.96	9.84	10.50	9.84	9.84	9.74	10.34	10.34				
Calc. ref pt (ft-msl)	769.23	769.23	769.26	769.23	769.26	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23	769.23				769.26
			Well No.	13B																						
Date	89/01/05	89/03/29	89/06/29	89/09/14	89/12/05	90/03/12	90/06/06	90/09/10	90/12/06	91/03/21	91/12/19	92/03/04	92/06/03	92/09/01	92/12/08	93/12/06	93/12/08	94/12/05	94/12/07							
Time	930	1100	1519	1202	1025	1427	1018	1312	1256	1150	1116	1023	1408	1341	1208	1205	1141		1121							
G.W. Ele (ft-msl)	757.48	757.88	758.63	757.71	755.55	758.24	757.58	757.48	757.85	746.62	759.29	759.39	759.16	748.43	761.22	758.70	758.63	758.47	758.60							
Well Depth (ft)	84.29	84.42	84.42	84.42	0.00	84.19	84.42	84.29	84.19	84.29	84.42	84.42	84.42	84.42	84.42	0.00	84.39	0.00	84.39							
Depth to Water (ft)	13.06	12.66	11.91	12.83	14.99	12.30	12.93	13.06	12.70	11.91	11.25	11.16	11.39	22.11	9.32	11.84	11.91	12.07	11.94							
Calc. ref pt (ft-msl)	770.54	770.54	770.54	770.54	770.54	770.54	770.51	770.54	770.54	770.54	770.54	770.54	770.54	770.54	770.54	770.54	770.54	770.54	770.54							770.54

			Well No.	14A																						
Date	89/01/05	89/03/30	89/07/06	89/07/06	89/09/18	89/11/30	90/03/12	90/09/12	90/12/06	91/03/20	91/06/04	91/09/11	91/12/18	92/03/03	92/06/04	92/09/02	92/12/10	93/06/09	93/12/06	93/12/07	94/06/14	94/12/05	94/12/07			
Time	1445	1318	1257	1258	1438	1347	1050	1251	1415	1453	1243	1038	1618	1414	1229	1236	1258	1509	1014	1047	1504		1413			
G.W. Ele (ft-msl)	746.69	747.08	747.74	747.74	746.69	745.51	747.21	746.30	746.82	745.34	747.28	746.33	747.38	747.15	746.46	745.61	746.92	745.61	747.90	747.58	730.65	746.59	746.99			
Well Depth (ft)	27.10	27.10	27.10	27.10	27.10	0.00	27.00	27.00	27.00	27.00	26.90	27.10	27.10	27.10	27.10	27.10	27.10	27.10	27.10	27.10	27.07	0.00	27.07			
Depth to Water (ft)	14.63	14.27	13.62	13.62	14.67	15.81	14.11	15.06	14.50	13.91	14.04	10.01	13.98	14.21	14.90	15.75	14.44	15.75	13.45	13.78	30.71	14.78	14.37			
Calc. ref pt (ft-msl)	761.32	761.36	761.36	761.36	761.36	761.32	761.32	761.36	761.32	761.36	761.32	761.36	761.36	761.36	761.36	761.36	761.36	761.36	761.36	761.36	761.36	761.36	761.36			761.36
			Well No.	14B																						
Date	89/01/05	89/03/30	89/07/06	89/09/18	89/11/29	90/03/08	90/03/08	90/06/11	90/09/12	90/12/06	91/03/20	91/03/21	91/12/18	92/03/03	92/06/04	92/09/02	92/12/10	93/06/09	93/12/06	93/12/07	94/06/14	94/12/05	94/12/07			
Time	1415	1341	1242	1523	1329	1330	1331	1227	1232	1433	1517	1517	1758	1406	1222	1228	1246	1402	1016	1102	1449		1432			
G.W. Ele (ft-msl)	745.71	744.85	745.44	744.33	741.83	744.98	744.98	744.82	744.59	745.12	734.71	745.67	745.38	745.74	745.08	733.34	745.12	742.95	745.21	745.08	744.82	744.39	744.39			
Well Depth (ft)	42.69	42.68	42.69	42.69	0.00	42.69	42.69	42.69	42.59	42.59	42.49	0.00	42.69	42.69	29.99	42.69	42.69	42.72	43.31	43.31	43.31	0.00	43.31			
Depth to Water (ft)	15.65	16.47	15.88	17.03	19.49	16.34	16.34	16.70	16.73	16.21	26.64	15.65	15.95	15.58	16.24	27.99	16.21	16.37	16.11	16.24	16.50	16.93	16.93			
Calc. ref pt (ft-msl)	761.36	761.32	761.32	761.36	761.32	761.32	761.32	761.32	761.32	761.32	761.36	761.32	761.32	761.32	761.32	761.32	761.32	761.32	761.32	761.32	761.32	761.32	761.32			761.36
			Well No.	15A																						
Date	89/01/03	89/03/30	89/07/05	89/09/18	89/12/05	89/12/06	90/03/12	90/06/07	90/09/06	90/12/05	91/03/15	91/06/04	91/09/11	91/12/23	92/12/10	93/06/09	93/12/06	93/12/07	94/06/14	94/12/05	94/12/08					
Time	1330	1157	1655	1336	1409	1343	1226	1447	1352	1330	1358	1219	924	1204	1142	1303	1024	1140	1411		1440					
G.W. Ele (ft-msl)	788.75	788.16	788.06	787.28	784.19	785.01	788.75	785.93	785.83	787.70	788.33	788.36	785.54	787.08	786.29	785.31	788.56	788.59	787.31	787.34	787.18					
Well Depth (ft)	28.22	28.22	28.22	28.09	0.00	0.00	27.99	28.22	27.99	27.99	27.99	27.99	28.09	28.22	28.22	28.22	28.18	28.18	28.15	0.00	28.22					
Depth to Water (ft)	7.42	8.01	8.07	8.86	11.94	11.12	7.42	10.20	10.34	8.43	7.81	7.78	10.60	9.06	9.84	10.83	7.58	7.55	8.83	8.79	8.96					
Calc. ref pt (ft-msl)	796.17	796.17	796.13	796.13	796.13	796.13	796.17	796.13	796.17	796.13	796.13	796.13	796.13	796.13	796.13	796.13	796.13	796.13	796.13	796.13	796.13					796.17
			Well No.	15B																						
Date	89/01/03	89/03/30	89/07/05	89/09/18	89/09/18	89/12/05	90/03/08	90/06/07	90/09/06	90/12/05	91/03/15	91/12/23	92/12/10	93/06/09	93/12/06	93/12/07	94/06/14	94/12/05	94/12/08							
Time	1400	1147	1545	1323	1324	1421	1417	1411	1420	1355	1423	1127	1129	1252	1026	1150	1358		1451							
G.W. Ele (ft-msl)	791.34	791.15	790.92	789.67	789.67	788.00	790.52	788.49	788.06	789.74	791.15	789.34	788.69	788.72	790.52	790.36	789.77	789.28	789.28							
Well Depth (ft)	46.79	46.69	46.79	46.69	46.69	0.00	46.49	46.69	46.49	46.49	46.49	46.69	46.69	46.59	46.69	46.69	46.66	0.00	46.72							
Depth to Water (ft)	4.59	4.79	5.02	6.27	6.27	7.94	5.41	7.45	7.87	6.20	4.79	6.59	7.25	7.22	5.41	5.58	6.17	6.66	6.66							
Calc. ref pt (ft-msl)	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94	795.94							795.94
			Well No.	16A																						
Date	89/01/04	89/03/29	89/07/06	89/09/14	89/12/04	89/12/04	90/03/08	90/06/07	90/06/07	90/09/11	90/12/05	91/03/15	91/06/03	91/09/11	91/12/19	92/03/04	92/06/04	92/09/02	92/12/10	93/06/09	93/12/06	93/12/07	94/06/14	94/12/05	94/12/08	
Time	905	1519	1137	1457	1238	1239	1228	1219	1220	1250	1204	1203	1423	1011	1526	1256	1134	1135	1040	1128	1038	1247	1300		1350	
G.W. Ele (ft-msl)	761.45	763.03	759.09	758.80	758.04	758.04	758.80	755.25	755.25	758.76	755.15	756.76	755.45	758.34	761.09	763.52	762.90	753.42	762.14	765.03	761.08	761.13	763.78	762.37	762.47	
Well Depth (ft)	66.21	66.21	66.21	66.21	0.00	0.00	66.11	66.31	66.31	66.21	66.21	66.11	66.11	66.21	66.21	66.21	66.31	66.21	66.21	71.53	0.00	66.24	66.24	0.00	66.24	
Depth to Water (ft)	7.19	5.61	9.55	9.84	10.60	10.60	9.84	13.39	13.39	9.88	13.48	11.88	13.19	10.30	7.55	5.12	5.74	15.22	6.50	3.61	7.58	7.51	4.86	6.27	6.17	
Calc. ref pt (ft-msl)	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64	768.64
			Well No.	16B																						
Date	89/01/04	89/03/29	89/07/06	89/09/14	89/12/04	90/03/08	90/06/07	90/09/11	90/12/05	91/03/15	91/12/19	92/03/04	92/06/04	92/09/02	92/12/10	93/06/09	93/12/06	93/12/07	94/06/14	94/12/05	94/12/08					
Time	1000	1445	1113	1530	1330	1135	1148	1322	1140	1135	1504	1245	1120	1113	1028	1101	1040	1310	1312		1318					
G.W. Ele (ft-msl)	761.59	762.57	762.67	760.57	758.47	762.60	759.88	758.76	759.78	762.01	762.83	763.42	762.87	745.15	762.14	760.60	760.96	760.96	764.21	762.44	762.54					
Well Depth (ft)	75.00	75.00	75.00	75.00	0.00	74.91	75.10	75.00	74.91	74.91	75.10	75.10	75.10	75.10	75.00	75.04	75.07	75.07	75.07	0.00	75.07					
Depth to Water (ft)	6.56	5.58	5.48	7.55	9.68	5.51	8.24	9.35	8.37	6.14	5.32	4.72	5.28	23.00	6.00	7.55	7.19	7.19	3.94	5.71	5.61					
Calc. ref pt (ft-msl)	768.15	768.15	768.15	768.11	768.15	768.11	768.11	768.11	768.15	768.15	768.15	768.15	768.15	768.15	768.15	768.15	768.15	768.15	768.15	768.15	768.15					768.15

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3/28/96

TVA-00014394

CLOSURE/POST CLOSURE PLAN ASH POND AREA

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

SEPTEMBER 1995

TVA

Prepared By:

Tennessee Valley Authority
Site and Environmental Engineering Section

Title: CLOSURE/POST-CLOSURE PLAN ASH POND AREA				Report No: N/A
				Plant/Unit: KINGSTON FOSSIL PLANT
Vendor	Contract No.	Key Nouns: Closure Plan, Ash Pond		
Applicable Design Documents	REV	RIMS NUMBER	DESCRIPTION	
	R0		Original Submittal	
References	R1		Correct for NOD from DSWM	
	R2			

TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO POWER
FOSSIL ENGINEERING
SITE AND ENVIRONMENTAL ENGINEERING

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REGISTERED ENGINEER
No. 015576
STATE OF TENNESSEE

Harold L. Petty

4/6/98

	Revision 0	R1	R2
Date	September 29, 1995	4/06/98	
Prepared	B. Keith Elder	BKE	
Checked	Harold L. Petty	HLP	
Reviewed	Kenneth W. Burnett	KWB	

CLOSURE/POST-CLOSURE PLAN
ASH POND AREA
TENNESSEE VALLEY AUTHORITY
KINGSTON FOSSIL PLANT

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APPENDICES

A. TVA Vegetation Specifications
B. TCLP and VOC Testing of KIF Ash
C. Groundwater Sample Collection Techniques and Quality Assurance Procedures
D. Hydrogeologic Evaluation of Ash Pond Area

I. INTRODUCTION

A. Facility Description

Kingston Fossil Plant (KIF) is located at the base of a peninsula formed by the Clinch and Emory River embayments of Watts Bar Lake about 2.7 miles above the confluence of the Clinch and Tennessee Rivers in Roane County, Tennessee (see Figure 1). The plant has 9 coal fired units with a total generating capacity of 1600 megawatts. On-site construction of the Kingston Steam Plant began in April 1951. The first unit was placed in commercial operation in February 1954 and the final unit began in December 1955.

B. Operational History

The combustion of coal for the purpose of generating electricity results in the production of by-products that include fly ash and bottom ash. The KIF produces approximately 386,000 cubic yards of ash per year. The present coal ash disposal method at KIF is sluicing fly ash and bottom ash to the active ash pond, which is approximately 100 acres in size and is located east of the three dredge cells. This pond requires periodic hydraulic dredging to maintain compliance with the NPDES Permit free water volume requirement. The ash dredged from this pond has been hydraulically conveyed to settling ponds (dredge cells)west of the active ash pond.

This Closure/Post-Closure Plan is for the Ash Pond Area, including the active ash pond, three dredge cells, and the stilling pool, of approximately 250 acres located northeast of the generating facility.

C. Expected Year Of Closure

The active ash pond receives ash from the powerhouse. The dredge cells receive ash from the active ash pond. The amount of cubic yards of dredged material removed from the active ash pond each year ranges from 120,000 to 440,000 with an average of 285,000 cubic yards to be dredged. On a yearly basis, approximately 386,000 cubic yards of ash are produced at the KIF. It is estimated that a total of approximately 10,200,000 cubic yards of volume is available for ash disposal within the dredge cells, in the dredge cells dikes, and in the ash material required to form the crest of the dredge cell area. Additional ash storage will also be available within the active ash pond.

The actual closure date will be affected by both ash production and ash utilization. However, in accordance with the DSWM solid waste regulations (March 18, 1990) TVA proposes to close this area in accordance with plans contained in this document. The proposed closure date is the year 2015.

D. **Facility Contact**

The name, address, and telephone number of the TVA contact for Kingston Fossil Plant is as follows:

Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, TN 37763
(423) 945-7212

As of date of this report, the plant manager is Mr. Nathan Burris.

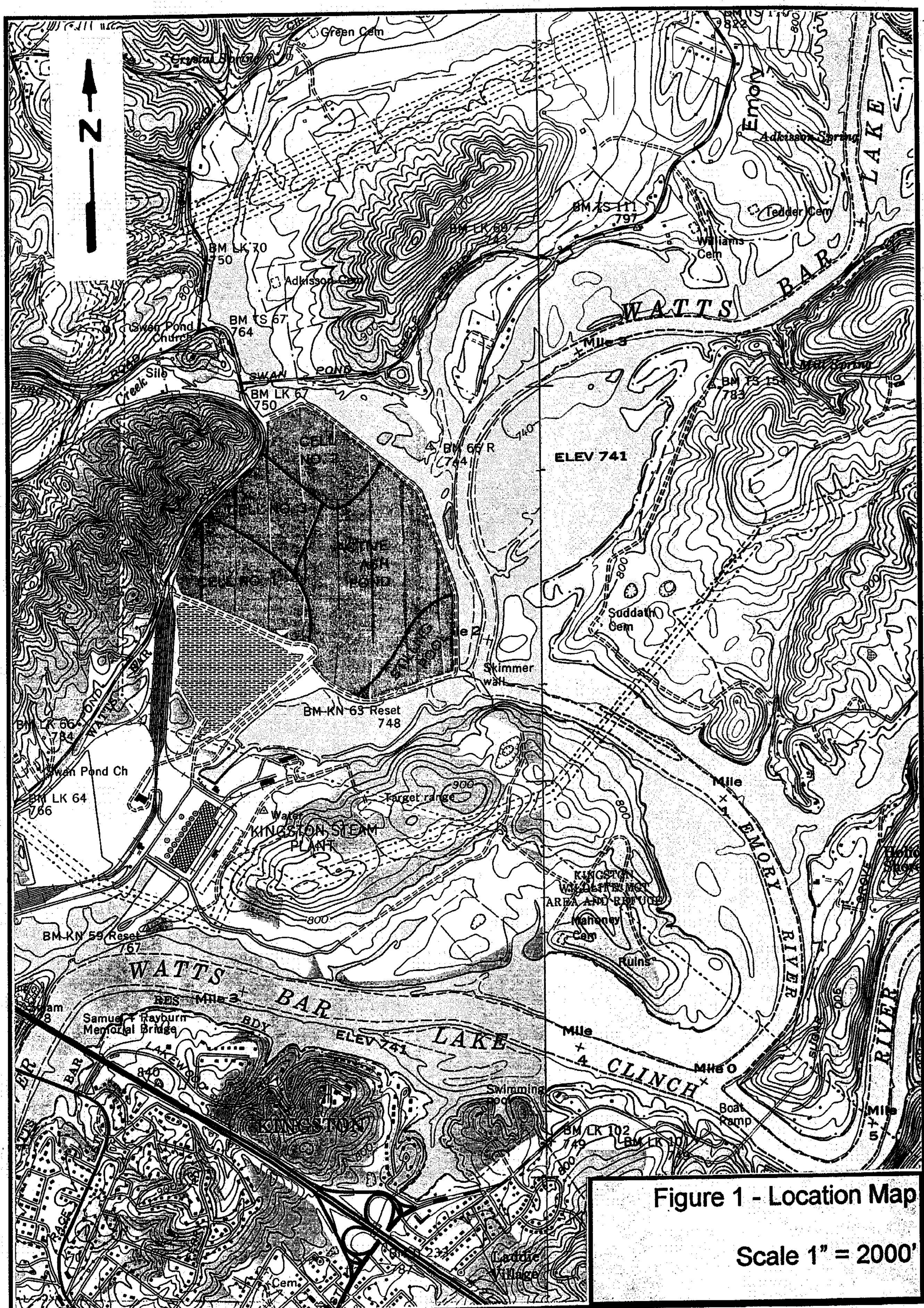

Figure 1 - Location Map

Scale 1" = 2000'

II. FACILITY CLOSURE

A. Partial Closure Steps

This section is for the purpose of explaining the steps that will need to be followed should the Ash Disposal facility be closed prior to the projected closure date discussed in Section I Subsection C, Expected Year of Closure. A basic premise for partial closure of the disposal facility is that this facility, if closed before the projected closure date, will result in final grades that are less than the proposed final grades shown on the plans submitted as part of this Closure/Post-Closure Plan. If such a partial closure is implemented, TVA will be required to submit revisions to the Closure/Post-Closure Plan (to include drawings and narrative). The specific items that may need to be modified are listed in Section II Subsection B, Complete Closure Steps. Each item in Section II Subsection B, Complete Closure Steps should be addressed even if the response would be that no change is necessary.

B. Complete Closure Steps

1. Facility Operation

The ash handling procedure consists of:

(1) Bottom ash and fly ash are pumped through a series of pipes to a point southwest of the active ash pond. At that location the ashes travel in separate sluice channels to the active ash pond. The heavier bottom ash settles out of the flow along the course of the bottom ash channel. The bottom ash is removed by dragline and pans on a continuous basis to be used to construct the dredge cells. Lighter fly ash continues to be sluiced to the active fly ash pond through a lined channel. This channel is presently synthetically lined but is gradually being replaced with rip rap lining.

(2) The fly ash and bottom ash waters continue into the active ash pond area. In this area a series of divider dikes and spillway skimmers separate the sluicing water from the transported ash. It is primarily fly ash that is deposited in the active ash pond.

(3) The sluicing water continues on through the stilling pool before it is discharged into the river. Within the stilling pool the water is treated with lime as needed to control the pH.

(4) The dredge cell dikes are constructed out of bottom ash material collected from the bottom ash sluice channel. This ash is collected and transported by pans to the dredge cell area. Pans, dozers, backhoe/loaders, front-end loaders and dump trucks are then used to shape and construct the dikes in accordance with the drawings included with this plan.

(5) During normal operation, material is then periodically dredged from the active ash pond and is hydraulically deposited to the interior of the dredge cell dikes.

(6) The disposal process is an essentially continuous incremental procedure. No daily earth cover will be required. Intermediate cover may be placed in areas of the dredge cell dike that do not achieve final contours and vegetated during inactive phases of operation. The ash is physically stable, nonputrescible, and is not an attractant for disease or animal vectors.

(7) The dredge cell side-slopes will continue at 3:1 with intermediate benches for erosion control and surface water drainage.

(8) Dust is controlled by utilizing a water tank truck as required on the haul roads and dikes.

(9) The ash disposal area dikes are formally inspected each spring.

2. Drainage System

The surface water drainage system will be operated with the same concepts as have proven to be historically successful during the operation of other TVA ash facilities.

The potential run-on from surrounding areas will continue to be intercepted in the existing diversion ditching network. The handling of this extraneous water assists in stormwater management and erosion control within the ash pond area.

The run-off from the dredge cell area will utilize the following method of controlling water. The run-off collection system will utilize side slope benches to control run-off by directing the water downslope along circuitous berm ditches on approximately one-percent (1%) slopes. These slopes and berm ditches will aid in controlling velocities and erosive forces while facilitating the deposition of ash that may accumulate in the run-off. Where the berm ditches are drained to the bottom of the dike area, scour will be controlled by lining the ditches with rock. The ditching from the dredge cell area flows to the active ash pond for additional sediment control. Discharge from the active ash pond is to an existing stilling pool on the site. This stilling pond is an NPDES permitted facility that provides surface water quality control and discharge of all ash dredge pond water used at the KIF (NPDES Permit No. TN0005452 DSN001).

Collection of any accumulated fly ash that settles in the ditches, settling pool or other areas will periodically be removed and placed within the dredge cell for disposal. As the height of the dredge cell dikes is raised on the 3 to 1 side slopes, the placement of intermediate cover material and establishment of vegetative cover will be accomplished as soon as possible. Past operations have maintained good attention to detail in this regard. This attention to detail will continue in order to keep the ash under erosion control and to prevent dusting.

3. Leachate Collection

This facility currently does not have a leachate collection system. Based on monitoring and model simulation at this facility as contained in the Hydrogeologic Report (Appendix D; *Hydrogeologic Evaluation of Ash Pond Area*), a leachate collection system is not required.

4. Gas Collection

Gas collection for ash disposal facilities is not applicable as so stated in DSWM Policy Memorandum SW-91-2. Ash produced from the combustion of coal is the principle waste material which will be deposited in this facility. Ash is completely composed of the noncombustible mineral components incorporated in the coal during its formation. Ash is basically inert, noncombustible, nonputrescible, and will not decompose to produce gases.

5. **Final Cover**

Final cover will be applied to the ash disposal area after dredging operations have been completed. The final cap to be utilized on top of the ash will be one of the following (from top layer downward):

- Soil suitable for the support of vegetation (12")
- Impervious liner (12" of clay compacted to achieve a maximum hydraulic conductivity of 1 x 10^{-7} cm/sec)

or

- Soil suitable for the support of vegetation (12")
- Drainage layer (geonet bonded with geotextile with a permeability of 1 x 10^{-1} cm/sec)
- Impervious liner (geosynthetic clay liner with a permeability of 1 x 10^{-9} cm/sec)
- Earthen liner (12" of clay compacted to achieve a maximum hydraulic conductivity of 1 x 10^{-6} cm/sec)

The footprint for the ash disposal area to receive final cover is shown on drawing 10W426-2. The footprint of the dredged ash stacking area is shown in detail on the 10W425 drawing series. These drawings are submitted as part of this Closure/Post-Closure Plan.

The continued use of the dredge cells until their closure will result in an increase in the vertical dimensions but no increase in the footprint. The dredged embankment of ash is proposed to be constructed to an approximate maximum final elevation of 866 msl. The closure of the dredge cell area to this grade, as shown on the drawings, will allow the area of 3 to 1 side slopes to be maximized while minimizing the amount of relatively flat surface area that will be the final top of the area. This final grading will facilitate controlling run-off of precipitation and further minimize the generation of leachate or accumulation of moisture within the ash.

6. **Intermediate Cover**

Intermediate cover consisting of 6-12 inches of compacted soil suitable for the support of vegetative cover is to be placed on areas that have not achieved final grades and will not receive ash for extended periods. During subsequent stages in the development of the area this cover may be removed and used elsewhere if practical.

7. Vegetative Cover

The conditioning, fertilizing and seeding of the intermediate and/or final cover in order to establish an adequate vegetative cover shall begin immediately upon placement of the intermediate and/or final cover. The applicable seeding methods and types to be used for vegetation will be selected in consideration of seasonal and other factors. TVA specifications for seed mixture application are included in Appendix A.

8. Groundwater Monitoring

(1) Compliance Monitoring Boundary

The compliance monitoring wells designated for the ash pond area as follows:

Upgradient Well - well 16A
Downgradient Wells - wells 4B, 6A, and 13B

The location of these wells are shown in Appendix D, Figure 1. The upgradient well (16A) is located on the north side of Swan Pond Road, northwest of the line separating dredge cells 1 and 3. Downgradient well 4B is located on the perimeter of the dike north of dredge cell 2; well 6A is located on the southeast corner of the perimeter dike near the stilling pool; and well 13B is located south of the toe of the dike near the fly ash sluice channel.

The compliance monitoring boundary of the facility will be defined by the segment of the ash pond area perimeter lying between the three down-gradient monitoring wells.

(2) Monitoring System for the Existing Facility

A groundwater monitoring system is in place and was installed to support assessment and permitting activities at Kingston. An evaluation of the monitoring data collected to date is included in Appendix D, Hydrogeologic Evaluation of Ash Pond Area, Kingston Fossil Plant, June 1995.

(3) Detection Monitoring Program

a. Sampling and Analysis Plan

Unfiltered groundwater samples will be collected semiannually from wells 4B, 6A, 13B and 16A. The groundwater samples will be analyzed for the constituents listed in Table 1.

Water surface elevations will be obtained on the same day on the Kingston reservation prior to sampling.

At the end of 8 sampling events, based on the data, TVA may request a variance from this plan to eliminate constituents that consistently show at or below method detection limits.

Table 1. Chemical Analyses for Groundwater Samples

Field Analyses

Acidity	Alkalinity
Conductivity	Depth to Water
Dissolved Oxygen	ORP
pH	Temperature

Laboratory Analyses, Filtered Samples

Antimony	Chromium	Lead	Silver
Arsenic	Cobalt	Mercury	Thallium
Barium	Copper	Nickel	Vanadium
Beryllium	Fluoride	Selenium	Zinc
Cadmium			

All sample analysis will be performed in accordance with US EPA SW 846 methods.

Monitoring for volatile organic compounds (VOC's) (listed in DSWM Solid Waste Regulations Appendix I) will not be necessary for this facility since these VOC's are not known or suspected to be constituents of coal fly ash. If any of these constituents were present in the coal, which is unlikely, the high temperatures of the combustion process (greater than 2,000 degrees F) would be expected to decompose or drive off all volatile constituents. TVA has conducted tests of fly ash for the presence of VOC's and the results indicated the VOC's were "nondetectible". These data are available for review in Appendix B.

b. Record Keeping and Reporting

A project field notebook will be maintained by the sampling survey leader to record pertinent information and observations. The survey leader will record all physical measurements, field analyses, and any pertinent observations in the project field note book. Auxiliary data that may prove useful in the interpretation of the water quality results will be recorded, e.g. the observation of gas bubbles in the sample line, rapid development of turbidity or color in the sample, equipment problems, and weather conditions. All field and laboratory data will be archived in STORET and reported to the project engineer.

Monitoring data will be reported in writing to the DSWM within 30 days after the completion of the analyses, beginning with the next routine sampling data following approval of this closure plan.

c. Well Plugging

Wells 5A, 5B, and 6B will be closed according to proper well abandonment procedures. Those consist of grouting the well casing by trimie methods with a high-swell bentonite grout, removing the upper 5 feet of well casing and compacting soil in the lifts above the abandoned well.

9. Closure Schedule

Upon determination that the closure of the facility is forthcoming a notification of TVA's intent to close the facility must be sent to DSWM sixty (60) days prior to the closure date.

After the final grade of ash has been reached, closure activities to include final grading and vegetative cover must be complete as soon as possible but are not to exceed 180 days.

TVA must notify DSWM in writing of completion of closure of the Ash Pond Area. Such notification must include a certification by TVA that the disposal facility has been closed in accordance with the approved Closure/Post-Closure care plan. Within 21 days of the receipt of such notice DSWM is supposed to inspect the facility to verify that closure has been completed and is in accordance with the approved plan. Within 10 days of such verification, DSWM is supposed to approve the closure in writing to TVA. Closure shall not be considered final and complete until such approval has been made by DSWM.

10. Notice in Deed to Property

TVA is required to ensure that within 90 days of completion of final closure of the facility and prior to sale or lease of the property on which the facility is located, there is recorded, in accordance with State law, a notation on the deed to the property or on some other instrument which is normally examined during title search that will in perpetuity notify any person conducting a title search that the land has been used as a disposal facility.

11. Post-Closure Care Activities

During the post-closure care period, the operator must, at a minimum, perform the following activities on closed portions of his facility:

1. Maintain the approved final contours and drainage system of the site such that precipitation run-on is minimized, erosion of the cover/cap is minimized, precipitation on the stack is controlled and directed off the stack, and ponding is eliminated.

2. Ensure that a healthy vegetative cover is established and maintained over the site.

3. Maintain the drainage facilities, sediment ponds, and other erosion/sedimentation control measures (if such are present at the disposal site), at least until the vegetative cover is established sufficiently enough to render such maintenance unnecessary.

4. Maintain and monitor the ground water monitoring system. The monitoring system and sampling and analysis program established in the previous sections shall be continued during the post-closure care period, unless the Closure/Post-Closure plan is modified to establish a different system or program. Monitoring data must be reported in writing to the DSWM within 30 days after the completion of the analysis.

12. Cost Estimate/Financial Assurance

TVA is an agency and instrumentality of the United States created by the TVA Act of 1933, 16 U.S.C. 831-

831dd (1988). TVA is not required to provide financial assurance in accordance with DSWM Solid Waste Regulations rule 1200-1-7-.03 (1)(b)(3) page .03-1. If requested, TVA will provide DSWM a copy of its cost estimate for the closure after the project is authorized for construction.

13. Dredge Cell Stability

The stability of the proposed dredge cell slopes was tested by using the UTEXAS3 computer program. Several methods for computing the factor of safety are available in the program. The Spencer method was chosen for this analysis since it satisfies both the force and moment balance for static equilibrium. The program can also perform two stage analyses to simulate undrained loading after a period of consolidation, which is pertinent for a pseudostatic seismic stability analysis.

Both a static analysis and a pseudostatic seismic analysis were performed on the proposed dike configuration with 3H:1V slopes and berms. The static analysis for long term conditions using R-bar strengths yielded a factor of safety of 1.75. The critical shear surface from the long term static analysis was used as the failure surface in the pseudostatic analysis. The maximum horizontal equivalent acceleration (MHEA) was calculated at the base of the critical shear surface and this value was input to UTEXAS3 for the seismic factor. The simulation yielded a factor of safety of 1.17 for the pseudostatic seismic case. A yield factor (K_y) of 0.11g was then calculated using the static critical shear surface. The maximum acceleration (K_{max}) at the base of the critical shear surface and the period (T_0) were calculated using the WESHAKE site response analysis program. These values were used in the Makdisi & Seed deformation chart (Figure 4 in "Technical Guidance Document, Tennessee Division of Solid Waste") to calculate a displacement of 2.3 to 7.6 inches at the base of the critical shear surface. The dredge cells have no liner or leachate collection system with which to compare the deformations, but the deformations are less than one-half of the thickness (2 feet) of the proposed cover system.

III. QUALITY ASSURANCE/QUALITY CONTROL

A. General

The purpose of this plan is to establish standards that must be followed by the registered professional engineer or geologist in order to insure that the construction of the facility meets the specification given in the design documents. The professional engineer or geologist shall use sound judgment when determining what additional procedures may be required in order to further assure the construction quality.

The Quality Assurance/Quality Control shall be performed by personnel that are knowledgeable and proficient in material placement, sampling, testing and reporting.

Detailed in this plan are the minimum standards for soil selection, minimum testing programs, minimum construction standards, and the minimum documentation required to assure that the requirements of the plans and specifications are met.

Throughout this document, the word "clay" is used to mean material of low permeability. This may include soil classified as clay or mixtures of soil with additives as required to meet the specifications.

B. Cap Requirements

The soil in the lower 12" layer of the final cap for the dredge cell area will meet the following requirements:

- A saturated, vertically oriented hydraulic conductivity no greater than 1 X 10^{-7} cm/sec (Cover Option 1) or 1 X 10^{-6} cm/sec (Cover Option 2) after compaction within the density and moisture content range specified for construction as determined through laboratory testing.
- A classification of CH or CL as determined by the Unified Soil Classification System, ASTM standard D-24887-69.
- Any alternative soil proposed will include documentation proving that the soil can be compacted to achieve the hydraulic conductivity and engineering properties of the soil specified above.

Clay Source Verification: The clay source will be tested and verified by a registered professional engineer or geologist as meeting the standards specified. Random samples of the source material will be obtained every 3,000 cubic yards and whenever the texture, color, or location of the source of the soil changes significantly. Samples will be tested for the following such that a correlation to permeability may be made:

1. Moisture-density relationship of the soil by the Standard Proctor Test, (ASTM D698);

2. Grain size analysis (ASTM D422);

3. Atterberg Limits (ASTM D4318).

Cap Construction: The cap will be constructed as outlined below:

1. Lift thickness of no more than 8 inches, loose lift (prior to compaction).

2. Each lift is thoroughly and uniformly compacted to that density and within that moisture content range determined necessary to achieve a hydraulic conductivity less than 1×10^{-7} cm/sec (Cover Option 1) or 1×10^{-6} cm/sec (Cover Option 2).

3. Generally, soil will not be compacted at moisture contents less than optimum, nor less than 95% of the maximum dry density, as determined by the Standard Proctor Test, ASTM D698; unless based on testing, that compaction criteria greater than 85% saturation consistently achieves the performance for hydraulic conductivity

4. The cap will be continuous and completely keyed together at all construction joints. Where required, the previous lift or area of construction shall be scarified to facilitate bonding between lifts.

5. During construction, the clay will be protected from detrimental climatic effects by:

   - Protecting construction from extraneous surface water, sloped to facilitate drainage;

   - Removing all ice and snow prior to placing a lift, and not using frozen soil in any part of cap;

- Recompacting any soil that has been subjected to a freeze and thaw cycle.

- Insuring that the cap is not subject to desiccation cracking by sprinkling the soil with water not less than twice per day, covering or tarping the soil, or other preventative measures;

- Removing soil which has experienced desiccation cracking before compacting the next lift or installing the next cap system component.

- By removing excessively wet soil or areas determined to be not acceptable by the registered professional engineer or geologist.

6. If the construction has areas determined to be not acceptable by the registered professional engineer or geologist, remedial actions shall be taken. As a minimum, additional tests may be required to locate the extent of the unacceptable area. It shall be remedied based on the engineer's or geologist's sound judgment. Actions may include recompaction or removal and replacement of unsatisfactory material with new material, compaction and retesting.

Documentation of these procedures shall be provided by the engineer or geologist.

Clay Construction Certification: A registered professional engineer or geologist will verify that a compacted cap is constructed in accordance with these criteria by performing all of the following quality control tests.

1. Field density-moisture measurements of the cap immediately after compaction, as specified by ASTM D2922 (nuclear methods), for each 3000 cubic yards placed, with a minimum of 1 test per day of construction of lift of soil. The location of the soil samples will be rotated with each lift to maximize the coverage of the tests. Field in-place density/moisture content tests will be conducted using a nuclear density gauge, sand cone or drive cylinder. If nuclear density methods are used sufficient numbers of the sand cone or drive cylinder tests will be performed to correlate and verify the nuclear gauge results. The moisture content of the fill materials will be kept within a range which allows the earthwork contractor to achieve the required

density and permeability. When, in the opinion of the certifying Engineer or Geologist the moisture content of the fill material is too high or too low, the material will be alternately dried or moistened to facilitate compaction to the specified density.

2. The undisturbed hydraulic conductivity of a soil sample will be conducted at a minimum once per 5 acres of the cap, by ASTM D5084. Permeability samples will be obtained by extracting a Shelby tube sample from the in-place compacted material and returning this sample to the laboratory for testing. The hole left by the Shelby tube will be carefully backfilled with bentonite mixture, hand tamped and compacted into place.

3. Upon completion of the clay construction, a minimum of one hand auger hole per acre will be made to confirm the final thickness of the soil layer. All auger holes will be backfilled as discussed above in section 2.

4. Provide documentation of the quality control measures performed with field notes and certifications.

5. The soil to be utilized for establishing the vegetative cover shall be capable of sustaining a healthy stand of vegetation, and shall consist of an ML, CL, SM, SC material as determined by ASTM D-2487-93. Material should contain less than 30% by weight of the fragment retained on a 3/4-inch sieve per ASTM D422-63. Once this soil has been applied and placed the area shall be seeded as soon as practical in order to minimize soil erosion. The soil for vegetation shall not be compacted such that vegetative growth is hindered. The top surface of the soil for vegetation may need to be roughened to create a favorable environment for vegetation to grow in. The seeding and fertilization schedule can be found in Appendix A of this manual.

The TVA specifications shown in Appendix A shall be modified to change the following: (1) reference to topsoil to read soil suitable for vegetative growth, (2) Section 580.3 shall be modified to provide 12" of soil suitable for vegetative growth to match the cap section detail shown on the plans (3) Section 580.4 - seed beds to be roughened or scarified shall be done in such a manner that will not damage the portion of the cap that consists of the 12" of soil with a maximum hydraulic conductivity of 1×10^{-7} cm/sec.

C. Documentation

1. Daily Logs

a. The personnel performing Quality Assurance/Quality

Control shall prepare a daily log giving the detailed descriptions of the cap construction operations.

b. The daily log shall include but not be limited to: Construction operations and their locations, operations and locations of other QA/QC engineers or geologists, all tests performed and their designation and location, all the locations and designations of samples taken, locations and findings of core sampling, meteorological conditions, and general comments and observations.

c. A copy of the daily logs shall be kept on site and made available to TVA, the QA/QC personnel, and the construction contractor.

d. All field and laboratory test data shall be accompanied by test/sampling data, location, reasons for the location, personnel and any comments.

2. **Approval Documentation**

a. All corrective measures taken to bring unsuitable work into conformance with the design specifications must be documented. This document must describe what is at fault and the exact location and test designation(s) that shows the work to be unsuitable, the corrective measures agreed upon to bring it into conformance with design specifications, the dates that corrective work was accepted, and the test designation that shows the work to be acceptable. All work shall be documented as to quality and verified by the engineer or geologist.

b. The documentation will be organized and indexed to enable easy access and retrieval of original inspection and testing data sheets and reports. During the construction period, originals of the documents will be maintained by the engineer or geologist and copies will be kept by the TVA. Once the construction quality assurance has been certified by a registered engineer or geologist and has been accepted by the Owner, originals of the documentation will be maintained by TVA through the closure and post closure period of the site.

APPENDIX A

TVA Vegetation Specifications

SECTION 580 - Seeding (Pay Item 580)

580.1 -- Description

This specification consists of furnishing and placing seed, commercial fertilizer, and agricultural limestone on roadway slopes, shoulders, borrow pits, channel banks, waste areas, lawns, meadows, beaches, open play areas, and other areas specified by the plans or the Engineer and in accordance with the methods outlined by these specifications.

580.2 -- Materials

1. Seeds

   Seeds shall meet the requirements of applicable seed laws and shall be tested in accordance with the most current edition of the U.S. Department of Agriculture Handbook No. 30, Testing Agricultural and Vegetable Seed. Seeds shall be from the last preceding crop and comply with the requirements outlined below for purity and germination. Each variety of seed shall be furnished in separate, strong bags with each bag being fully tagged or labeled to show the variety, weight, purity, germination, and test data prescribed by law. All test results shall be fully certified by the vendor or by a recognized seed testing agency. TVA reserves the right to require that samples be furnished, and to inspect and test the seeds after delivery. Seeds found not to comply with specification requirements shall be subject to rejection.

   When mixing or forming seed mixtures, the seeds shall be carefully and uniformly mixed. Seeds shall not be mixed until each variety of seed to be used in the mix has been inspected and/or tested separately and approved.

Seed Varieties	Purity, Minimum %	Germination, Minimum %
Korean Lespedeza (Lespedeza stipulacea), scarified . . .	90	85
White Clover (Trifolium repens)	95	85
Alsike Clover (Trifolium repens hybridum)	95	85

580.2 -- Materials (Continued)

Seed Varieties	Purity, Minimum %	Germination, Minimum %	
Red Clover (Trifolium pratense)	85	95	
Crownvetch (Coronilla varia), scarified	95	80	
Foxtail Millet (Setaria italica)	80	98	
Bermuda Grass (Cynodon dactylon), hulled	95	80	
Annual Rye (Lolium multiflorum)	90	90	
Perennial Rye (Lolium perenne)	90	90	
Kentucky 31 Fescue (Festuca arundinacea, variety Ky 31)	95	85	
Rebel Fescue (Festuca arundinacea, variety Rebel)	95	85	1
Hard Fescue (Festuca ovina, duriuscula)	95	85	1
Kentucky Bluegrass (Poa pratensis)	95	90	
Creeping Red Fescue (Festuca rubra)	95	90	
Centipede Grass (Eremochloa ophiuroides)	90	75	
Weeping Lovegrass (Eragrostis curvula)	95	90	
Switchgrass (Panicum virgatum)	80	75	1
Zoysia Grass (Zoysia japonica)	95	80	
Little Bluestem Grass (Andropogon scoporius)	40	60	
Bahia Grass (Paspalum notatum)	75	80	
Buffalo Grass (Buchloe dactyloides)	85	50	

580.2 -- Materials (Continued)

Seeding materials shall be free from seeds or bulbets of Wild Onion (Allium vineale), Canada Thistle (Cirsium arvense), and Johnson Grass (Sorghum halepense).

Seed species shall not contain more than six seeds per ounce of the seed of any of the following noxious weeds or the seeds of any other weed specifically listed as noxious:

Bindweed (Convolvulus arvensis)
Buckthorn (Plantago lanceolata)
Corncockle (Agrostemmo githago)
Dodder (Cuscuta species)
Oxeyedaisy (Chrysanthemum leucantheumum)
Quackgrass (Agropyron repens)
Sorrel (Rumex acetosella)

Seed species shall not contain an excess of 2 percent by weight of weed seeds, noxious or otherwise.

2. Seed or seed mixtures, rates, and seasons

Seeding mixtures, rates, and seasons shall be those specified herein. The types to be used for each area or project will be specified by the drawings or by memorandum. Mixtures or rates of application other than those specified shall be used only when specified by the plans or the Engineer. Seeding shall be planted during the season and between the dates specified. Temporary cover shall be planted when it is required during seasons not suitable for planting the seed specified by the plans.

a. Lawns

Type 1: Spring or fall seeding (Plant between March 15 and May 1, or between August 15 and October 15).

(1) Kentucky 31 Fescue . . . 120 pounds per acre
(2) Rebel Fescue . . . . 120 pounds per acre | 1
(3) Creeping Red Fescue . . 80 pounds per acre

Type 2: Fall seeding (Plant between August 15 and October 15).

(1) Perennial Ryegrass . . . 120 pounds per acre
(2) Kentucky Bluegrass . . . 80 pounds per acre

Type 3: Spring seeding (Plant between March 15 and May 1).

Bermuda Grass . . . . 40 pounds per acre

580.2 -- Materials (Continued)

b. Meadows

Type 4: Spring seeding (Plant between March 15 and May 1).

Mixture:

(1) Kentucky 31 Fescue . . . 50 pounds per acre
Korean Lespedeza (scarified) . . . . . . 10 pounds per acre
Alsike Clover . . . . . 10 pounds per acre
Total mixture . . . 70 pounds per acre

(2) Bermuda Grass (hulled) . . . . 40 pounds per acre
Korean Lespedeza (scarified) . . . . . . 10 pounds per acre
Total mixture . . . 50 pounds per acre

(5) Crownvetch (inoculated and scarified) . . . . 30 pounds per acre
Kentucky 31 Fescue . . . 30 pounds per acre
Total mixture . . . 60 pounds per acre

Type 5: Fall seeding (Plant between August 15 and October 15).

Mixture:

(1) Kentucky 31 Fescue . . . 50 pounds per acre
White Clover . . . . 15 pounds per acre
Total mixture . . . 65 pounds per acre

(2) Bluegrass . . . . 50 pounds per acre
White Clover . . . . 15 pounds per acre
Total mixture . . . 65 pounds per acre

580.2 -- Materials (Continued)

c. Channel Banks, Cuts, Fill Slopes, Waste Areas, and Other Disturbed Areas

Type 6: Spring seeding only (Plant between March 15 and May 15).

Mixture:

(1) Kentucky 31 Fescue . . . 60 pounds per acre

(2) Bermuda Grass (hulled) . 40 pounds per acre

(3) Creeping Red Fescue . . 80 pounds per acre
(Shaded slopes only)

(4) Weeping Lovegrass . . . 15 pounds per acre
Korean Lespedeza
(scarified) . . . . 10 pounds per acre
Total mixture . . . 25 pounds per acre

(7) Crownvetch (scarified
and inoculated) . . . . 30 pounds per acre
Kentucky 31 Fescue . . . 30 pounds per acre
Total mixture . . . 60 pounds per acre

(8) Bahia Grass . . . . 40 pounds per acre
Bermuda Grass . . . . . . 20 pounds per acre
Switch Grass . . . . . . 10 pounds per acre
Total mixture . . . 70 pounds per acre

(9) Rebel Fescue . . . . . . 40 pounds per acre
Hard Fescue . . . . 10 pounds per acre
White Clover . . . . . . 5 pounds per acre
Total mixture . . . 55 pounds per acre 1

580.2 -- Materials (Continued)

c. Channel Banks, Cuts, Fill Slopes, Waste Areas, and Other Disturbed Areas (Continued)

Type 7: Summer seeding (Plant between May 15 and July 15).

Mixture:

(1) Bermuda Grass (hulled) . 40 pounds per acre
Korean Lespedeza
(scarified) . . . . 10 pounds per acre
Total mixture . . . 50 pounds per acre

(2) Buffalo Grass . . . . . . 40 pounds per acre
Korean Lespedeza
(scarified) . . . . 10 pounds per acre
Total mixture . . . 50 pounds per acre

Type 8: Fall seeding (Plant between August 15 and October 15).

(1) Kentucky 31 Fescue . . . 60 pounds per acre
White Clover . . . . 15 pounds per acre
Total mixture . . . 75 pounds per acre

(2) Hard Fescue . . . . 10 pounds per acre
Rebel Fescue . . . . 40 pounds per acre
White Clover . . . . 5 pounds per acre 1
Total mixture . . . 55 pounds per acre

(3) Rebel Fescue . . . . 40 pounds per acre
Hard Fescue . . . . 10 pounds per acre
White Clover . . . . 5 pounds per acre
Total mixture . . . 55 pounds per acre

d. Highway Shoulders

The planting dates and seed mixtures for each type listed here are described above.

Type 6: Spring seeding [Mixture (1), (2), (3) or (9)]

Type 7: Summer seeding [Mixture (1) or (3)] 1

Type 8: Fall seeding [Mixture (2)]

580.2 -- Materials (Continued)

e. Temporary Cover

Type 9: Temporary winter seeding (Plant between October 15 and March 15).

Annual Ryegrass	80 pounds per acre
White Clover	10 pounds per acre
Total mixture . . .	90 pounds per acre

Type 10: Temporary summer seeding (Plant between May 1 and August 15).

Mixture:

(1)

Korean Lespedeza (scarified)	20 pounds per acre
Foxtail Millet	20 pounds per acre
Total mixture . . .	40 pounds per acre

(2)

Red Clover	20 pounds per acre
Weeping Lovegrass . . .	10 pounds per acre
Total mixture . . .	30 pounds per acre

3. Fertilizer

Fertilizers shall be those readily available commercially. The application of fertilizer shall be at a rate of 200 pounds Ureaform (38-0-0) per acre with either 400 pounds of 15-15-15 per acre or 600 pounds of 6-12-12, unless specified otherwise by the drawings or memorandum.

Ammonium nitrate (NH_4NO_3) may be used for supplemental fertilization when specified by the Engineer.

4. Agricultural Limestone

Limestone shall contain no less than 85 percent calcium carbonate by weight. It shall be crushed so that at least 85 percent will pass a No. 10 sieve. The application of limestone shall be at the rate of 2 tons per acre unless specified otherwise by the drawings or memorandum. Hydrated lime may be substituted at a rate of 1 ton per acre.

580.3 -- Topsoil

All lawn areas to be seeded shall have a 2-inch minimum depth of topsoil immediately below finish grade. Topsoil requirements for other areas, if any, will be determined by field inspection and shall comply with Section 581.3.

580.4 -- Soil Preparation

Areas to be seeded shall have approved cross sections and grades. Objects such as large roots, stones, stumps, coarse vegetation, debris, or any other items that might impede mechanical mowing shall be removed and disposed of satisfactorily.

Seedbeds shall be plowed, disked, harrowed, scarified, or cultivated to the approved depth. In areas where it is practical, this work shall be done with farm-type equipment. On steep slopes, preparation of seedbeds shall be done with the tools and methods specified by the Engineer. It is strongly recommended that scarifying and preparation of seedbeds on cut and fill slopes be accomplished with tools or equipment specially designed for this purpose. Small furrows or grooves formed in the slopes shall be horizontal or as nearly horizontal as practical. The work shall be performed only when the ground is in a workable and tillable condition as determined by good farming practices.

580.5 -- Special Hydroseeding Equipment

Equipment to be used for the hydraulic application of planting materials shall be a Finn Hydro-Seeder, Bowie Hydro Mulcher, Toro Environmental Control Unit, or an approved equal. The equipment shall have mixing tanks with built-in agitators having operating capacities sufficient to agitate, suspend, and homogeneously mix slurries of water and planting materials. Tanks shall have capacities of 1000 gallons or more, and shall be mounted on traveling units that can be either self-propelled or towed by a separate vehicle. The slurry distribution lines shall be large enough to prevent clogging or stoppage. Discharge lines shall be equipped with sets of different sized hydraulic spray nozzles capable of providing for even distribution of varying slurry mixtures on areas to be seeded. Slurry mixture rates are described in Section 580.6.

580.6 -- Seeding Methods

Seeds shall be sown with approved mechanical power-drawn drills or seeders, hand cyclone seeders, or with special hydroseeding equipment. Rates specified in Section 580.2 shall be maintained in a manner that will guarantee uniform coverage. Seeding operations shall not be performed when drought, high winds, and excessive moisture or other factors may defer satisfactory results.

On slopes where the use of drills or seeders is not practical and in other areas specified by plans or by memorandum, seeding shall be accomplished using hydroseeding equipment.

Drill seeding shall be performed in rows with spacing suitable for the type of seed or mixture used. Fertilizer may be drilled simultaneously if drills are equipped for this type of operation. Where fertilizer is not drilled, it may be applied during the cultivation operation described in Section 580.4. When fertilizer and seed are applied separately, the fertilizer shall be spread uniformly over the prepared seedbeds prior to final filling. Rates of application shall be those specified by the plans or the Engineer or those specified in this section. It shall be thoroughly mixed with soil for a depth of 1/2-inch.

580.6 -- Seeding Methods (Continued)

Care shall be taken to ensure that seed and fertilizer remain uniformly and thoroughly mixed in the seeding equipment. Additional mixing shall be performed if necessary to avoid segregation of the seed or seed and fertilizer.

Hydroseeding is the method of applying lime, fertilizer, seed, and mulch combined with water in a single operation. Using the equipment described in Section 580.5, mixing tanks shall be filled with water to the level indicated inside of the tanks. With the engines turned on and the agitators running, the following materials shall be added: (1) limestone at the specified rate of 1/5 per acre (finely ground); (2) fertilizer; (3) seed (Section 580.2); and (4) wood fiber mulch (Section 582.2), for each 1000 gallons of water. The resulting slurries shall be applied to seedbeds at a rate of 5000 gallons per acre.

When hydroseeding slopes are 2:1 or steeper, a vinyl or plastic mulch (Section 582.2) shall be added to the slurries at the rate specified by the manufacturer.

Discharge lines are activated by opening bypass valves with hand levers that allow the slurries to spray through the nozzles. Slurries shall be sprayed on the seedbeds as the spraying vehicles move slowly across the area. Care shall be taken to ensure that all areas are evenly covered. If wind or rough terrain causes skips to occur, additional applications shall be made before moving to other areas. To provide for the even distribution of a slurry, hydroseeding should be performed with the wind or preferably with no wind at all.

For steep slopes, even coverage is best obtained when an application is begun at the top and worked down a slope with successive overlapping passes. When a hydroseeder is located on top of a slope, the reverse is true.

Seed not sown by drills or hydroseeders shall be covered to a depth of approximately 1/4-inch by lightly harrowing or raking. Raking or harrowing shall follow contours as closely as practical.

Where mulching is to be done, the mulch shall be applied immediately after the seeding is completed to avoid the loss of soil moisture or possible erosion. Mulching shall comply with Section 182.

When specified by the Engineer, one or more applications of fertilizer shall be made after a stand of grass has been obtained and allowed to grow for a period of from 3 to 6 weeks. The grade and rate of application of the fertilizer will be specified by the Engineer. When ammonium nitrate or a similar soluble fertilizer is used alone, areas shall be thoroughly soaked as soon as an application is completed.

580.7 -- Maintenance

Seeded areas shall be maintained until a satisfactory cover of plant material is secured, unless stipulated otherwise. All areas shall be preserved, repaired, and protected as specified for this purpose. Areas having poor stands of plant material shall be seeded again and fertilized at the proper rates.

Watering shall be accomplished during the maintenance period to the extent necessary.

580.8 -- Method of Measurement

Seeded areas will be measured in square yard units and include the seeded areas along slopes.

580.9 -- Costs

Costs for Pay Item 580 shall include all materials, labor, tools, equipment, and incidentals necessary to complete the work for this item.

SECTION 582 - Mulching (Pay Item 582)

582.1 -- Description

This item consists of mulching roadway slopes, shoulders, or other areas by covering them with straw, hay, hydro mulch, or similar materials in accordance with these specifications and at the locations specified by the plans or the Engineer.

582.2 -- Materials

The materials used for mulching shall conform to the following requirements and must be approved by the Engineer before being used. The stems or stalks of straw, hydro mulch, and hay should be as long as is feasible to obtain an overlapping or shingling effect when these materials are applied. Materials containing large amounts of chaff, leaves, short fragments of straw, or stems will not generally be approved.

Straw shall consist of stalks of oats, rye, or wheat; straw is preferred.

Hay shall be obtained from any grasses or legumes that are reasonably free of noxious weeds.

Hydro mulch shall be a product manufactured from wood fiber, vinyl, or plastic materials designed specifically for use as a hydro mulch and for application by the hydro jet method.

Wood fiber mulch, such as Conwed "Hydro Mulch," Weyhauser "Silvafiber," or the equivalent, shall consist of a natural wood cellulose fiber which is readily dispersable in water, nontoxic to plant germination and growth, and does not react with other materials. The mulch shall be dyed, preferably green, to allow for visual metering during application. The moisture content shall be no greater than 12 percent, ash content no greater than 1 percent, and the pH no less than 4.5. The waterholding capacity measured in grams of water per 100 grams of fiber shall be a minimum of 1150 percent. The mulch shall be packaged in moisture-resistant bags.

Vinyl or plastic mulch, such as "Aerospray 70," "Terratack," or the equivalent, shall consist of a natural gelatinous material in a synthetic plastic, vinyl, or latex base that does not react with any other material. The mulch shall be readily dispersible in water, nontoxic to plant germination and growth, not hazardous to wildlife or the environment, and comply with Federal health standards. The material shall be acceptable in solid or liquid forms and packaged in measured containers.

Emulsified asphalt for adhesive shall conform to type SS-1 (Section 1115) except that the residue penetration at 25°C shall be 150 to 200. If type SS-1 is unavailable, emulsified asphalt type AE-3 may be used. Asphalt emulsions shall be prepared so that their specified characteristics will not change during transportation or normal storage. They shall be nontoxic to plants. Vinyl or plastic hydro mulch described previously may be used in place of asphalt where costs and availability permit.

582.3 -- Mulching

Hay or straw mulch shall be applied to a thickness of approximately 1 inch unless otherwise specified by the Engineer. This application corresponds to a rate of approximately 1 ton per acre. The exact thickness required will be determined by the Engineer for the material being used. It shall be loose enough to allow sunlight to penetrate small, closely spaced areas, air to slowly circulate, and thick enough to shade the ground and to reduce erosion and moisture loss.

Hay or straw mulch shall be applied by approved mechanical spreaders, such as the Finn Mulch Spreader. Throughout the mulching process, machines shall not appreciably cut or break the lengths of mulching materials. On slopes that are 4:1 or steeper, an adhesive consisting of an approved grade of emulsified asphalt shall be added at the rate of approximately 60 to 65 gallons per acre. Vinyl or plastic hydro mulch may be substituted for the asphalt and applied separately at the manufacturer's recommended rate.

Wood fiber hydro mulch shall be applied with special hdyro seeding equipment (Subsection 580.5). Mulch may be added to other planting materials and applied in one operation (Subsection 580.6) or it may be applied separately. When the mulch is applied separately, it shall be mixed at the rate of 400 pounds of mulch for each 1000 gallons of water and applied at the rate of 4000 gallons per acre.

Where mulching is applied to areas that are seeded or sprigged, the application of the mulching materials shall immediately follow the seeding or planting operations to avoid soil moisture loss or possible erosion.

The mulching materials shall be applied to produce a shingling or overlapping effect. On slopes the application shall begin at the lower edges of slopes and proceed upward.

Where mulch is not applied by a mechanical spreader, suitable methods shall be used to avoid the displacement of material such as by rolling with rollers, cultipackers, sheeps-foot rollers, or through the use of brush-mats, erosion nets, and other methods approved by the Engineer.

582.4 -- Maintenance

Mulching materials that become displaced or destroyed by wind, erosion, or other causes shall be replaced to maintain fully protected areas while the construction and maintenance of the project are in progress.

582.5 -- Method of Measurement

Areas specified to be mulched shall be measured in square yards along their slopes or other surfaces.

582.6 -- Costs

Costs for Pay Item 582 shall include all materials, labor, tools, equipment, and incidentals necessary to complete the work for this item.

APPENDIX B

TCLP and VOC Testing of KIF Ash

Lab Sample Number :92/01018 Project Leader :David M. Varnell

Sample ID Information :KIF-92-1
Sample comments :KINGSTON DREDGED ASH
Sample type/matrix :WASTE
Sample login date :920129 Sample received by lab :920128
Sample account number :8616-767000-X1340H

Alt. IDC	Analysis Performed	result	units
D004'AS	Arsenic, TCLP Extract	230.	ug/L
D010'SE	Selenium, TCLP Extract	11.	ug/L
D006'CD	Cadmium, TCLP Extract	5.	ug/L
D008'PB	Lead, TCLP Extract	25.	ug/L
D007'CR	Chromium, TCLP Extract	5.	ug/L
D005'BA	Barium, TCLP Extract	2100.	ug/L
D011'AG	Silver, TCLP Extract	< 10.	ug/L
D009'HG	Mercury, TCLP Extract	< 2.0	ug/L
TCLP'MET	Tox. Char. Leach. Metals	02/04/92	
RES'RCRA	Residue, RCRA Waste	980000.	mg/L
PH'RCRA	pH on RCRA Waste	7.6	pH Units

KINGSTON FOSSIL PLANT
ASH ANALYSIS

CHEMICAL ANALYSIS	FLY ASH 01/10/92 UNIT 5	FLY ASH 03/10/88 UNIT 7	FLY ASH 02/19/81 UNIT 6
SiO2	49.45	69.29	55.73
Al2O3	27.83	17.01	26.19
Fe2O3	13.16	7.15	6.53
CaO	2.29	1.2	2.72
MgO	0.88	1.66	1.11
SO3	0.03	0.36	0.29
Na2O	0.74	0.12	
K2O	2.32	1.2	
L.O.I.	5.35	0.04	

KINGSTON FOSSIL PLANT
BY-PRODUCT TCLP ANALYSIS

PARAMETER	DRINKING WATER STANDARD	TCLP BOTTOM ASH 12/90 5-SAMPLES	TCLP DREDGED ASH 03/92 KIF-92-1	TCLP FLY ASH 10/93 KFP FA 93
ARSENIC, (mg/L)	0.05	<0.05	0.23	2.2
BARIUM, (mg/L)	1	0.31-0.91	2.1	0.72
CADMIUM,(mg/L)	0.01	<0.01	0.005	0.001
CHROMIUM,(mg/L)	0.05	<0.01	0.005	<0.01
LEAD, (mg/L)	0.05	<0.05	0.025	0.002
MERCURY, (mg/L)	0.002	<0.0005	<0.002	<0.0002
SELENIUM, (mg/L)	0.01	<0.01	0.011	0.049
SILVER, (mg/L)	0.05	<0.01	<0.01	<0.01
pH		7.6		

APPENDIX C

Groundwater Sample Collection Techniques
and
Quality Assurance Procedures

Appendix C.

Groundwater Sample Collection Techniques and Quality Assurance Procedures

Groundwater Sampling Procedures

The following groundwater sampling procedures are based on TVA's Field Engineering Procedures Manual, Section ES-41.6, "Groundwater Sample Collection Techniques". The pump handling procedures do not apply to the dedicated sampling equipment installed in wells 13B and 16A.

Prior to any sampling or pumping, the depth to water surface (Dws) will be measured from the top of each well casing measured to the nearest centimeter with a tape and plunker or electronic water level indicator. The depth of the well (Dw) will be measured with a tape and plunker. Data, observations, and computations will be recorded on the appropriate field worksheet. The volume of water in the well (Vw), in liters, is calculated using the formula shown below:

$$Vw = (Dm)^2 \times \pi/4 \times 10^{-3} \times (Dw - Dws) \text{ or}$$

$$= (Dm)^2 \times 7.854 \times 10^{-4} \times (Dw - Dws)$$

Dm = well casing internal diameter in millimeters (mm);

Dw = Depth of well in meters;

Dws = Depth to water surface in meters.

(Note: Dm of wells 4B and 6A is 102 mm; Dm of wells 13B and 16A is 51 mm.)

"Good housekeeping" practices will be employed to minimize the potential for contamination caused by contact of the ground with the pump and pump tubing. Any equipment that enters a well will be placed on a clean tarpaulin or sheet of plastic. Prior to placing the pump into the well, the outside of the pump and the first few feet of tubing will be rinsed with distilled water.

The pump will be lowered to approximately 0.5 meters below the water surface before pumping commences. The pump will be lowered with the drop in water surface. This ensures that no stagnant water remains in the well after pumping. Ideally, at least two well volumes of water should be purged before sampling. For wells with slow recharge, the pump rate will need to be reduced to minimize the drawdown of the level in the well. If possible, drawing the water level down below the level of the screen will be avoided. Pumping rate and distance to the water surface will be recorded throughout the pumping procedure. If insufficient water for sampling exists after purging, the wells can be allowed to recover, but sampling should take place as soon after purging as possible. To lessen the chance of contamination, the same pump should be used for purging, monitoring of field parameters, and sampling. While pumping, temperature, pH, DO, ORP, and conductivity will be continuously monitored using a calibrated Hydrolab® flow through cell system to avoid air contact and recorded approximately every five minutes.

When the Hydrolab® readings have stabilized and at least two well volumes have been pumped, samples will be collected for the parameters listed in Table 1 of section II. B. 8. (3). The sample bottles must be labeled with the proper identification number. When filling the various sample bottles, care will be taken to minimize sample aeration by lowering the pumping rate if necessary. Some of the sample containers and bottles may contain a measured amount of chemical preservative. Consequently, the containers and bottles are <u>not</u> rinsed with sample water before filling. Care will be taken to avoid overfilling and diluting the preservative. It is especially important that TIC samples are collected with zero head space. Good technique includes filling the sample bottles one at a time and recapping before filling the next bottle.

Alkalinities will be titrated to pH 8.3 (phenolphthalein alk.) and pH 4.5 (total alk.); acidities will be titrated to pH 3.7 (mineral acidity) and pH 8.3 (CO2 acidity). All values will be reported as mg CaCO3/L.

Normally, 100 ml of sample are titrated with 0.02 N H2SO4 and 0.02 N NaOH. For highly alkaline or acidic samples, sample volume may be decreased or titrant strength increased. Note that 0.02 N NaOH is stable for only about three days.

Immediately after purging and sampling, the water surface depth will be measured. After the pumps are removed from a well, they should be rinsed and the sampling lines should be purged with clean water. Then any remaining water left in the pump and tubing will be pumped out before proceeding to the next well.

Any problem observed that might affect the quality of these procedures will be identified and noted in the project field notebook and on the appropriate field data sheet with the action(s) taken to resolve it. Problems which might affect quality include clogged sampling tubes, highly turbid samples, defective material or equipment, failure to comply with quality procedures, or other similar deficiencies.

Quality Assurance/Quality Control

Appropriate procedures regarding sample containers, preservation techniques, and holding times will be followed. Properly cleaned sample containers with pre-added preservative (where appropriate) will be used. Immediately following collection, samples will be placed in plastic bags and on ice. All shipping containers will be sealed and closed with strapping tape. Samples will be shipped to the analytical laboratory by an appropriate carrier to ensure that all holding times are met.

The sample collector will be responsible for the care and custody of all samples until they are properly dispatched to the receiving laboratory. When samples are dispatched to the laboratory for analysis, a completed Environmental Chemistry Analysis Request and Custody Record form, and copies of the field worksheets will accompany the samples. The sample collector will retain a copy of these forms. Note that the number and kind of sample bottles being sent to the laboratory are indicated. Sample identification numbers (tag numbers) shown on the Custody record will be clearly and permanently marked on all sample bottles. These sample tag numbers will also be cross-referenced on the field worksheets which record information about well location, date and time of collection, name of sample collector(s), water quality field data (physical and chemical), etc. All field and laboratory results are referenced to their unique sample tag numbers, thus maintaining sample traceability. The Sample Custody Record will also record the name and telephone number of the sample collector/shipper. The carrier's shipping record receipts for will be retained by the sample collector/shipper as part of permanent chain of custody documentation. Upon receipt, the laboratory will inspect for broken seals on shipping containers and will inspect the samples for breakage, missing samples, tampering, etc. The laboratory will verify by cross-referencing tag numbers between the Sample Custody Record and the sample bottles received that samples have been received complete and intact. The sample collector will be immediately notified by telephone of any discrepancies.

All samples will be analyzed by the Environmental Chemistry Laboratory for the constituents identified in the Sampling and Analysis Plan in section II. B. 8. (3). The analyses will be conducted according to the methods listed in Table 1 below.

The Laboratory will adhere to all quality assurance measures stated in the document, "TVA Environmental Chemistry Quality Assurance Program Operating Procedures Manual, Revision 1", December 1993. This manual is available for review upon request.

A sample Environmental Chemistry Analysis Request and Custody Record form is included in Appendix C.

Table 1. Sample Analysis Methods

Samples will be analyzed according to the methods listed below:

Parameter	Instrument	Method
Total Inorganic Carbon	Carbon Analyzer	OI 0524B
Chloride	Colorimeter	1-EPA 326.1
Sulfate	Colorimeter	1-EPA 375.1
Total Dissolved Solids		1-EPA 160.1
Al, B, Ba, Be, Ca, Cu,	ICP	2-EPA 6010
Fe, Mg, Mn, Sr, V, Zn	ICP	"
As	GFAA	2-EPA 7060
Sb	GFAA	2-EPA 7041
Cd	GFAA	2-EPA 7131
Cr	GFAA	2-EPA 7191
Pb	GFAA	2-EPA 7421
Ni	FAA	1-EPA 249.1
K	FAA	2-EPA 7610
Na	FAA	2-EPA 7770

Method Key

Code	Reference
OI 0524B	Instruction and Procedures Manual. Oceanography International Corporation. Section VII-IX, 1976.
1-EPA	Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.
2-EPA	Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Revision 2, June 1990.

TENNESSEE VALLEY AUTHORITY WATER MANAGEMENT
ENVIRONMENTAL CHEMISTRY ANALYSIS REQUEST AND CUSTODY RECORD

FORM CONTROL # 10810

ROJECT ID ______

REFERENCE: ☐ WORKPLAN ☐ OTHER

ACCT NO. ______

DATE REQUIRED ______

RESULTS TO ______

LAB USE ONLY

TEST IDC'S ______

DATE RECEIVED ______ DAYS DUE ______

PROJECT LEADER ______ NO. LABELS ______

LAB USE ONLY LAB ID	FIELD ID	SAMPLE DESCRIPTION	SAMPLE MATRIX	DATE/TIME COLLECTED	NO. OF BOTTLES	ADDITIONAL IDC'S

FIELD COMMENTS ______

ANALYSIS REQUESTED ______

SUBMITTED BY ______ DATE/TIME ______

RECEIVED BY ______ DATE/TIME ______

LABORATORY COMMENTS ______

DISTRIBUTION OF COPIES
1 - LABORATORY 2 - RETURN TO REQUESTOR 3 - RETAINED BY REQUESTOR

TVA 30488 (RG-WM 3-94)

APPENDIX D

Hydrogeologic Evaluation of Ash Pond Area

TENNESSEE VALLEY AUTHORITY
RESOURCE GROUP, ENGINEERING SERVICES
NORRIS ENGINEERING LABORATORY

HYDROGEOLOGIC EVALUATION OF ASH POND AREA

KINGSTON FOSSIL PLANT

Report No. WR28-2-36-124

Prepared by
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Andrew J. Danzig
and
Jami A. Schroeder

Norris, Tennessee
June 1995

EXECUTIVE SUMMARY

A hydrogeological investigation was conducted to evaluate the long-term effects of the ash pond area on local groundwater and surface water resources following the expected closure of the facility in the year 2015. The study examined local hydrogeologic conditions, groundwater quality, and groundwater use within a two-mile radius of the site. Hydrogeologic and water quality data were primarily derived from previous groundwater investigations at the plant site.

The ash pond area occupies a peninsula bounded by Watts Bar Reservoir on the north and east sides, and by Pine Ridge on the west side. Total area of the facility is approximately 244 acres. At closure, the surface of the area will be graded to promote runoff. A 1-ft surface cap of low permeability (1 x 10^{-7} cm/s) clay will be constructed over the entire surface area to minimize surface infiltration. A 1-ft layer of vegetated top soil will then be placed over the clay cap to prevent erosion.

The area is underlain by shale bedrock of the Conasauga Group and the Rome formation. A mantle of predominantly alluvial soils consisting of clay, silt, and sand with occasional gravel lies above bedrock. Thickness of the alluvium is highly variable, ranging from about 5 to 65 ft. Ash and ash-soil fill materials ranging up to 70 ft in thickness are present above the alluvium. Ash deposits are composed almost entirely of fly ash; bottom ash is estimated to comprise less than ten percent of the ash fill. The water table currently lies within the ash deposits in the ash pond area, and is expected to lie within the ash after facility closure. Groundwater movement at the site generally follows topography with groundwater flowing eastward and southeastward from Pine Ridge toward the reservoir. Groundwater originating on, or flowing beneath, the ash pond area ultimately discharges to the reservoir without traversing private property.

Background groundwater quality as measured in two up-gradient monitoring wells is generally characterized by near-neutral pH, low TDS, and ionic distributions dominated by calcium, magnesium, and carbonate. No exceedances of primary MCLs have been observed in background wells, although secondary MCLs have been exceeded for aluminum, iron, and manganese in some background samples. Groundwater in the immediate vicinity of the ash pond area is affected by ash leachate, and typically exhibits acidic pH, high levels of iron and manganese, and moderate to high levels of sulfate and TDS. Evidence suggests that pyrite oxidation contributes to the high dissolved iron concentrations observed in groundwater. The presence of heavy metals at levels above MCLs is rare. Only arsenic consistently exceeded its MCL in several shallow wells screened in or near ash deposits. Sampling results from depth-staged monitoring wells located around the perimeter of the facility indicate that the effects of ash leachate on groundwater quality are limited to shallow depths.

EPA's HELP2 code [Schroeder et al., 1989] was used to estimate the overall water balance, including leachate production, for the ash fill during a 30-yr period following closure. Results indicated that leachate discharge gradually increases during the first 10 years of the post-closure period reaching a quasi-steady rate of approximately 6.3 million cfy (cubic feet per year)

thereafter. The overall water balance for the ash fill in terms of percent of total incident precipitation was as follows: surface runoff, 18.8 percent; evapotranspiration, 64.1 percent; lateral seepage from top-soil layer, 1.0 percent; net change in water storage, 2.3 percent; and leachate reaching the water table, 13.8 percent. To assess the impact of ash leachate on reservoir water quality, a dilution ratio was estimated by comparing the predicted average leachate flowrate to the mean flow in the reservoir just downstream of the plant outfall. Full mixing of leachate influx and reservoir water was assumed. The mean flow in the Clinch River immediately below the plant outfall is estimated to be approximately 7,000 cfs. The resulting dilution ratio for the quasi-steady leachate discharge predicted during the last 20 years of the water budget simulation of 6.3 million cfy (0.20 cfs) is 1:35,000.

Incremental increases in chemical concentrations in Watts Bar Reservoir due to the influx of ash-leachate effected groundwater were estimated by multiplying the dilution ratio by the mean parameter concentrations. Groundwater quality data for wells located on the perimeter of the disposal area which exhibited exceedances for primary and secondary drinking water standards were selected for the calculation. Parameters exceeding drinking water MCLs included arsenic, nickel, iron, manganese, sulfate, and TDS. Predicted incremental increases in reservoir concentrations were negligible for all constituents except iron which showed a slight increase of 29 μg/L. However, the iron present in groundwater appears to be in a reduced state, and on entering the oxidizing environment of the reservoir is expected to precipitate out of solution.

A survey of water use in the site vicinity in March 1995 identified six residential wells located within approximately one mile of the center of the ash pond area. Two of these wells lie north of Swan Creek embayment and are hydrologically isolated from the site. The remaining four wells lie up-gradient of the Kingston reservation. There is no evidence that pumping from these wells or any of the more distant wells in the site vicinity has induced off-site ash leachate movement from the ash pond area. No adverse off-site groundwater impacts associated with the ash pond are indicated under present conditions or expected under post-closure conditions.

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HYDROGEOLOGIC EVALUATION OF ASH POND AREA
KINGSTON FOSSIL PLANT

1. INTRODUCTION

Background

The ash pond area at Kingston Fossil Plant is located in Roane County, Tennessee, on Watts Bar Lake (Emory River Mile 2) as shown on Figure 1-1. The ash pond area consists of the active ash pond, three dredge cells, and a stilling pool. Total area of the facility is approximately 244 acres. Final closure of the disposal area is planned for the year 2015. At closure the surface of the area will be graded to promote runoff. A 1-ft surface cap of low permeability (1×10^{-7} cm/s) clay will be constructed over the entire surface area to minimize surface infiltration. Then a 1-ft layer of vegetated top soil will be placed over the clay cap to prevent erosion.

Purpose and Scope

A hydrogeological investigation was conducted to evaluate the long-term effects of the ash pond area on local groundwater and surface water resources following facility closure. The study was initiated with an examination of local hydrogeologic conditions, groundwater quality, and groundwater use in the site vicinity. Hydrogeologic and water quality data were primarily derived from previous groundwater investigations at the plant site. Local groundwater use was established by a survey of residents within a two-mile radius of the disposal site. A water budget simulation of the closed facility was performed to quantify ash leachate production rates during a 30-year post-closure period. The ultimate impact of the closed facility was evaluated using the predicted leachate discharge in conjunction with a knowledge of leachate chemical characteristics and groundwater flow patterns in the site vicinity.

Previous Investigations

The hydrogeologic data and groundwater quality data used in the present investigation are based largely on three previous investigations at the Kingston plant site. The first was an EPA-sponsored study by Milligan and Ruane [1980] to examine the effects of coal ash leachate on groundwater quality. This study was initiated in 1976 with core sampling and monitoring well construction at eight sites, J1 through J8 (Figure 1-1). (Note that the "J" well prefix was dropped in later investigations and does not appear on figure well labels in the present report.) Soil samples were collected using a 2-inch diameter split-spoon sampler through a 12-inch outer diameter hollow-stem auger. Fourteen, four-inch diameter PVC wells, screened over the lower 1.5 ft, were installed through the auger following core sampling. Wells were installed either singly or in staged multiple-well clusters. Lithologic logs for these wells are presented in Appendix I. In addition, laboratory permeameter measurements of the horizontal and vertical components of hydraulic conductivity were performed on selected core samples.

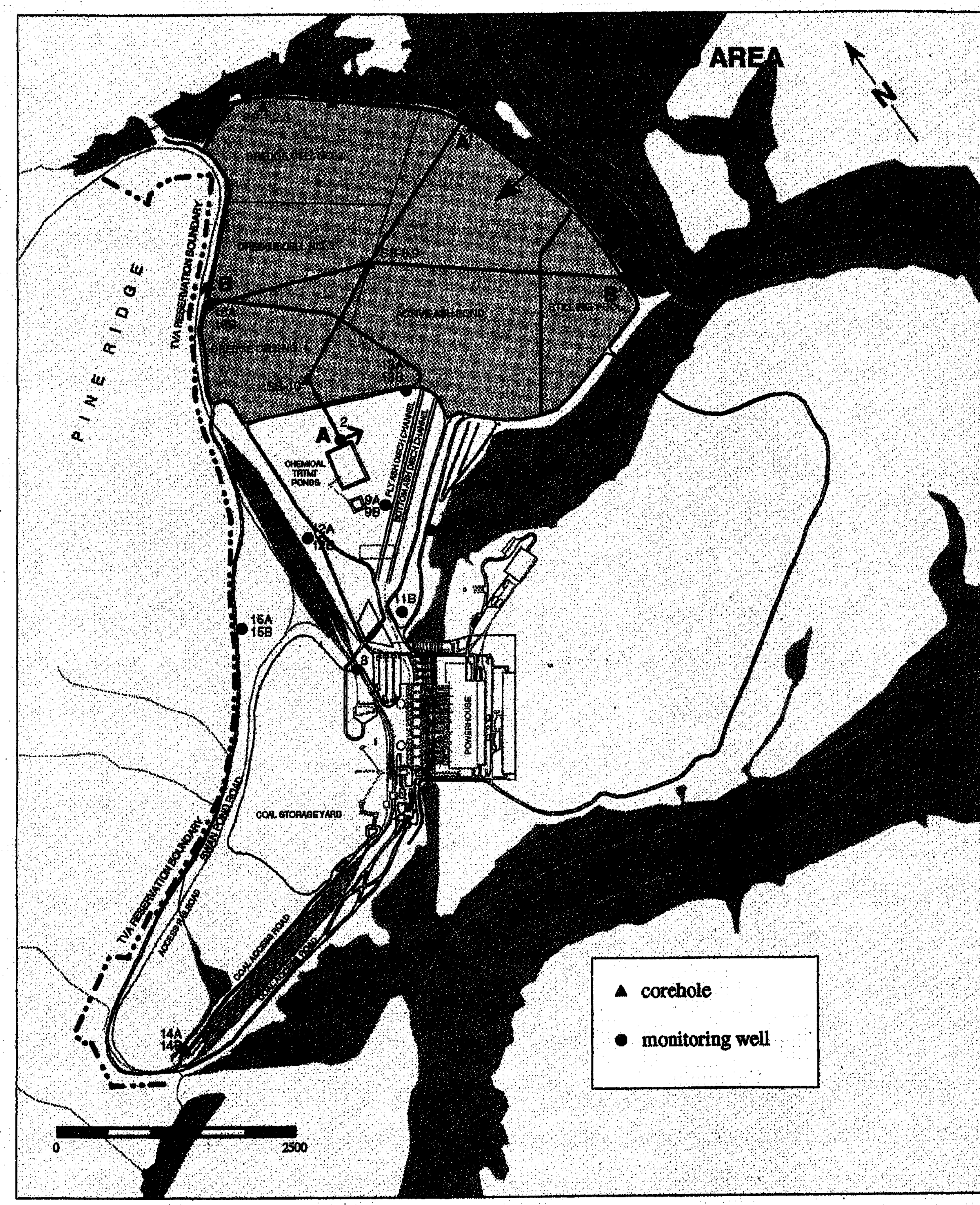


Figure 1-1. Site Location Map Showing Monitoring Well and Corehole Locations

The second investigation consisted of a site-wide assessment of groundwater conditions at the Kingston reservation [Velasco and Bohac, 1991]. Single-well or multiple-well clusters were installed at eight additional sites (sites 9 through 16) in 1988 as part of the investigation. Wells were constructed with 2-inch PVC casing and were screened over the lower 10 ft. Lithologic logs for these wells are given in Appendix I and well construction diagrams are presented in Appendix II. These wells and those installed in 1976 were sampled six times between 1988 and 1990 to examine spatial and temporal trends in groundwater quality at the plant site. Constant-rate injection tests were performed at eight wells to determine bulk hydraulic conductivities of the overburden and shallow bedrock materials. These data were used in development of a groundwater flow model of the site. In June 1992, the original casings of the three wells at site 5 were removed and replaced with near fully-screened PVC casing thereby rendering these wells unsuitable for sampling. Four additional wells (17-20) were installed across the dike at site 5 in July 1992.

A third investigation was conducted by Singleton Laboratories [1994] in the dredge cell area which provided additional useful subsurface information. Two-inch split-spoon and three-inch Shelby tube samples were collected at ten sites for laboratory geotechnical testing. Top-of-rock and groundwater level elevations were established at each site. Appendix I contains lithologic logs for the ten coreholes.

2. SITE HYDROGEOLOGY

Geology

The Kingston plant site is located in the Valley and Ridge physiographic province of the Appalachian Highlands region. This region is characterized by a sequence of long, narrow ridges and valleys trending northeast-southwest. In general, ridges are formed by relatively resistant sandstone, limestone, and dolomite units while the valleys are underlain by soluble limestones and easily weathered shales. The controlling structural feature of the site is a series of northeast-striking thrust faults which have forced older Cambrian and Ordovician rocks over younger units. Bedrock dips southeast at angles ranging from a few degrees to about 90 degrees [Velasco and Bohac, 1991].

The site geologic map shown on Figure 2-1 indicates that the entire ash pond area is underlain by the Conasauga Group (middle to upper Cambrian age) with exception of the northern tip of the area where the Rome formation (lower Cambrian age) is present. Specific geologic units within the Conasauga Group represented at the site include the Maynardville, Nolichucky, Maryville, Rogersville, Rutledge, and Pumpkin Valley formations. These formations are locally of low water-producing capacity, and predominantly consist of shale with interbedded siltstones, limestones, and conglomerates [Velasco and Bohac, 1991]. Total thickness of the Conasauga Group beneath the site is unknown but is estimated to be approximately 1500 ft [Harris and Foxx, 1980]. Pine Ridge, which borders the ash pond area to the northwest, is underlain by interbedded shale, sandstone, and siltstone of the Rome formation.

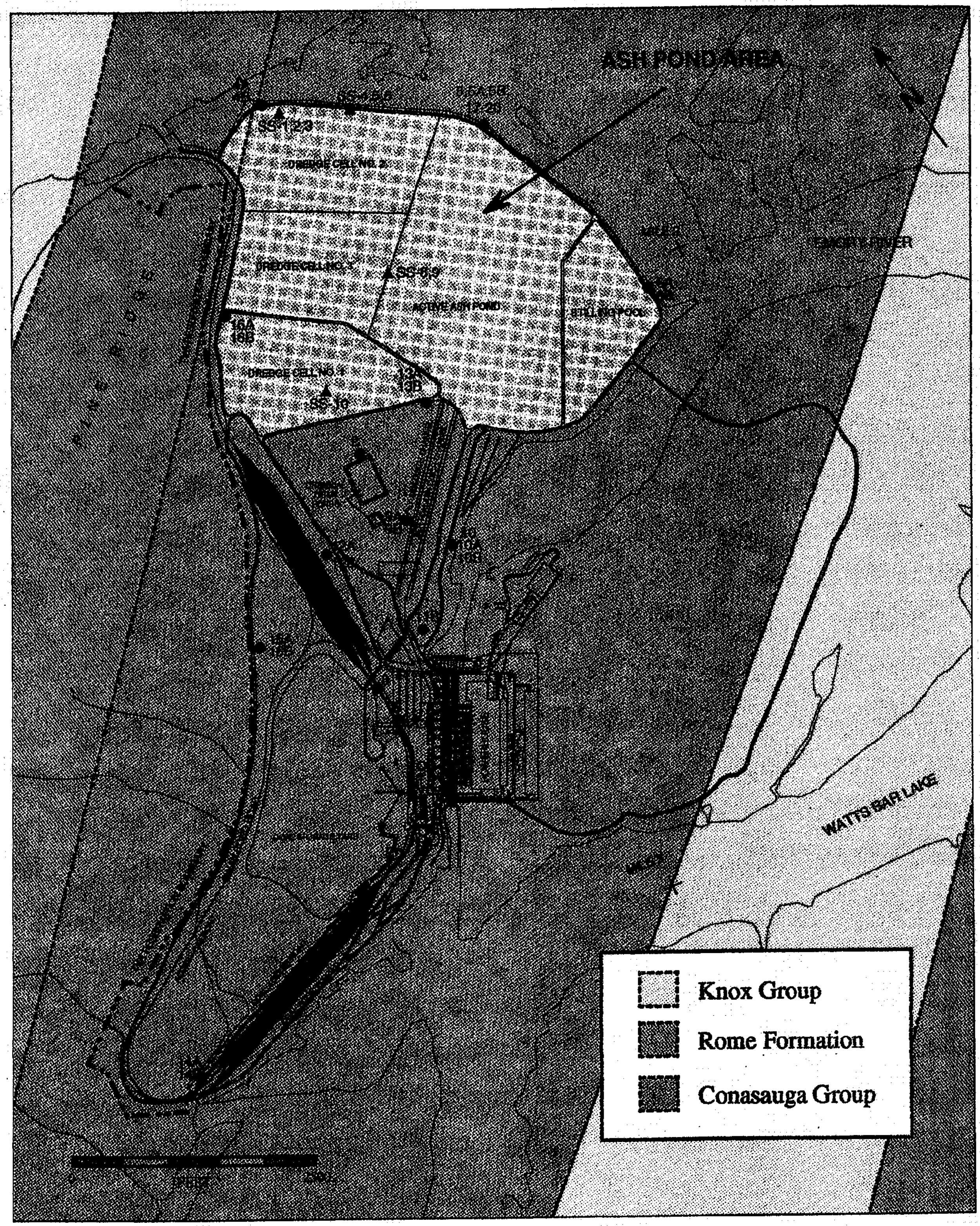


Figure 2-1. Site Geologic Map

The elevation of the top-of-rock directly beneath the ash pond area is relatively uniform, varying from approximately 700 to 715 ft-MSL (Figure 2-2). Outside this area the bedrock surface rises steeply to the west and southwest. The lower bedrock terrace corresponding to the disposal area apparently represents an erosion surface associated with the ancestral Emory River. The upper few feet of bedrock generally consists of a weathered fissile shale with occasional limestone fragments.

Soils and Ash Fill

A mantle of predominantly alluvial soils generally lies above bedrock in the ash pond area as indicated in the two hydrogeologic profiles presented on Figure 2-3 and the soil isopachous map of Figure 2-4. Soil thickness is highly variable, ranging from about 5 ft along a portion of the northern perimeter of the site to a maximum of 65 ft on the western boundary. The alluvial deposits are unconsolidated and lenticular, and consist of clay, silt, and sand with occasional gravel. A thin layer of residuum is occasionally present directly above bedrock. The residuum is composed of clay and silt with weathered shale fragments.

The ash and ash-soil fill materials present above the alluvium/bedrock range up to 70 ft in thickness. Ash deposits consist almost entirely of fly ash; bottom ash is estimated to comprise less than ten percent of the ash fill. Ash pond dikes are constructed of mixtures of fly ash, bottom ash, clay, and silt. As indicated on Figure 2-3 the water table generally lies within the ash deposits.

Hydraulic Properties

Field and laboratory measurements of hydraulic conductivity for soil, ash, and shallow bedrock were performed during previous plant site investigations. A summary of these data are given in Table 2-1. In general, the field conductivity measurements are about an order of magnitude larger than the laboratory estimates for the same material. Such differences between field and laboratory measures are commonly observed and are attributed to differences in measurement scale.

The upper weathered bedrock zone exhibited the highest field-measured horizontal hydraulic conductivity (K_h) with values averaging about $2x10^{-5}$ cm/s. Field estimates of K_h for the "silty clay" alluvium averaged approximately $7x10^{-6}$ cm/s. A conductivity of approximately $2x10^{-5}$ cm/s was indicated for the permeameter-tested fly ash sample.

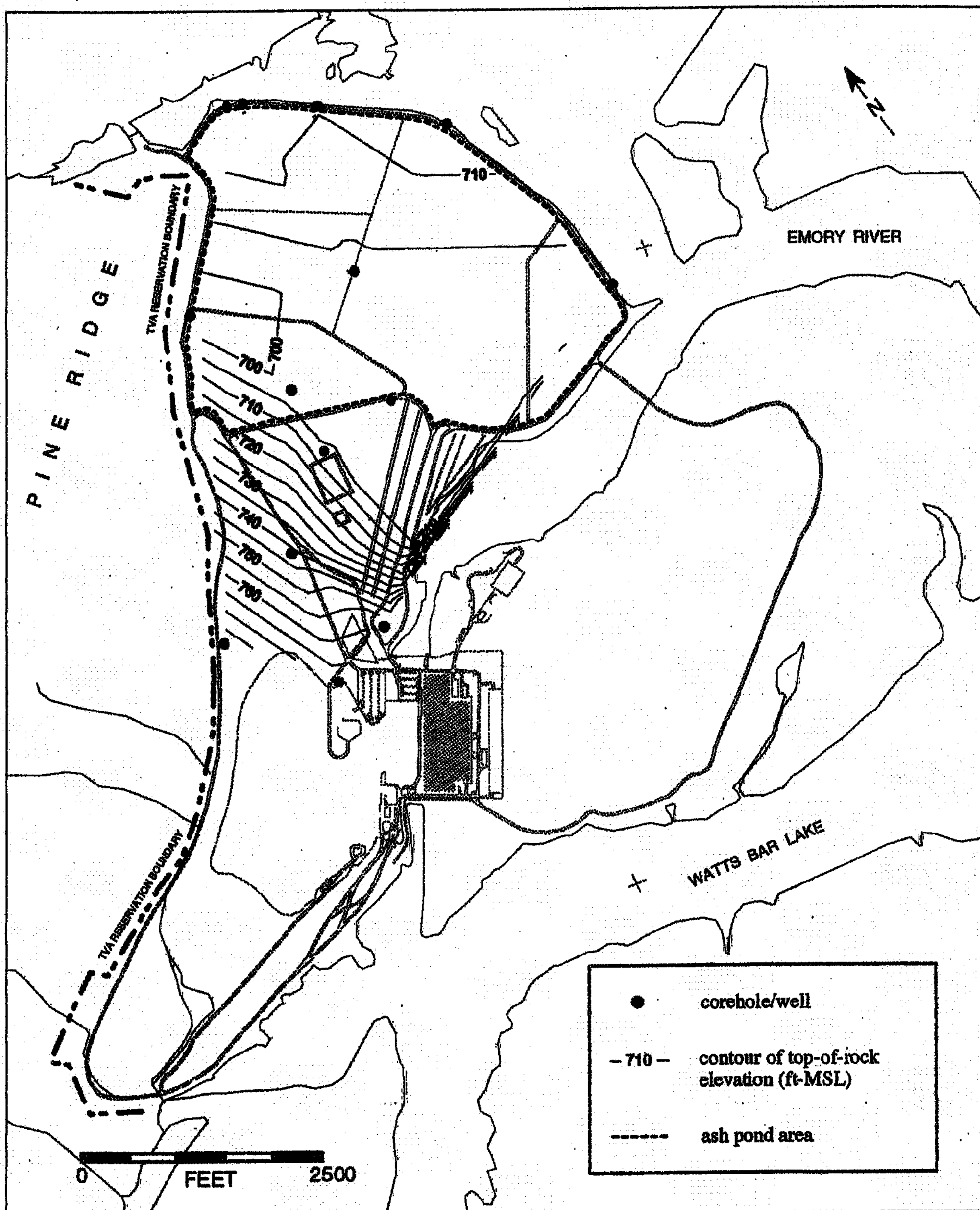


Figure 2-2. Top-of-Rock Elevation Contour Map

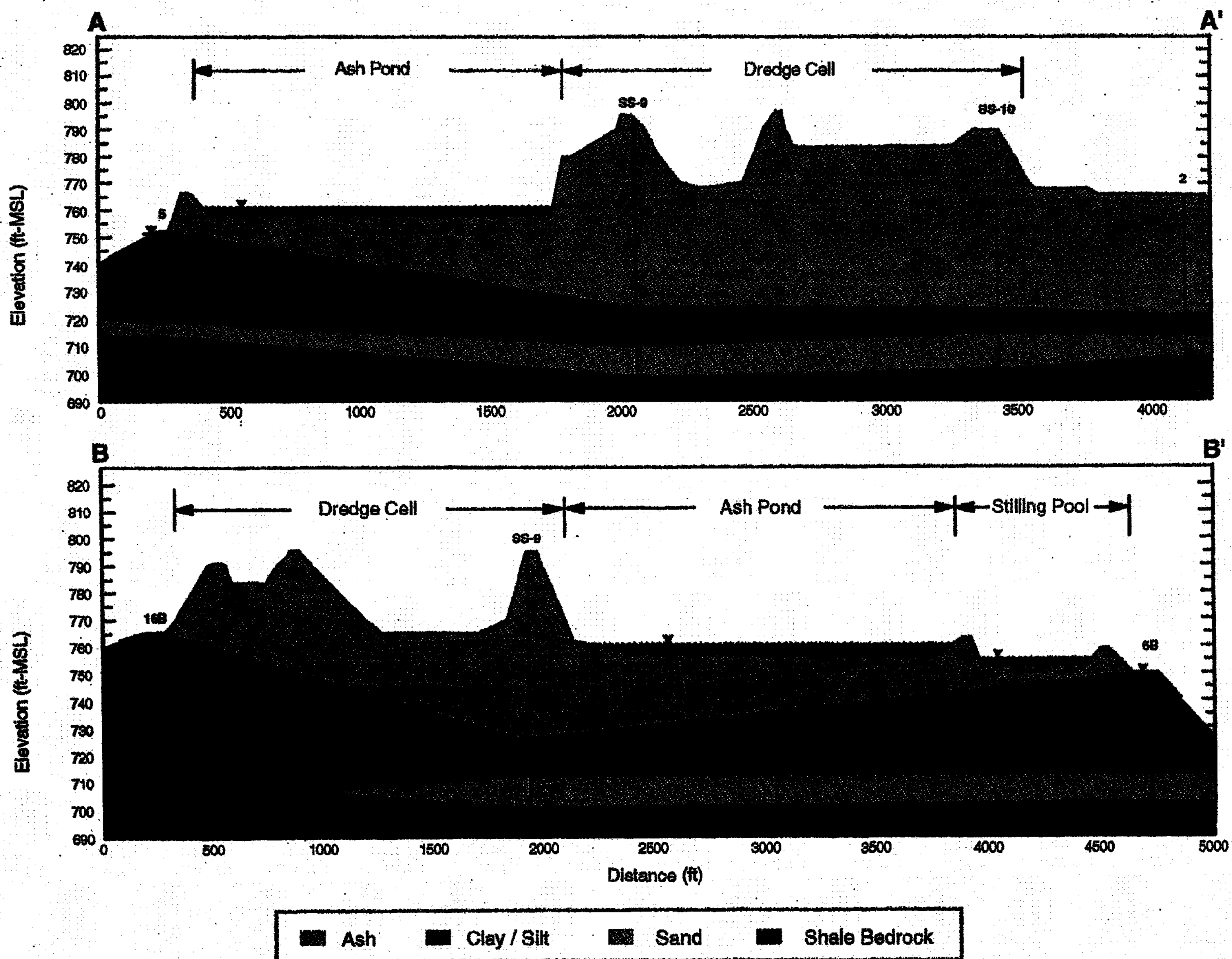


Figure 2-3. Hydrogeologic Sections Through Ash Pond Area

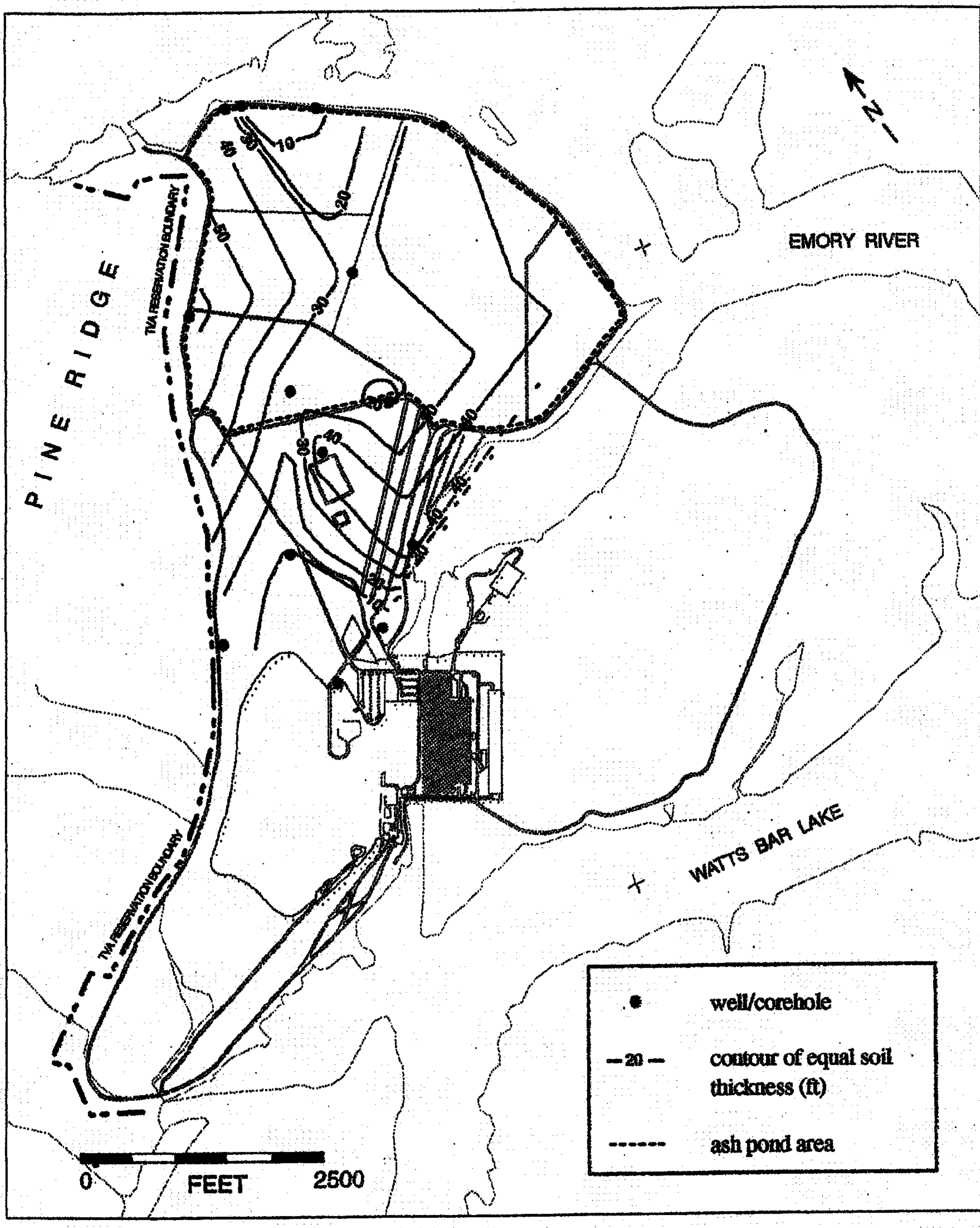


Figure 2-4. Soil Thickness Contour Map

TABLE 2-1

Summary of Hydraulic Conductivity Data

Well No.	Laboratory Permeameter Tests: Sample Elevation (ft-MSL)	Kh (cm/s)	Kv (cm/s)	Material Type	Field Tests: Screen Elevation Interval (ft-MSL) Top	Bottom	Kh (cm/s)	Material Type
2	715.6	7.4E-08	6.3E-08	silty clay	723.4	721.9	9.1E-06	silty clay
4	721.4	8.8E-06	3.1E-06	sand	–	–	–	–
	728.9	6.6E-08	2.8E-07	silty clay	–	–	–	–
4B	–	–	–	–	716.3	714.8	6.1E-06	silty clay
5	731.4	2.8E-07	4.0E-07	silty clay	725.4	723.9	9.1E-06	silty clay
6	702.4	1.3E-06	1.4E-06	weathered shale	–	–	–	–
	725.7	2.5E-06	4.4E-07	silty clay	–	–	–	–
9B	–	–	–	–	697.2	687.2	6.1E-06	shale
13A	–	–	–	–	712.6	702.6	3.0E-06	silty clay
13B	–	–	–	–	697.4	685.4	2.1E-05	shale w/ ls. and ss.
15A	–	–	–	–	777.9	767.9	3.0E-05	shale
–	(surface sample)	2.1E-05	2.1E-05	fly ash	–	–	–	–

References: soil permeameter test results reported by Milligan and Ruane [1980]; fly ash data from Young et al. [1993], Appendix A; all field test data from Velasco and Bohac [1991].

Groundwater Levels and Movement

Groundwater movement at the plant site is generally eastward and southeastward from Pine Ridge toward the reservoir as indicated by the water table contour map shown on Figure 2-5. Because the ash pond area occupies a peninsula bounded on two sides by the reservoir, groundwater originating on or upgradient of the disposal area ultimately discharges to the reservoir. Although potentiometric head data for the interior of the disposal area are limited, it is probable that the continuous recharge by ash sluice water in the active ash pond produces local on-site mounding of the water table. Similarly, temporary local mounding of the water table may occur during periodic sluicing/dredging of ash to the three dredge cells.

It is difficult to discern any natural seasonal trends in groundwater levels in the monitoring well hydrographs shown on Figure 2-6. This may be partially due to the infrequency of the measurements, i.e., only four or less observations were made per year. However, given the close proximity of most monitoring wells to the active ash pond, dredge cells, and/or the reservoir, it is likely that these artificial hydrologic features largely control local groundwater levels.

Precipitation and Recharge

Based on historical meteorological data for Oak Ridge (approximately 20 miles northwest of the site), the annual precipitation at the site is estimated to range from 39 to 70 inches and average approximately 52 inches. Average net groundwater recharge at the site, according to the Kingston groundwater investigation of Velasco and Bohac [1991], is 2.4 inches per year.

3. GROUNDWATER QUALITY

Methods and Approach

From three to 23 samples have been collected from wells at Kingston since 1989. All wells were purged with either a centrifugal, bladder, or peristaltic pump and sampled with either a bladder or peristaltic pump. Wells 2, 4A, 4B, 5, 5B, 6A, and 8 were pumped dry and sampled after they recovered, either later the same day or the next day. Dedicated sampling equipment (QED systems) was installed in wells 10A, 13B, and 16A on January 27, 1993.

While data from all wells sampled at Kingston are presented, this analysis focuses on groundwater quality in the active ash pond area. This area includes wells 2, 4A, 4B, 5, 5A, 5B, 6A, 13A, 13B, 16A, 16B, 17, and 19. The periods of record for each well sampled at Kingston are indicated in the summary tables in Appendix III. These tables also present sample number, mean, median, and range of values for each parameter measured. Results reported as less than the analytical determination limit were recorded at the concentration of that limit. Thus, the

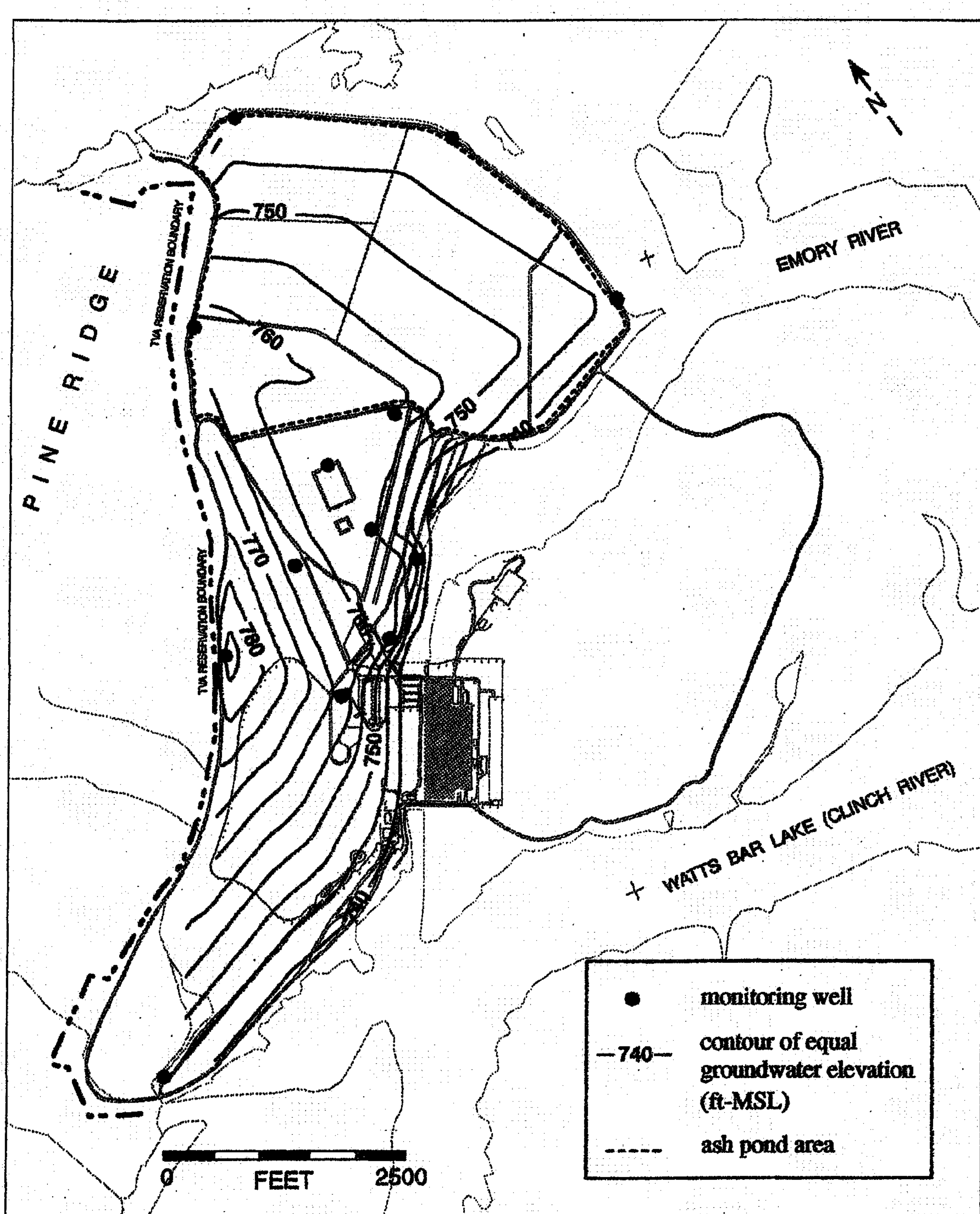


Figure 2-5. Water Table Contour Map

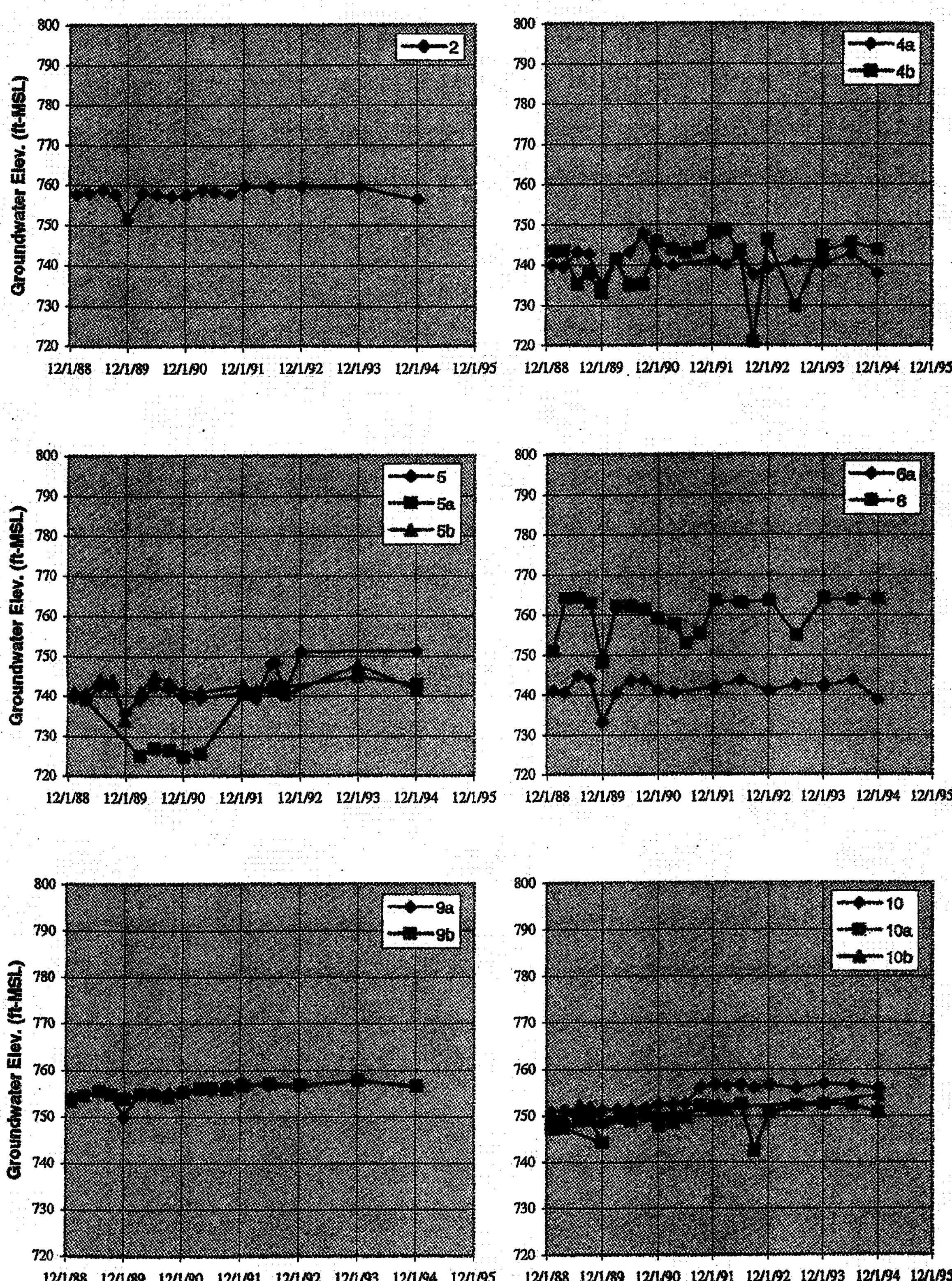


Figure 2-6. Groundwater Hydrographs

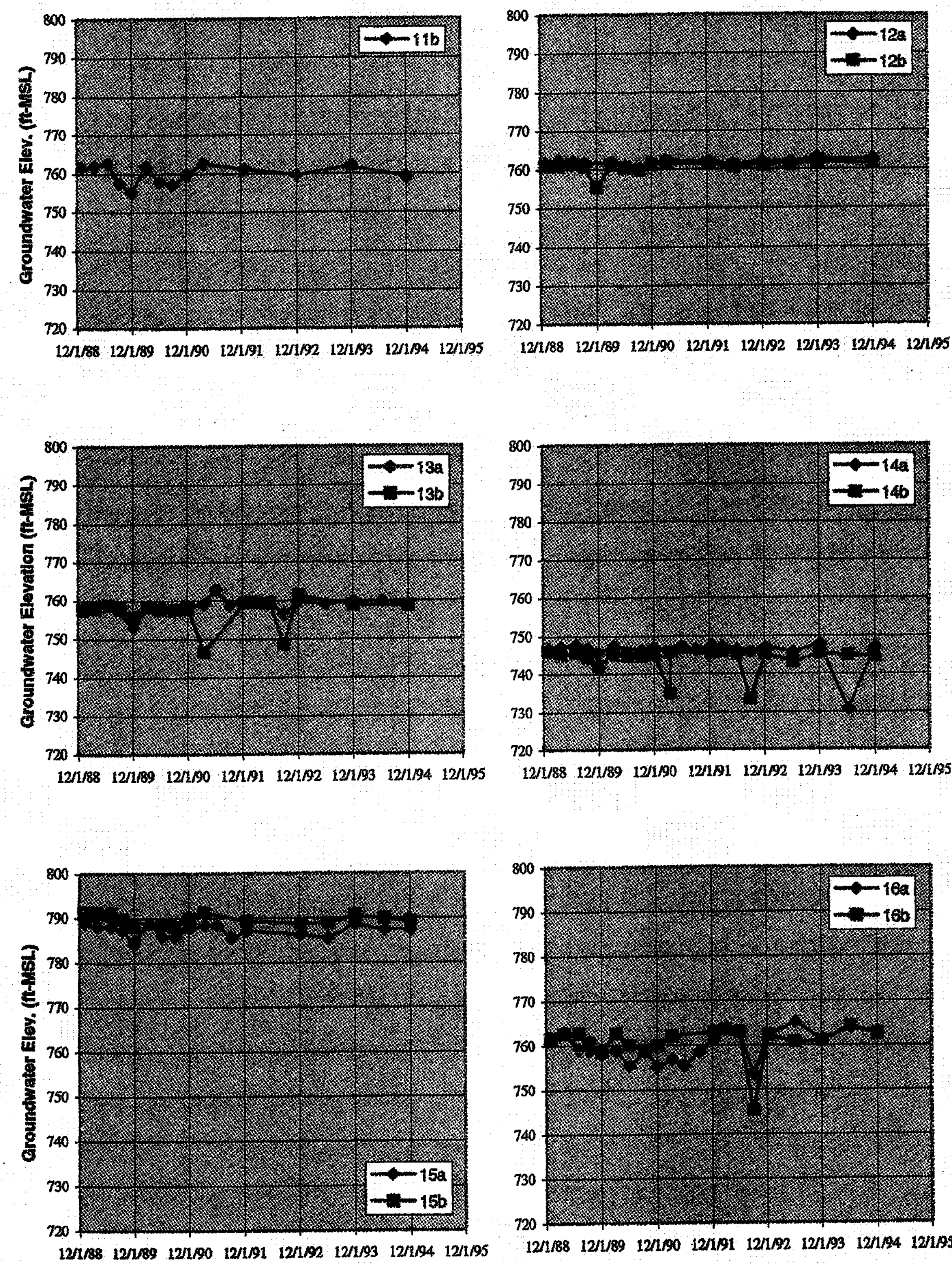


Figure 2-6. Groundwater Hydrographs (Continued)

median values listed may be higher than the true values. The number of observations which exceeded Maximum Contaminant Levels (MCLs) for drinking water is also shown.

Groundwater data for wells in the ash pond area were compared to drinking water criteria as one means of evaluating the potential impacts to groundwater quality from the plant's ash disposal activities. (The MCLs are listed in Table 3-1.) Tables 3-2 and 3-3 summarize the number of samples which were above the primary (health-related) and secondary (aesthetic) MCLs for drinking water. The MCLs are shown in parentheses below each parameter. The number above the slash shows the number of samples for which the concentration was observed to be above the particular MCL. The number below the slash shows the total number of analyses available from the well for the parameter in question.

Due to concerns about the effects of turbidity on the results, a number of samples were filtered through a pore size of 0.45 μm. Table 3-4 contains the total and dissolved concentrations from the 12 samples that were both filtered and unfiltered. Figures 3-1 and 3-2 show the ionic distributions, on the basis of equivalents, of the major mineral constituents based on the median values reported in the summary tables (Appendix III). (An equivalent is 1 molecular weight of an element divided by its valence.) For comparison, data obtained from eight stations on the Emory River are included in Figure 3-1 and data from the coal yard drainage basin (CYDB) are included in Figure 3-2.

Figure 3-3 is a key to the quartile plots for twelve indicator parameters (Figures 3-4 through 3-15). Tables 3-5 and 3-6 relate to ash leachate indicators. Table 3-7 summarizes all the analyses considered to gauge impacts to groundwater at Kingston Fossil Plant.

Background Water Quality

The wells at sites 15 and 16 are upgradient of the plant and are considered to provide background water quality. There were virtually no exceedances of primary MCLs observed in these wells and almost all of the secondary MCL exceedances occurred for aluminum, iron, and manganese. These constituents, while not uncommon in groundwater, are also associated with particulate matter in samples. Comparison with other wells, e.g., Figures 3-8 and 3-10 for iron and manganese, shows that these wells contain some of the lowest levels observed at the Kingston site. It is clear from Figure 3-11 that the pH of the groundwater in these wells is near neutral. The ionic distributions of these waters are marked by low ionic levels (which is related to total dissolved solids (TDS)) predominated by calcium, magnesium, and carbonate.

Ash Pond Area Groundwater Quality

Tables 3-2 and 3-3 identify 108 out of 3074 observations that exceeded primary MCLs and 1586 out of a total of 3616 observations that exceeded secondary MCLs. While four-fifths of the primary exceedances are for arsenic, it appears that 5 of the 6 wells that had high arsenic levels were screened in or near ash, i.e. only well 19 was not screened in ash. Of the wells closest to the closure plan area, 13A, 17, and 19 had frequent exceedances of arsenic and 4A

TABLE 3-1

Maximum Contaminant Levels for Drinking Water - Inorganics

Parameter	Current Concentration
Primary	
Antimony	6 mg/L
Arsenic	50 mg/L
Asbestos	7 X 10^6 fibers/L (fibers > 10m)
Barium	2000 mg/L
Beryllium	4 mg/L
Cadmium	5 mg/L
Chromium	100 mg/L
Copper	1.3 mg/L[a]
Cyanide	200 mg/L
Fluoride	4.0 mg/L
Lead	50 mg/L[b]
Mercury	2 mg/L
Nickel	100 mg/L
Nitrate (as N)	10 mg/L
Nitrite (as N)	1 mg/L
Selenium	50 mg/L
Sulfate	500 mg/L - Proposed
Thallium	2 mg/L
Secondary	
Aluminum	50 to 200 mg/L[c]
Chloride	250 mg/L
Copper	1000 mg/L
Fluoride	2.0 mg/L
Iron	300 mg/L
Manganese	50 mg/L
pH	6.5-8.5
Silver	100 mg/L
Sulfate	250 mg/L
TDS	500 mg/L
Zinc	5000 mg/L

[a]EPA established action levels (ALs) rather than MCLs; effective December 7, 1992
[b]MCL used by states; EPA AL = 15 mg/L
[c]Limit is to be determined by states

Sources: Federal Register, Vol. 57, No. 138, July 17, 1992
Federal Register, Vol. 56, No. 20, January 30, 1991
Federal Register, Vol. 55, No. 143, July 25, 1990
Federal Register, Vol. 59, No. 243, December 20, 1994

TABLE 3.2
Kingston Fossil Plant. Data Through December 1994.
Comparison of Groundwater Data with Primary Water Quality Standards - Number of Samples Exceeding an MCL/Total Number of Samples, for Each Parameter, for Each Well.

MCL WELL ID	Sb (6) (µg/L)	As (50) (µg/L)	Ba (2.0) (mg/L)	Be (4) (µg/L)	Cd (5) (µg/L)	Cr (100) (µg/L)	Cu (1.3) (mg/L)	Pb (50) (µg/L)	Ni (100) (µg/L)	Se (50) (µg/L)	NO3-N (10) (mg/L)	TOTAL
2	0/ 4	20/ 20	0/ 18	1/4	0/ 20	0/ 18	0/ 20	0/ 18	0/4	0/13	0/13	21/152
4A	0/ 5	0/ 19	0/ 17	0/5	2/19	0/ 17	0/ 19	0/ 17	4/6	0/10	0/10	6/144
4B	0/ 5	0/ 21	0/ 19	0/5	0/ 20	0/ 18	0/ 21	0/ 19	0/6	0/12	0/12	0/158
6A	0/ 5	0/ 17	0/ 15	0/5	0/ 16	0/ 14	0/ 17	0/ 15	0/6	0/11	0/10	0/131
8	0/ 6	0/ 20	0/ 18	0/6	0/ 19	0/ 17	0/ 20	0/ 18	0/6	0/13	0/12	0/155
9A	0/ 4	17/ 18	0/ 16	1/4	0/ 17	0/ 15	0/ 18	0/ 16	0/4	0/13	0/12	18/137
9B	0/ 4	0/ 17	0/ 15	0/4	0/ 16	0/ 14	0/ 17	0/ 15	0/4	0/12	0/11	0/129
10	0/ 5	21/ 21	0/ 19	0/5	0/ 20	0/ 18	0/ 21	0/ 19	0/5	0/12	0/12	21/157
10A	0/ 5	0/ 21	0/ 19	1/5	0/ 20	0/ 18	0/ 21	3/19	0/5	0/12	0/11	4/156
10B	0/ 3	0/ 14	0/ 12	0/3	0/ 13	0/ 11	0/ 14	0/ 12	0/3	0/10	0/10	0/105
11B	0/ 3	0/ 15	0/ 13	0/3	0/ 14	0/ 12	0/ 15	0/ 13	0/3	0/11	0/11	0/113
12A	0/ 3	0/ 15	0/ 14	1/3	0/ 14	0/ 13	0/ 15	0/ 14	0/3	0/10	0/10	1/114
12B	0/ 3	0/ 16	0/ 14	1/3	0/ 15	0/ 14	0/ 16	0/ 15	0/4	0/10	0/10	1/120
13A	0/ 5	21/ 21	0/ 19	0/5	0/ 20	0/ 18	0/ 21	1/19	0/5	0/13	0/12	22/158
13B	0/ 3	0/ 17	0/ 15	0/3	0/ 16	0/ 15	0/ 17	0/ 16	0/4	0/10	0/10	0/126
14A	0/ 5	2/21	0/ 19	0/5	0/ 20	0/ 18	0/ 21	0/ 20	0/5	0/13	0/12	2/159
14B	0/ 5	0/ 20	0/ 18	0/5	1/19	0/ 18	0/ 20	0/ 19	0/7	0/12	0/11	1/154
15A	0/ 5	0/ 18	0/ 16	0/5	1/17	0/ 15	0/ 18	0/ 16	0/5	0/14	0/12	1/141
15B	0/ 5	0/ 17	0/ 15	0/5	0/ 16	0/ 15	0/ 17	0/ 16	0/6	0/13	0/11	0/136
16A	0/ 5	0/ 23	0/ 20	0/5	0/ 22	0/ 20	0/ 23	0/ 21	0/6	0/16	0/14	0/175
16B	0/ 5	0/ 20	0/ 18	0/5	0/ 19	0/ 18	0/ 20	0/ 19	0/6	0/10	0/10	0/150
17	0/ 3	3/3	0/ 3	0/3	0/ 2	0/ 2	0/ 3	0/ 3	0/3	0/1	0/0	3/26
19	0/ 4	2/4	0/ 4	0/4	0/ 3	0/ 3	0/ 4	0/ 4	0/4	0/1	0/0	2/35
CYDB	0/5	0/5	0/5	1/5	0/4	0/4	0/5	0/5	4/5	0/0	0/0	5/43
TOTAL	0/105	86/403	0/361	6/105	4/381	0/345	0/403	4/368	8/115	0/252	0/236	108/3074

TABLE 3.3

Kingston Fossil Plant. Data Through December 1994.

Comparison of Groundwater Data with Secondary Water Quality Standards - Number of Samples Exceeding an MCL/Total Number of Samples, for Each Parameter, for Each Well.

MCL WELL ID	pH (6.5-8.5) (SU)	Cl (250) (mg/L)	SO4 (250) (mg/L)	TDS (500) (mg/L)	Al (200) (μg/L)	Cu (1000) (μg/L)	Fe (300) (μg/L)	Mn (50) (μg/L)	Zn (5000) (μg/L)	TOTAL
2	2/18	0/ 20	0/ 20	2/ 20	19/ 20	0/ 20	20/ 20	20/ 20	0/20	63/178
4A	19/ 19	0/ 19	19/ 19	19/ 19	19/ 19	0/ 19	19/ 19	19/ 19	0/19	114/171
4B	5/21	0/ 21	20/ 21	21/ 21	16/ 21	0/ 21	21/ 21	21/ 21	0/21	104/189
6A	17/ 17	0/ 17	17/ 17	17/ 17	15/ 17	0/ 17	17/ 17	17/ 17	0/17	100/153
8	0/ 19	0/ 20	19/ 19	20/ 20	12/20	0/ 20	19/ 20	20/ 20	0/20	90/178
9A	13/ 18	0/ 17	18/ 18	18/ 18	18/ 18	0/ 18	18/ 18	18/ 18	0/18	103/161
9B	5/18	0/ 17	3/17	0/ 17	3/17	0/ 17	3/17	11/17	0/17	25/154
10	0/ 20	0/ 21	9/21	8/21	14/ 21	0/ 21	21/ 21	21/ 21	0/21	73/188
10A	22/ 22	0/ 21	14/ 21	14/ 21	21/ 21	0/ 21	21/ 21	21/ 21	0/21	113/190
10B	14/ 14	0/ 14	14/ 14	13/ 14	9/14	0/ 14	14/ 14	14/ 14	0/14	78/126
11B	1/15	0/ 15	15/ 15	15/ 15	9/15	0/ 15	13/ 15	15/ 15	0/15	69/135
12A	2/15	0/ 15	1/15	10/15	8/15	0/ 15	14/ 15	14/ 15	0/15	49/135
12B	0/ 15	0/ 16	16/ 16	16/ 16	4/16	0/ 16	16/ 16	16/ 16	0/16	68/143
13A	2/20	0/ 21	3/21	2/21	20/ 21	0/ 21	21/ 21	21/ 21	0/21	69/188
13B	0/ 17	0/ 17	0/ 17	0/ 17	4/17	0/ 17	1/17	1/17	0/17	6/153
14A	21/ 21	0/ 21	20/ 21	20/ 21	12/21	0/ 21	21/ 21	21/ 21	0/21	115/189
14B	2/19	0/ 20	19/ 20	19/ 20	11/20	0/ 20	19/ 20	20/ 20	0/20	90/179
15A	0/ 19	0/ 18	1/18	2/18	10/18	0/ 18	8/18	15/ 18	0/18	36/163
15B	0/ 17	0/ 17	1/17	3/17	7/17	0/ 17	17/ 17	17/ 17	0/17	45/153
16A	0/ 21	0/ 23	1/23	0/ 23	16/ 23	0/ 23	23/ 23	23/ 23	0/23	63/205
16B	0/ 19	0/ 20	0/ 20	0/ 19	14/ 20	0/ 20	11/20	20/ 20	0/20	45/178
17	3/3	0/ 3	3/3	3/3	3/3	0/ 3	3/3	3/3	0/3	18/27
19	3/3	0/ 4	4/4	4/4	4/4	0/ 4	4/4	4/4	0/4	23/35
CYDB	5/5	0/5	4/5	3/5	5/5	0/5	5/5	5/5	0/5	27/45
TOTAL	136/395	0/402	221/402	229/402	274/403	0/403	349/403	377/403	0/403	1586/3616

TABLE 3-4

Kingston Groundwater Data
Unfiltered (Total Concentration) vs. Filtered (Dissolved Concentration)
Samples Collected on December 7-10, 1992

Parameter	Units	CYDB Tot.	CYDB Diss.	4A Tot.	4A Diss.	4B Tot.	4B Diss.	6A Tot.	6A Diss.	9A Tot.	9A Diss.	10 Tot.	10 Diss.
Aluminum	µg/L	9900	8900	15000	9800	4200	<50	10000	<50	3900	80	1000	<50
Iron	µg/L	40000	40000	290,000	250,000	16000	60	1,300,000	950,000	47000	35000	11000	6400
Manganese	µg/L	5800	5600	54000	48000	5000	130	76000	66000	35000	32000	310	250
Copper	µg/L	20	20	<10	<10	<10	<10	<10	<10	<50	<10	<10	<10
Calcium	mg/L	180	180	330	300	220	190	380	320	300	250	66	60
Magnesium	mg/L	39	39	76	71	19	17	69	64	57	51	8.2	7.9
Zinc	µg/L	250	250	670	570	60	<10	240	100	50	30	<10	<10
Barium	µg/L	20	10	30	<10	40	<10	210	40	70	30	60	20
Boron	µg/L	<500	<500	670	500	<500	<500	3500	2800	1600	1500	<500	<500
Molybdenum	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	70	70
Strontium	µg/L	740	730	1500	1400	390	280	3500	2900	3100	2900	700	670
Beryllium	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	6	<1	<1	<1
Arsenic	µg/L	<1	<1	2	2	5	1	4	4	120	87	180	150
Cadmium	µg/L	1.5	1.5	2.9	2	0.4	0.1	1.9	0.1	0.4	0.1	<0.1	<0.1
Chromium	µg/L	<1	<1	<1	<1	2	<1	13	<1	2	<1	<1	<1
Lead	µg/L	<1	<1	12	5	6	<1	37	<1	2	<1	2	<1
Antimony	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	5	<1	<1
Lithium	µg/L	60	60	30	30	<10	<10	50	40	30	30	110	100
Nickel	µg/L	140	140	120	52	9	2	12	5	53	35	4	3
Vanadium	µg/L	10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
Total Susp Sol	µg/L	5		170		420		470		170		90	
Total Diss Sol	µg/L	1200		2600		710		4200		1700		280	

Parameter	Units	10A Tot.	10A Diss.	10B Tot.	10B Diss.	14A Tot.	14A Diss.	14B Tot.	14B Diss.	17 Tot.	17 Diss.	19 Tot.	19 Diss.
Aluminum	µg/L	6900	520	340	<50	60	<50	2200	<50	38000	<50	2400	60
Iron	µg/L	26000	18000	18000	15000	130,000	100,000	3000	720	100,000	69000	390,000	330,000
Manganese	µg/L	7700	5800	8400	6900	7600	5000	790	600	3700	3200	12000	9200
Copper	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	70	<10	<10	<10
Calcium	mg/L	67	55	150	120	710	590	260	220	430	380	550	460
Magnesium	mg/L	10	9.5	23	20	120	120	33	27	28	26	46	44
Zinc	µg/L	100	60	<10	<10	<10	<10	<10	<10	130	40	150	120
Barium	µg/L	40	20	60	30	20	<10	90	30	310	20	40	20
Boron	µg/L	1300	1100	<500	<500	560	<500	<500	<500	1000	930	3100	2300
Molybdenum	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Strontium	µg/L	1100	940	670	550	2300	1900	420	370	2200	2000	3400	2700
Beryllium	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	µg/L	4	3	5	5	42	42	<1	<1	580	500	50	44
Cadmium	µg/L	<0.1	<0.1	0.1	0.1	0.3	<0.1	0.2	0.2	1.4	0.3	<0.1	<0.1
Chromium	µg/L	<1	<1	<1	<1	<1	<1	1	<1	56	<1	<1	<1
Lead	µg/L	6	<1	1	<1	<1	<1	<1	<1	46	<1	<1	<1
Antimony	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	5	5	1	1
Lithium	µg/L	50	40	10	<10	40	40	20	20	230	160	310	300
Nickel	µg/L	56	42	4	1	3	3	2	<1	49	9	<1	<1
Vanadium	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	130	<10	<10	<10
Total Susp Sol	mg/L	78		47		44		39		1800		110	
Total Diss Sol	mg/L	390		660		3100		890		1900		3500	

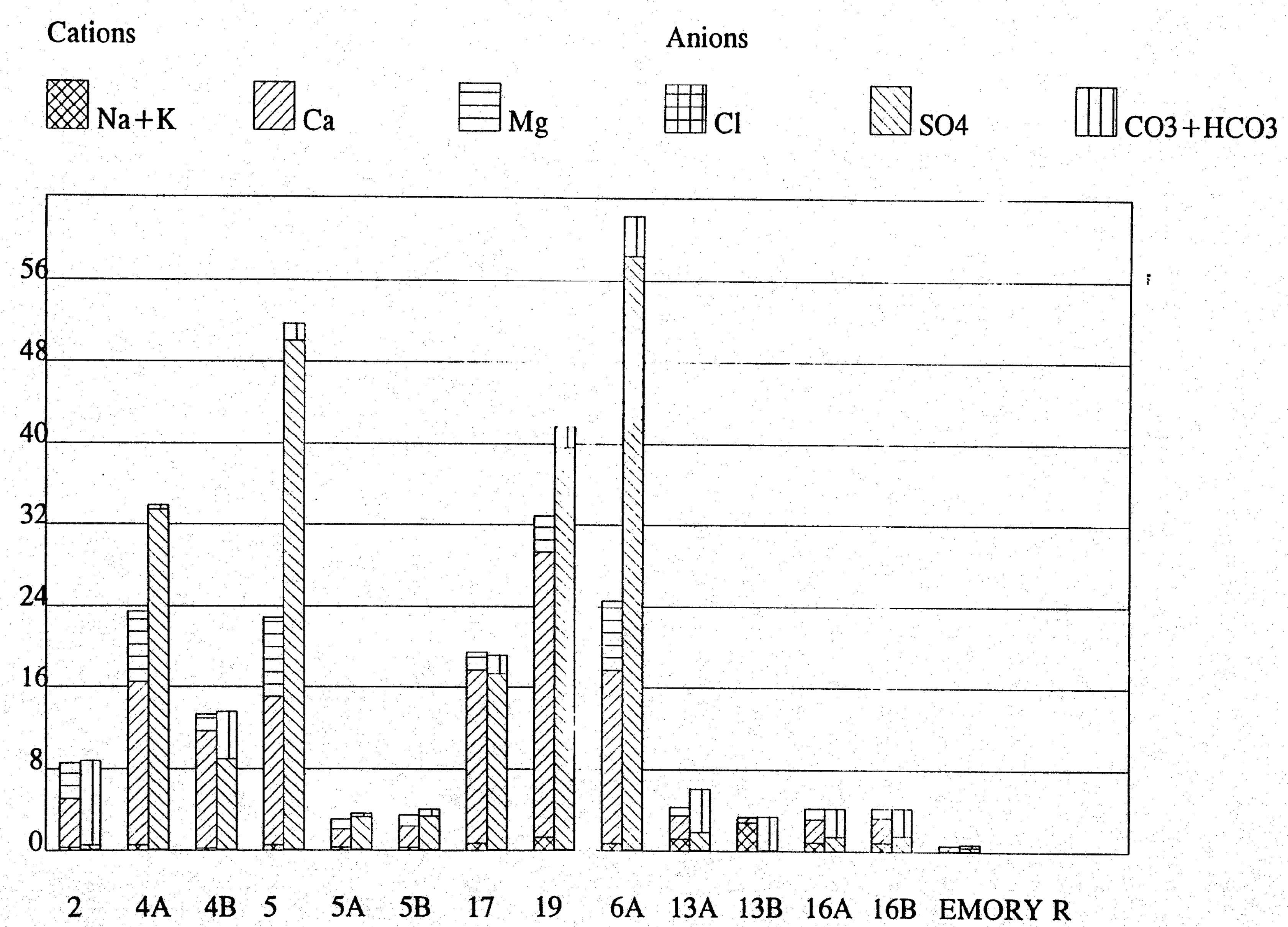


Figure 3-1. Ionic Distributions for Ash Pond Area

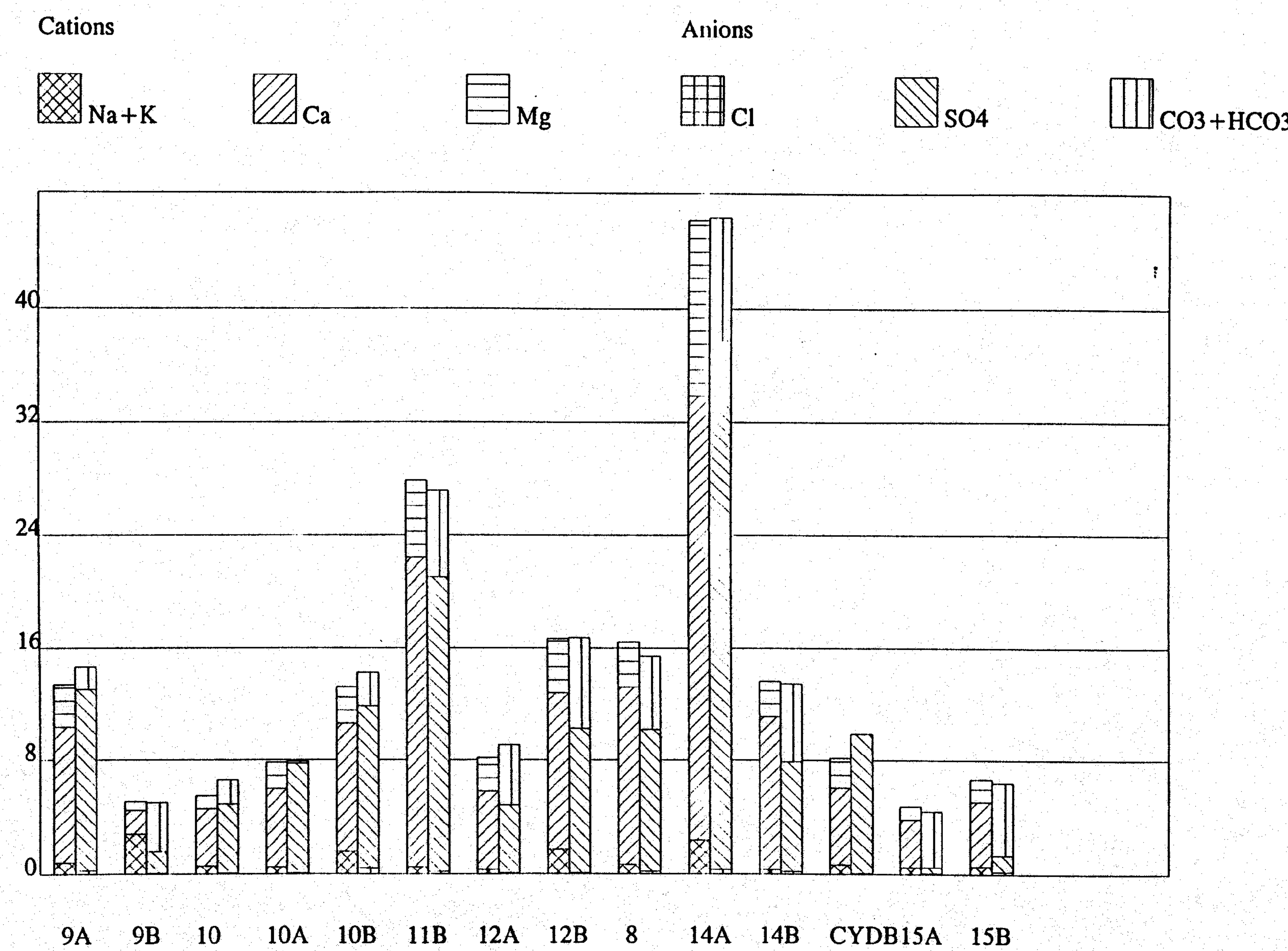


Figure 3-2. Ionic Distributions for Metal Cleaning Pond and Coal Yard Areas

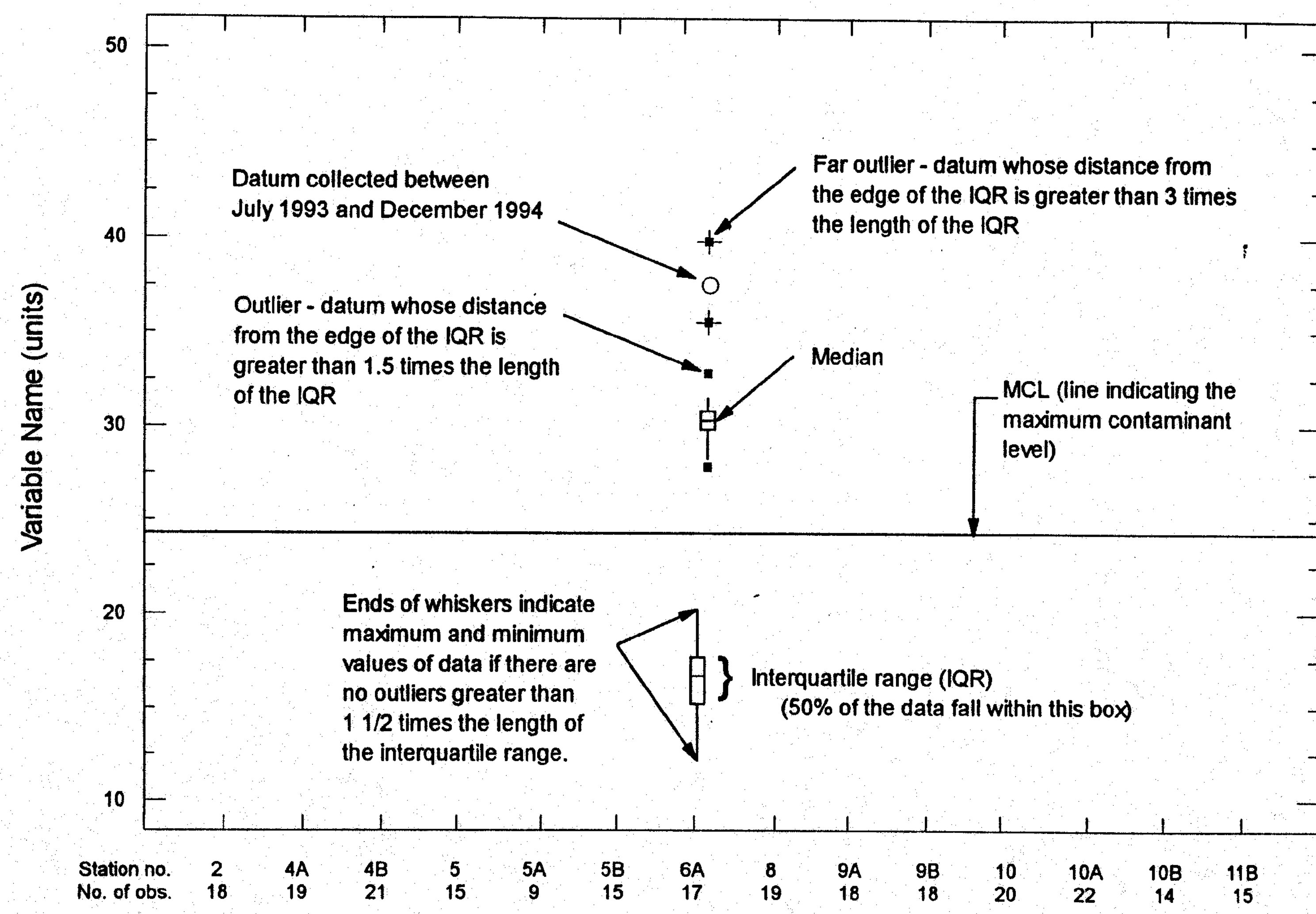


Figure 3-3. Key to Box and Whiskers Plots

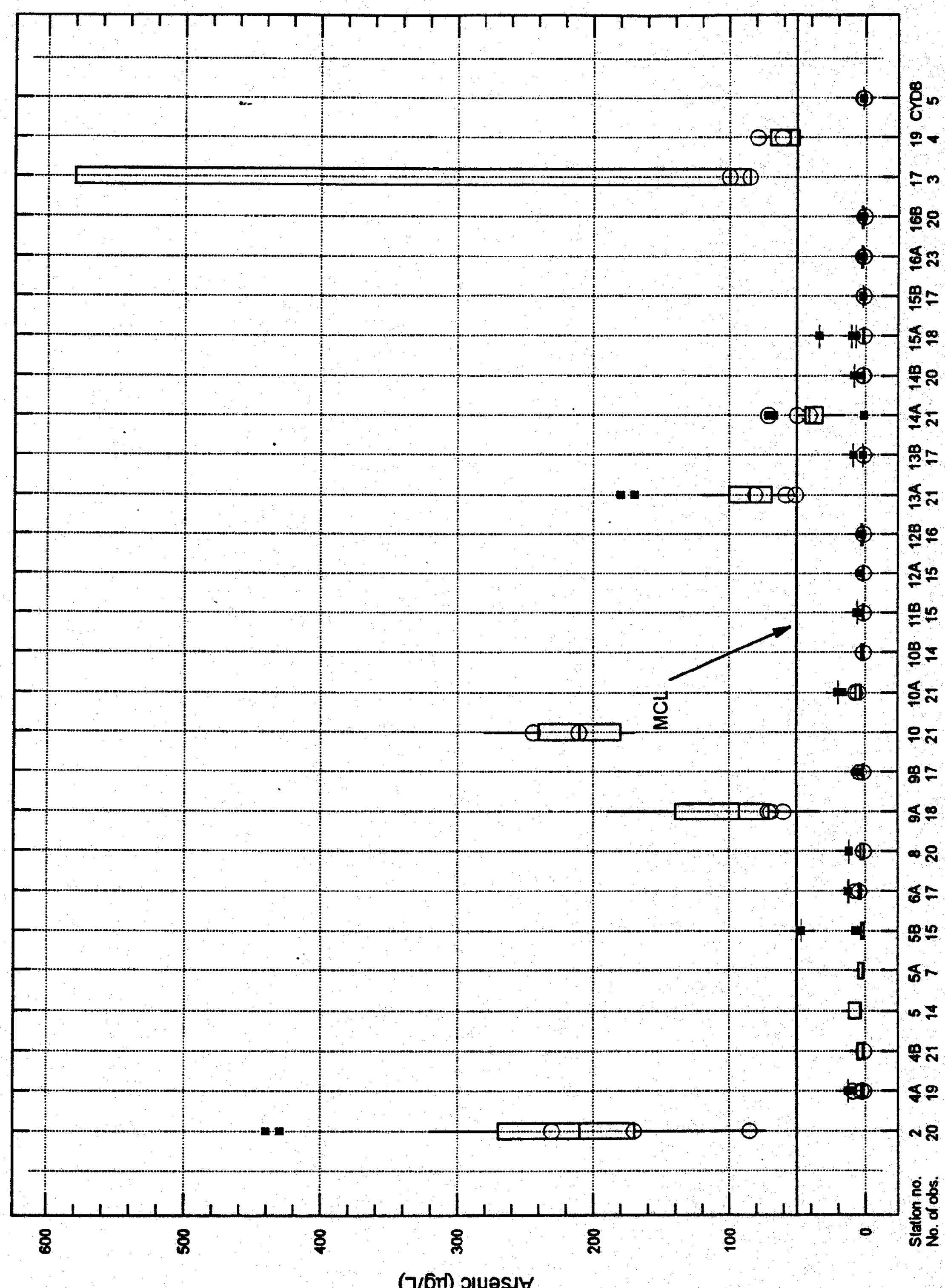


Figure 3-4. Arsenic Groundwater Data Through April 1995

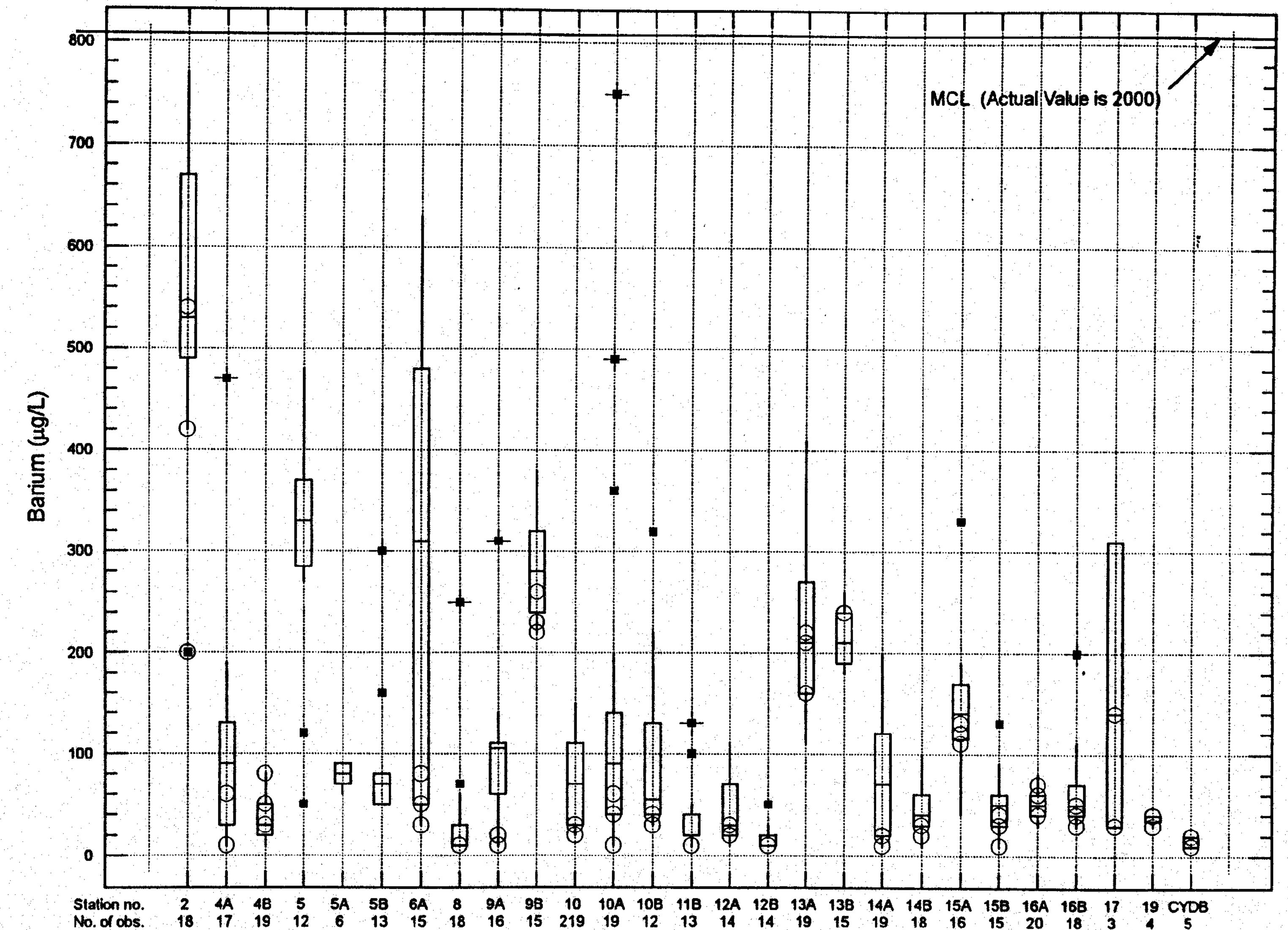


Figure 3-5. Barium Groundwater Data Through April 1995

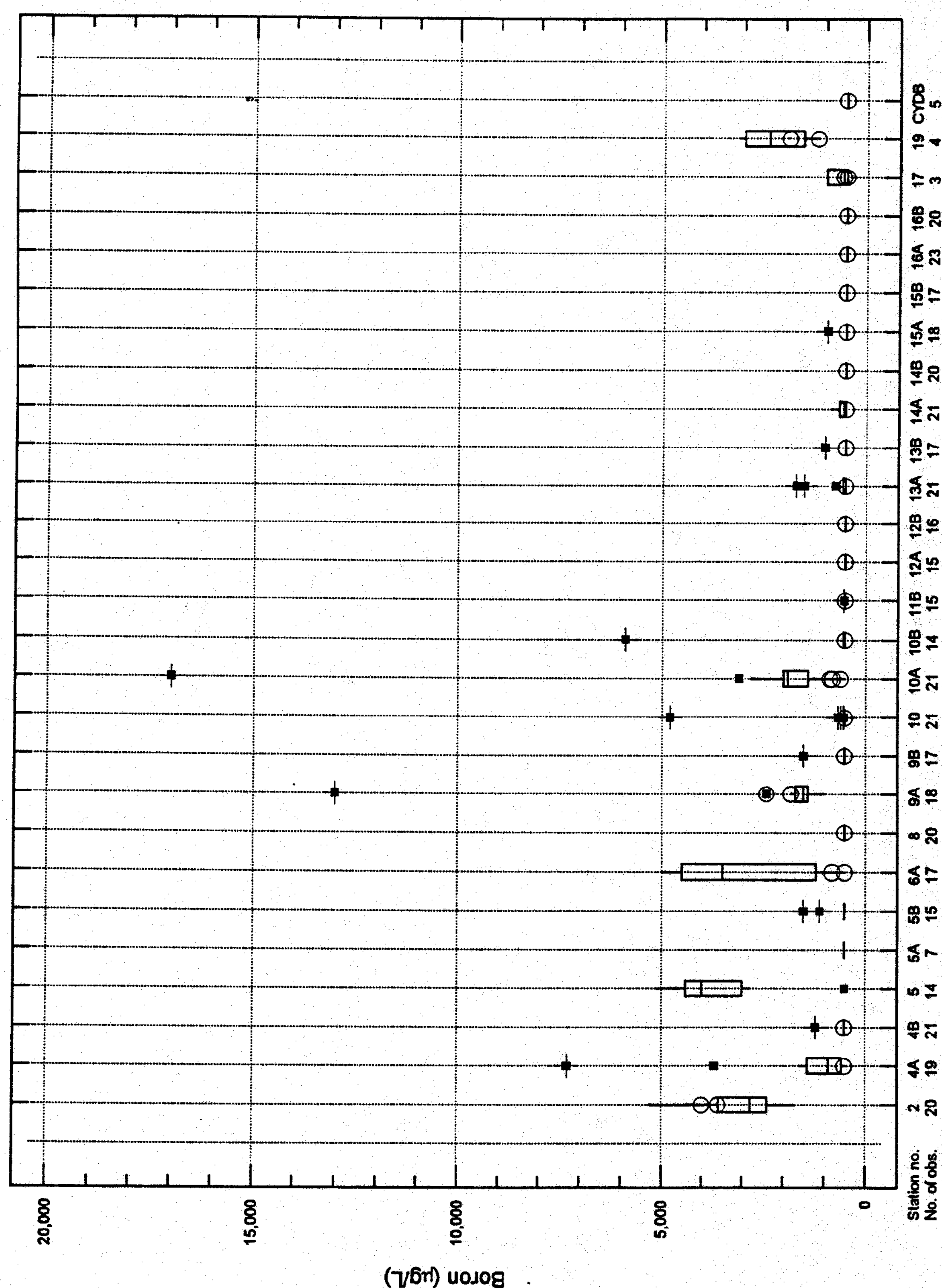


Figure 3-6. Boron Groundwater Data Through April 1995

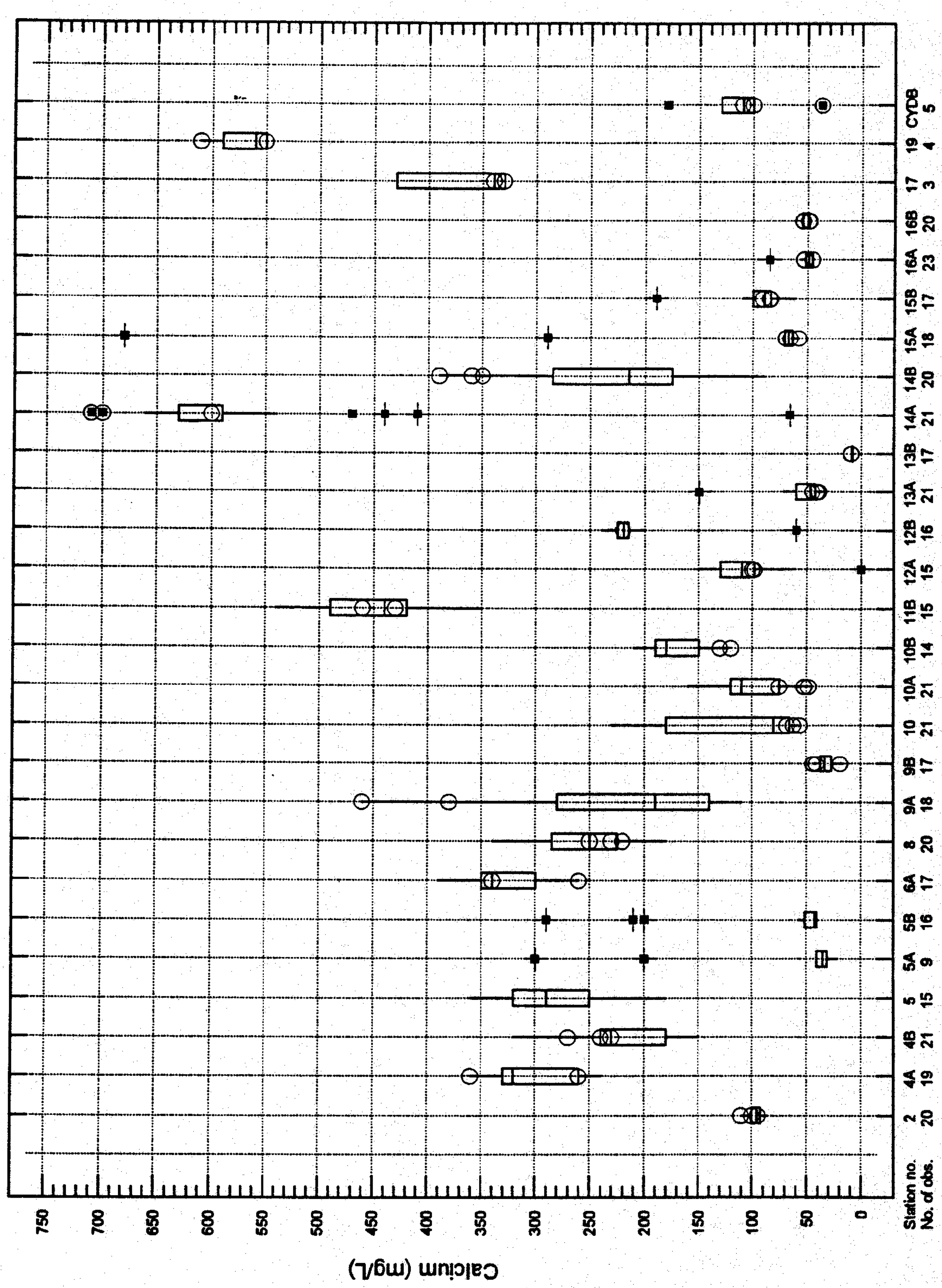


Figure 3-7. Calcium Groundwater Data Through April 1995

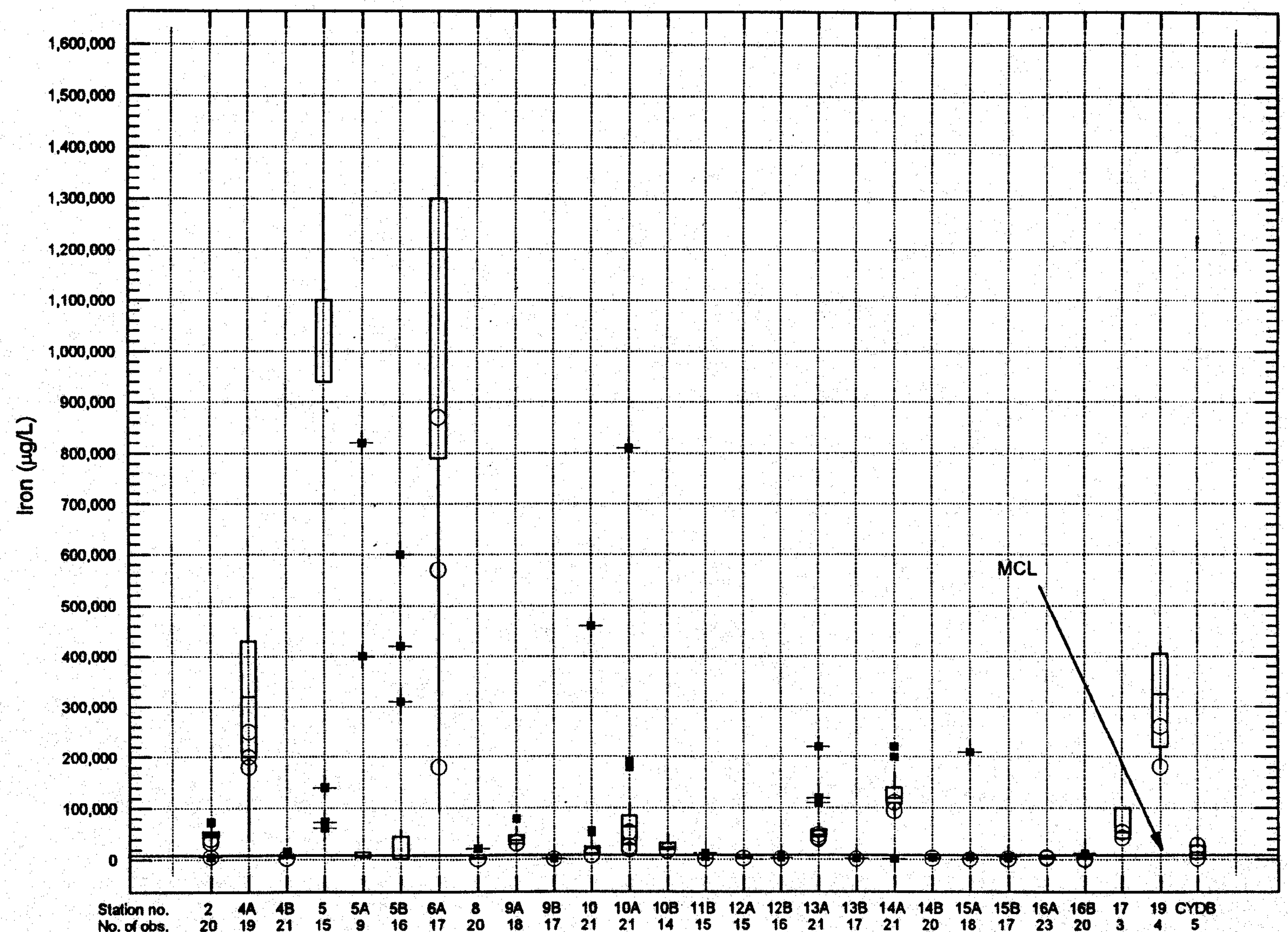


Figure 3-8. Iron Groundwater Data Through April 1995

TVA-00014470

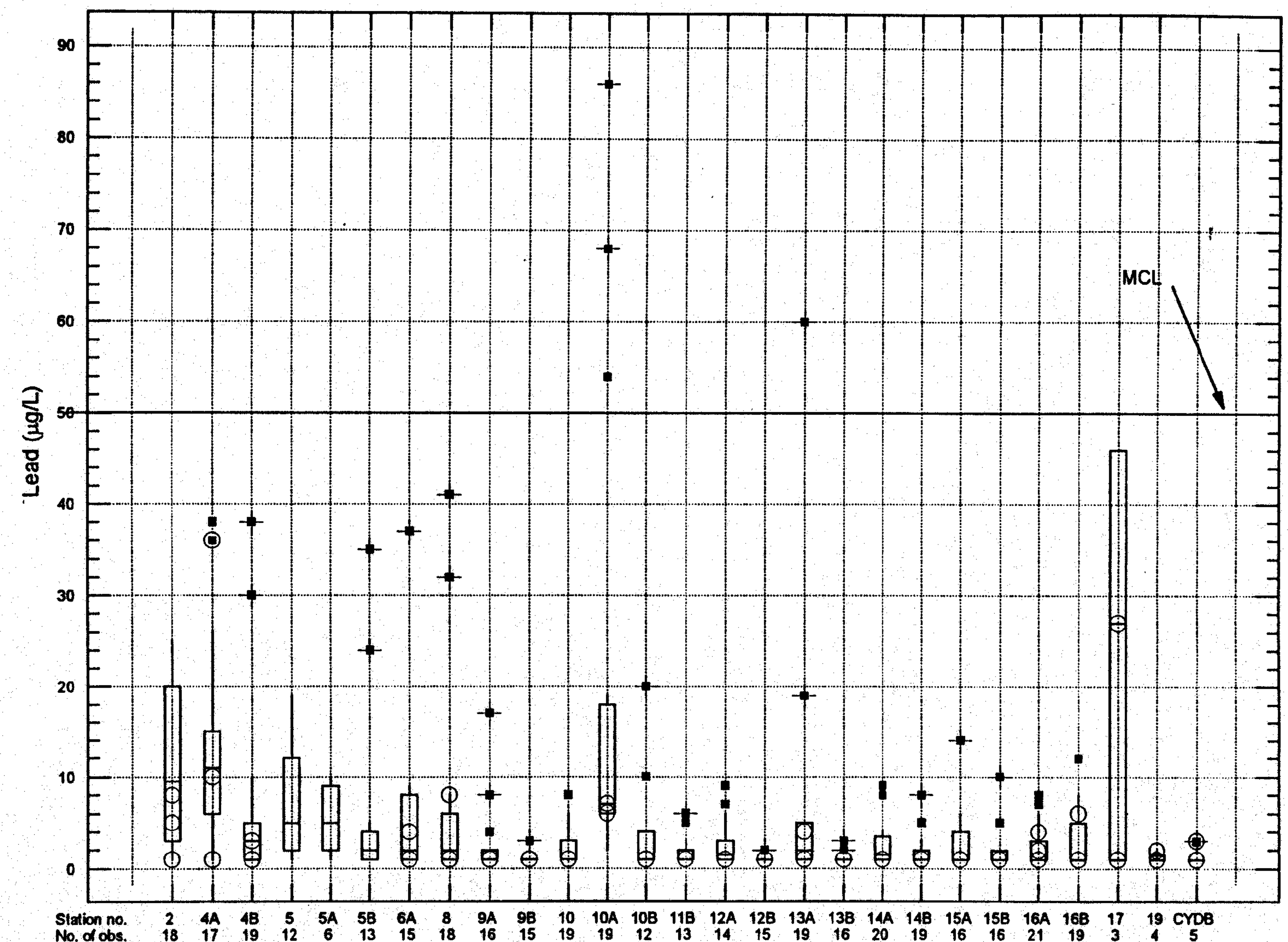


Figure 3-9. Lead Groundwater Data Through April 1995

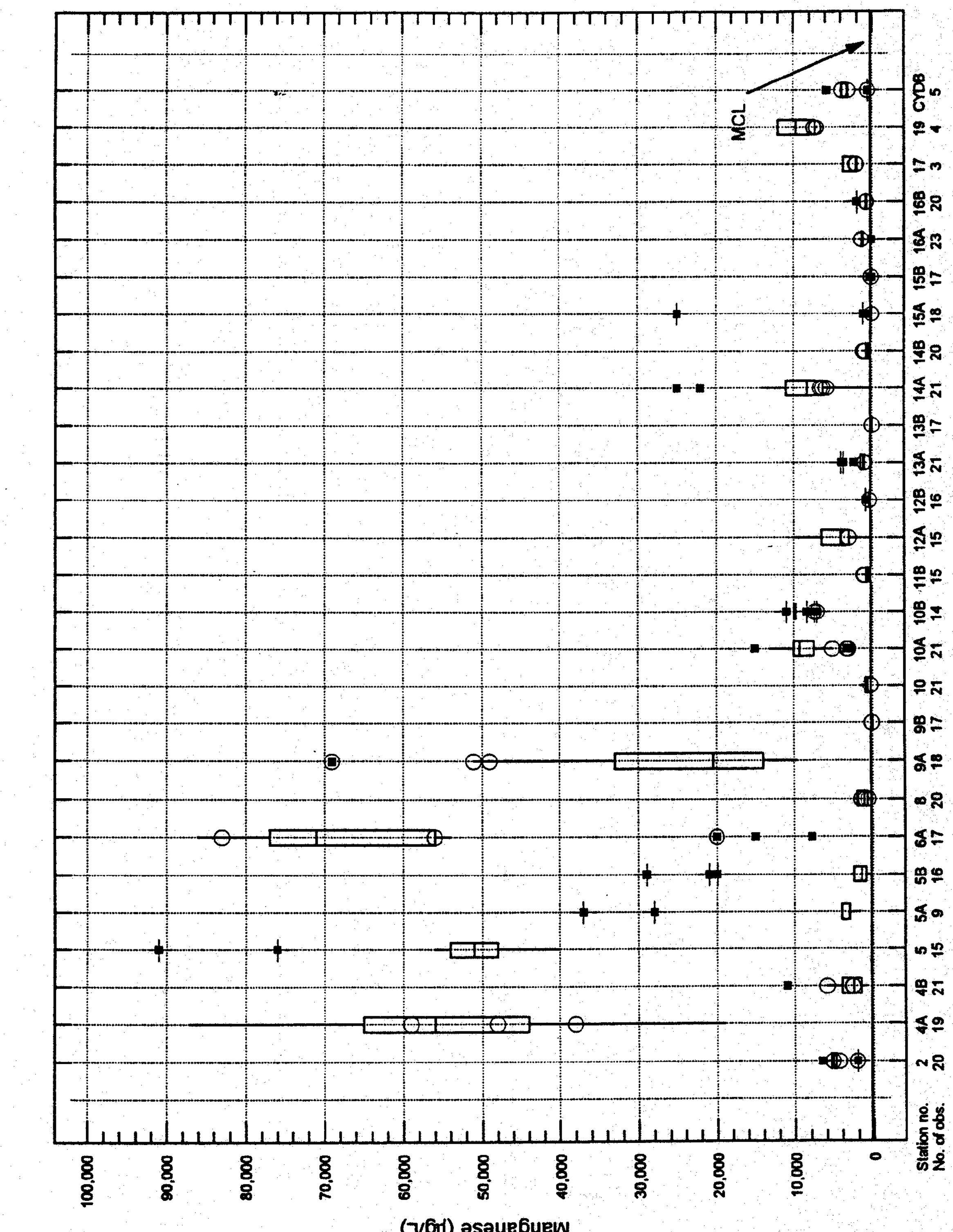


Figure 3-10. Manganese Groundwater Data Through April 1995

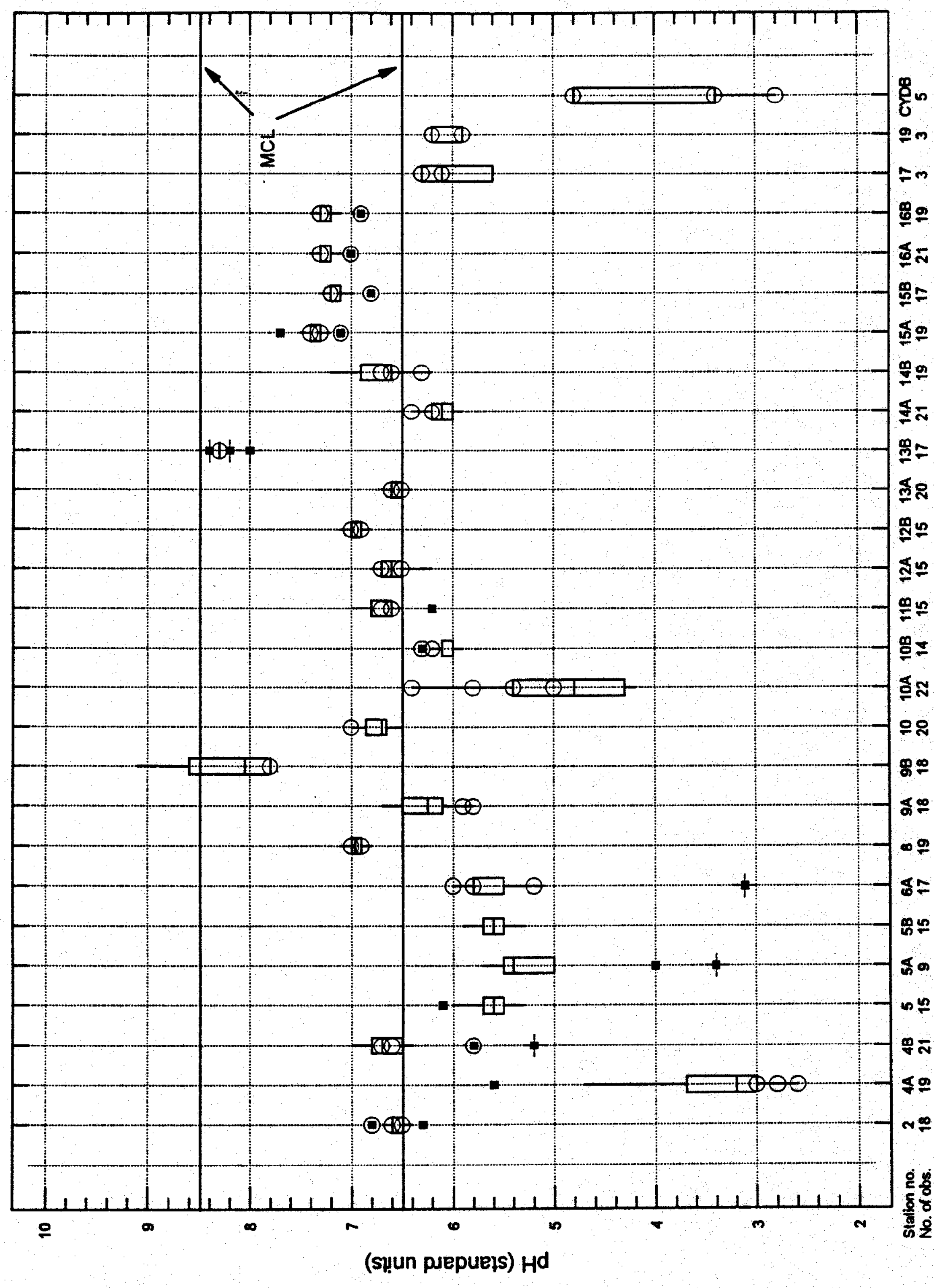


Figure 3-11. pH Groundwater Data Through April 1995

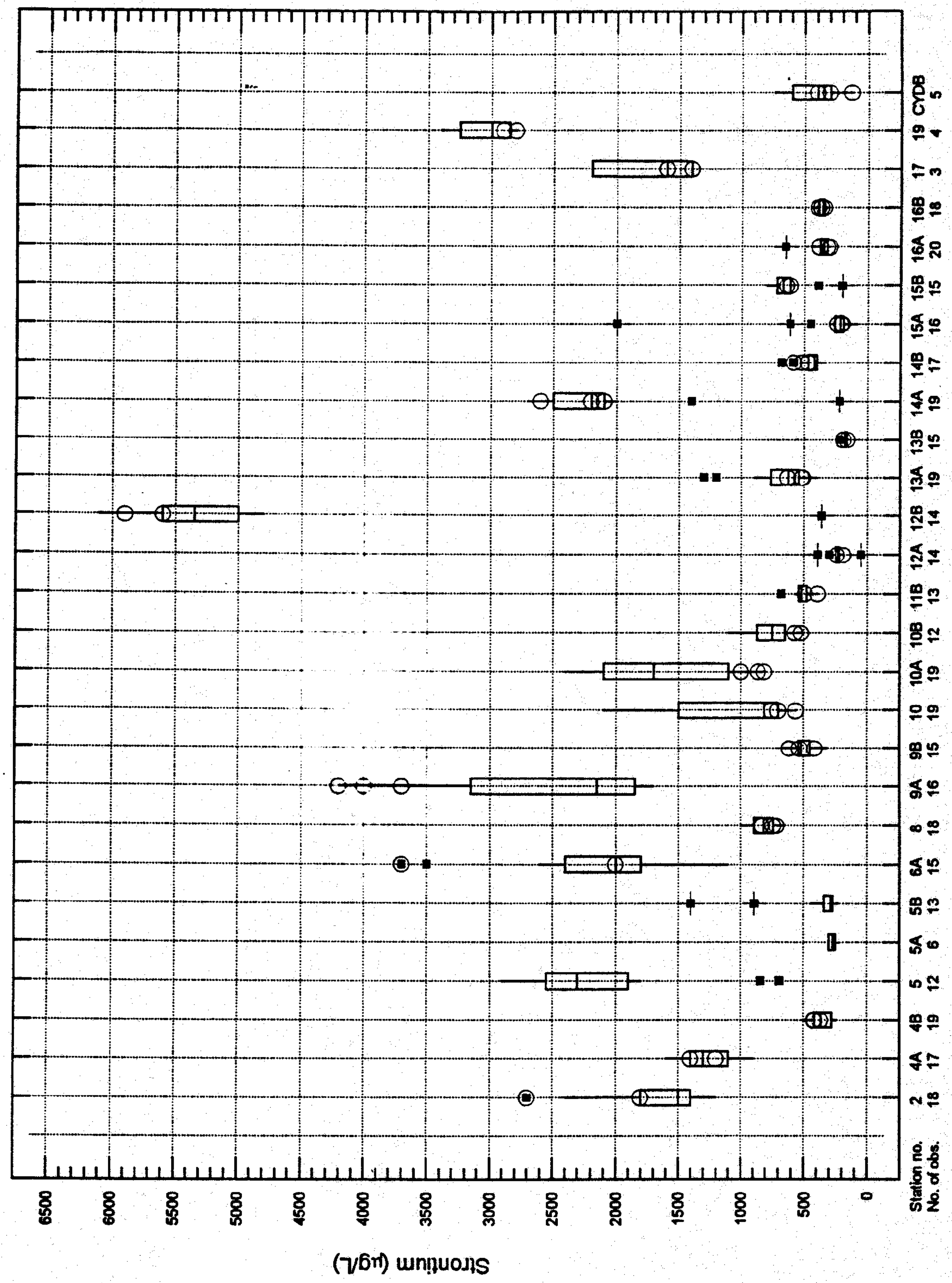


Figure 3-12. Strontium Groundwater Data Through April 1995

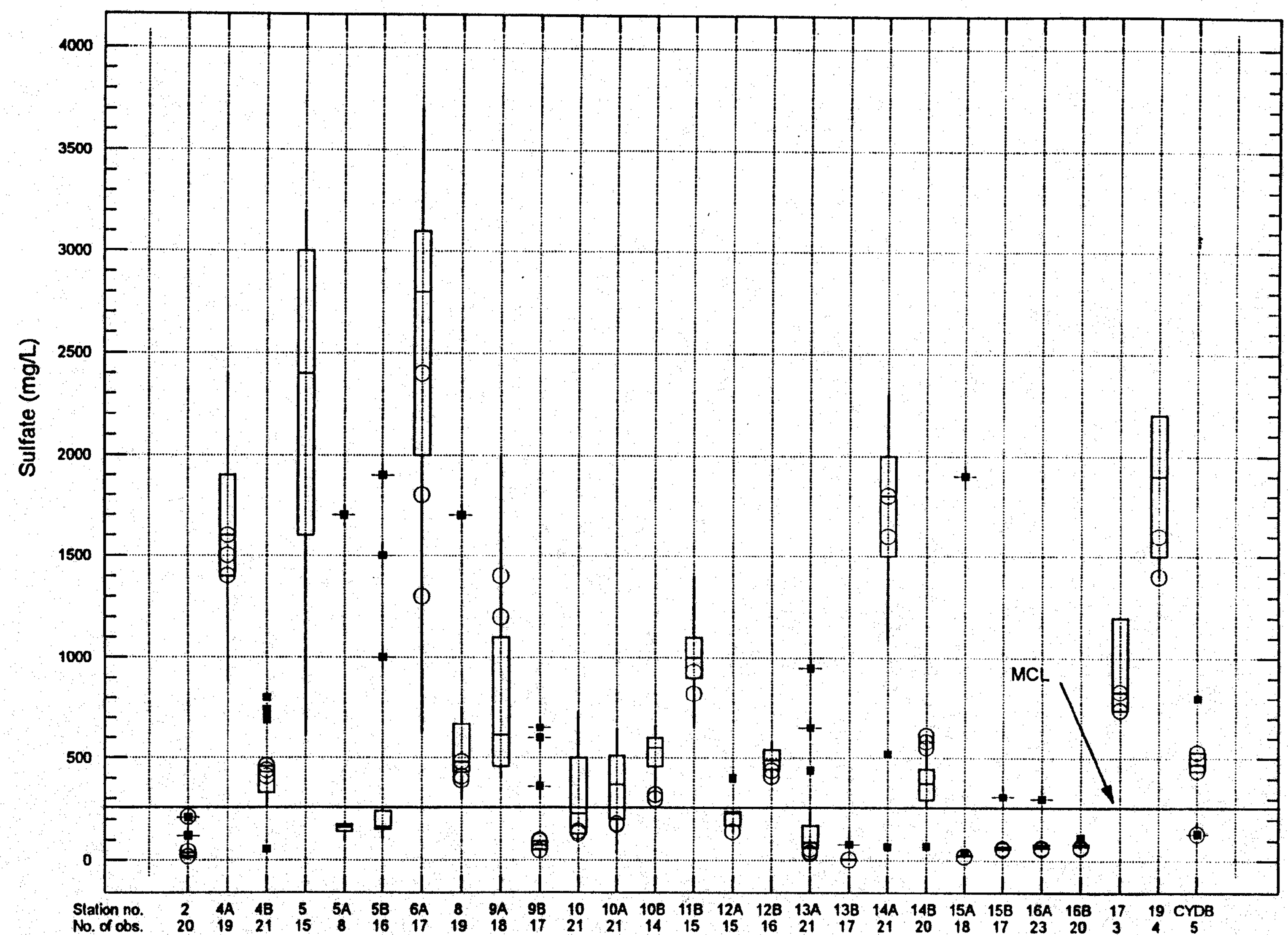


Figure 3-13. Sulfate Groundwater Data Through April 1995

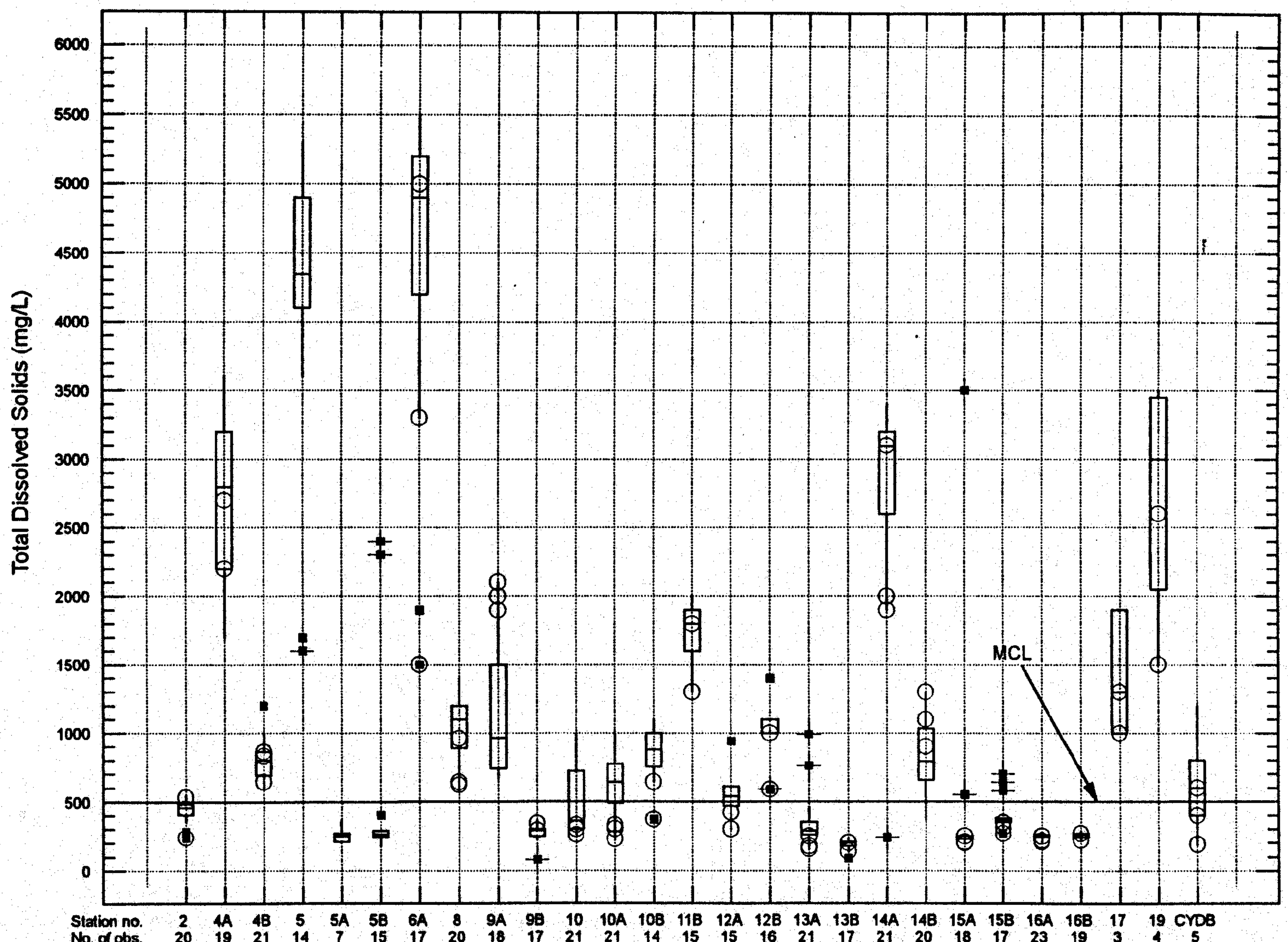


Figure 3-14. Total Dissolved Solids Groundwater Data Through April 1995

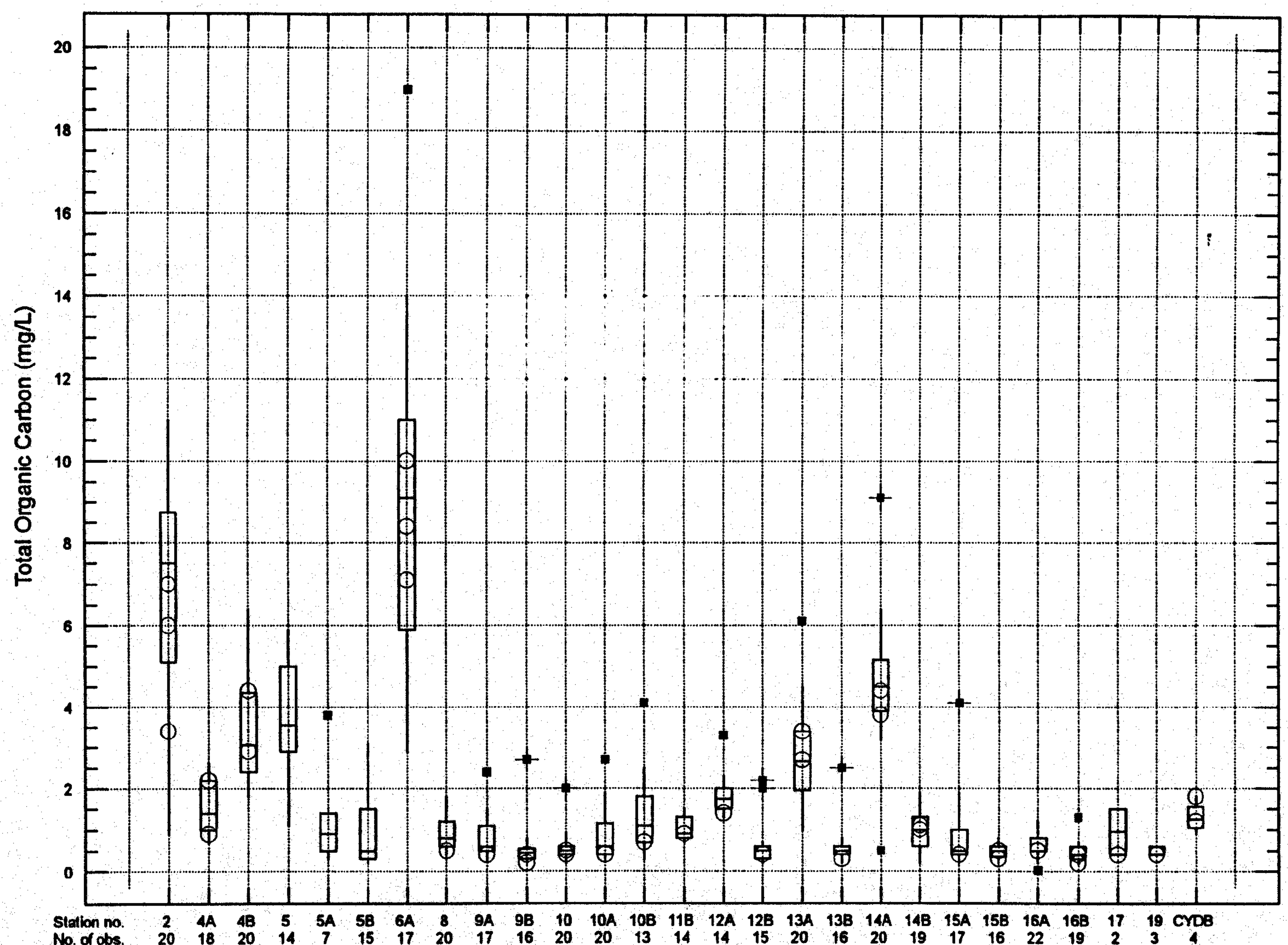


Figure 3-15. Total Organic Carbon Groundwater Data Through April 1995

TABLE 3-5
Fly Ash Leachate Characteristics Based on EPRI Estimates and TVA Data.

FOWL Leachate Estimates [a]						TVA Well Point data [b]		
Constituent	Units	Leachate Concentration				Minimum	Maximum	Mean
pH	S.U.	4	5	6	7	6.0	9.4	7.6
Al	µg/L	4037	523	149	146	50	3500	309
Ba	µg/L	254	255	253	253	30	630	190
Ca	mg/L	395	396	394	394	15	390	92
Cr	µg/L	40	2	2	2	1	4	1
Mo	µg/L	1879	748	679	672	20	6200	688
Si	mg/L	26	26	26	26	1	18	6
Sr	µg/L	1624	1631	1616	1616	220	2700	945
So_4	mg/L	960	953	946	946	8	990	163
As	µg/L	109	99	99	99	3	3520	945
B	µg/L	2856	3340	3907	4569	500	23000	5270
Cd	µg/L	34	8	2	2	0.1	6	1
Cu	µg/L	244	24	4	4	10	770	43
Fe	µg/L	511	104	21	5	10	25000	4684
Mg	mg/L	8.9	4.9	2.7	1.5	0.6	41	14
Na	mg/L	8.5	9.7	11	12	90	20	5.8
Ni	µg/L	197	50	13	9	1	65	10
Se	µg/L	0	0	41	65	1	27	4
Zn	µg/L	747	85	10	10	10	10000	794
TDS	mg/L	772	762	757	758	110	1500	464

[a] Source: Hostetler et al., 1988

[b] Based on approximately 40 samples from 17 well points at 4 different TVA fossil plants

TABLE 3.6

Indications of Ash Leachate in Wells in the Active Ash Pond Area at KIF.

Comparison of Predicted Threshold Concentrations (FOWL) with Observed Median Values.

Well Number	Arsenic µg/L	Barium µg/L	Boron µg/L	Calcium mg/L	Iron mg/L	Strontium µg/L	Sulfate mg/L	TDS mg/L	pH S.U.
2	210/180[a]	530/460	2800/2400	96/99	48.5/36	1500/1400	20.5	455	6.6
4A	2/1	90/20	890/720	320/300	320/280	1300/1400	1600	2800	3.2
4B	2/1	30/10	500/500	230/220	3.6/0.2	360/280	430	800	6.7
5	4/7.5	330/190	4000/1900	290/290	1100/500	2300/1520	2400	4350	5.6
5A	2/2	80/50	500/500	35/40	4.8/7.5	270/50	160	250	5.4
5B	1/1	70/40	500/560	43/107.5	2/125	290/475	165	260	5.6
6A	4/2.5	310/370	3500/3650	340/350	1200/1250	2000/2000	2800	4900	5.8
13A	85/82	220/170	500/500	47/44	48/43	630/550	88	290	6.6
13B	1/1	210/190	500/500	8.4/8.8	0.12/.02	170/160	2	200	8.3
17	100/293	140/15	580/755	340/360	53/58	1600/1750	830	1300	6.1
19	55.5/44	40/20	2400/2000	560/460	325/300	3000/2600	1900	3000	5.9
16A	1/1	50/60	500/500	49/51	1.10/0.70	350/340	70	250	7.3
16B	1/1	50/40	500/500	50.5/49	.33/.01	360/320	72.5	260	7.3
FOWL[b]	100	250	3000	400	0.2	1600	950	750	4 TO 7

[a] Total/Dissolved Median Values

[b] Hostetler et al., 1988

Shaded values consistent with FOWL predictions

TABLE 3-7

Summary of Analyses Indicating Ash Leachate Effects at Kingston Fossil Plant Through December 1994

Well	Regulated Parameters								Nonregulated Parameters	Ionic Distribution Effects	Nearest Possible Source
	1° (% > MCL)					2°(% > MCL)					
	As	Be	Cd	Pb	Ni	pH	SO4	TDS			
2	100	25				11		10	B, Sr	No	CTP
4A			10		67	100	100	100	Sr	Yes	Dredge Cells
4B						24	95	100		Yes	Dredge Cells
5						100	100	100	B, Sr	Yes	Ash Pond
5A						100	12			Maybe	Ash Pond
5B						100	25	13		Maybe	Ash Pond
6A						100	100	100	B, Sr	Yes	Stilling Pond
8							100	100		Yes	Coal Yard
9A	94	25				72	100	100	Sr	Yes	CTP
9B						28	18		Na	No	CTP
10	100						43	38		Maybe	ALD
10A		20		16		100	67	67	Sr	Maybe	ALD
10B						100	100	93		Yes	ALD
11B						7	100	100		Yes	ALD
12A		33				13	7	67		Maybe	Coal Yard
12B		33					100	100	Sr	Yes	Coal Yard
13A	100			5		10	14	10		No	Ash Pond
13B									Na	No	Ash Pond
14A	10					100	95	95	Sr	Yes	CYDB
14B		5				11	95	95		Yes	CYDB
15A		6					6	11		No	Coal Yard
15B							6	18		No	Coal Yard
16A							4			No	Dredge Cells
16B										No	Dredge Cells
17	100					100	100	100	Sr	Yes	Ash Pond
19	50					100	100	100	B, Sr	Yes	Ash Pond
CYDB		20			80	100	80	60			CYDB

Abbreviations: ALD = Anoxic Limestone Drain CTP = Chemical Treatment Plant CYDB = Coal Yard Drainage Basin exceeded the MCL for nickel two-thirds of the time. Previous modeling studies [Velasco and Bohac, 1991] suggest that arsenic is readily adsorbed by soil and is not very mobile in groundwater. This is supported by the data from the deeper wells at sites 9, 10, and 13, where high arsenic levels were observed in the shallow wells. The only other MCL exceedances for health-related parameters were for lead at two wells and beryllium at six wells. However, most were single occurrences.

Of the secondary parameters, MCLs were frequently exceeded for pH, sulfate, TDS, aluminum, iron, and manganese. High levels of the three metals mentioned are often attributed to sediment in the samples. About half the wells produced samples with some level of turbidity. Total suspended solids (TSS) is a quantitative measure of the amount of sediments and particulate matter in a sample. Unfiltered samples provide total concentrations of all constituents and are therefore viewed as being the most conservative. However, concerns have been raised that levels of some regulated metals such as arsenic and lead will be abnormally high if they are associated with the sediment and not mobile in the aqueous phase. To remove these biases, it is often suggested to filter all samples through a glass fiber filter of standard pore size, usually 0.45 um, to yield dissolved concentrations. However, false low levels may arise if mobile elements adsorb onto soil particles during filtration. In order to help resolve some of these questions, both filtered and unfiltered samples were collected at the same time at several locations. Table 3-4 contains the total and dissolved concentrations from the 12 samples that were both filtered and unfiltered.

From Table 3-4, it is clear that for the sample from wells 14A and 14B there was very little difference observed between the total and dissolved concentrations. These results would be expected because that sample also had a very low amount of TSS (5 mg/L). In the other samples, where TSS levels ranged from 39 to 1800 mg/L, the greatest differences between total and dissolved concentrations were for constituents associated with sediment, i.e., aluminum, iron, and manganese. In only one instance, beryllium in well 9A, the dissolved value was below an MCL that was exceeded in the unfiltered samples. The higher level of antimony observed in the dissolved 9A sample was assumed to be anomalous.

In four of the five wells on the ash pond dike (wells 4A, 6A, 17, 19), the levels of most metals, such as aluminum, barium, boron, iron, manganese, strontium, and zinc in the filtered samples were usually within 20 percent of the levels in the unfiltered samples. That is, if the total concentration of a constituent was elevated, its dissolved fraction was usually elevated also, albeit at a lower level. Levels of other indicator parameters such as arsenic and lithium were very similar in both filtered and unfiltered samples. These results suggest that while sediment in samples can cause interferences in the levels of some parameters, including some heavy metals, sample filtration is not warranted for the purpose of monitoring ash leachate effects in groundwater. The levels of iron and manganese in wells 4A, 6A, and 19 are particularly noteworthy as they are much higher than would be expected to occur from just fly ash leaching.

Ash Leachate Composition

While pore water samples were not collected at Kingston, in situ samples have been collected at five other TVA fossil plants using a well point leachate collection method developed by Milligan and Bohac [1991]. The range and mean of values observed from these samples is shown in Table 3-5. Also shown in Table 3-5 are the values provided by FOWL, the Electric Power Research Institute's computer code used to estimate ash leachate composition as a function of pH [Hostetler et al., 1988]. Data collected from the TVA ash pond wells reveal that the characteristics of ash leachate may vary at a site, as well as from site to site. Differences are probably due to age of ash and types of coal burned.

The pH of most of the TVA pore water samples was alkaline. However, the pH of the groundwater in the active ash pond area is acidic. Therefore, the Kingston data were compared with the FOWL leachate estimates at the pH 4 to 7 range (Table 3-6). The quartile plots (box and whisker graphs) in Figures 3-4 to 3-15 facilitate ready comparison of all wells at the site for most of the parameters of interest. The median values of eight indicator parameters are shown in Table 3-6. The numbers in the shaded boxes exceed or are near the threshold concentrations predicted by FOWL. Wells 2, 5, 6A, 17, and 19 showed the most evidence of ash leachate. Wells 2 and 17 are screened in ash; wells 5, 6A, and 19 are screened in the ash pond dike which could contain significant amounts of bottom ash.

Aside from iron, which was found in all wells, TDS, strontium, sulfate, and boron were the indicator parameters that most frequently exceeded the threshold values. The iron levels were found to be high in wells 4A, 5, 6A, 17, and 19, suggesting the occurrence of pyrite oxidation in the ash pond or in the dikes. The oxidation state of the iron is not known. If this iron-rich water were to enter a surface water, such as the river, its potential impacts would depend on the oxidation state. If it is in the ferric (+3) form, the iron would likely hydrolyze to form insoluble ferric hydroxide and produce 3 moles of acidity for every mole of iron. However, if the iron is in the ferrous (+2) form, the iron will consume acidity as it is oxidized to the ferric form before it is hydrolyzed [Milligan and Ruane, 1980]. The oxidation reduction potential (ORP) values observed in most of the wells along the ash pond dike suggest that the waters are in a slightly oxidizing state. Specific analyses for ferrous and ferric iron would have to be conducted to determine the actual oxidation state of the iron.

In terms of ionic distributions in ash leachate, the predominant anion is sulfate and the predominant cation is calcium. In addition, ash leachate has high TDS. The length of the bars is related to the amount of TDS in the water. Figures 3-1 and 3-2 may be compared to Figure 3-15 in order to associate which bar lengths are most closely related to a TDS level of interest. For example, the MCL of 500 mg/L appears to be associated with a bar length of approximately 8 milli-equivalents (meq), and the level predicted by FOWL (750 mg/L) with a bar length of about 12 meq. The ionic distributions of wells 4A, 4B, 5, 6A, 17, and 19, as well as wells 9A, 10B, 11B, 12B, 8, 14A, and 14B have bar lengths greater than 12 meq. In addition, the predominant anion in all these wells is sulfate. On the other hand, ionic distributions most similar to background were observed in wells 2 and 13A. Several wells, including 5A and 5B have low ionic levels, but the anions are nearly all sulfate. A high predominance of sulfate with low ionic levels may be indicative of pyrite oxidation rather than ash leachate. The only wells that stand out on the basis of the cation distribution are wells 9B and 13B which were predominated by sodium.

Summary

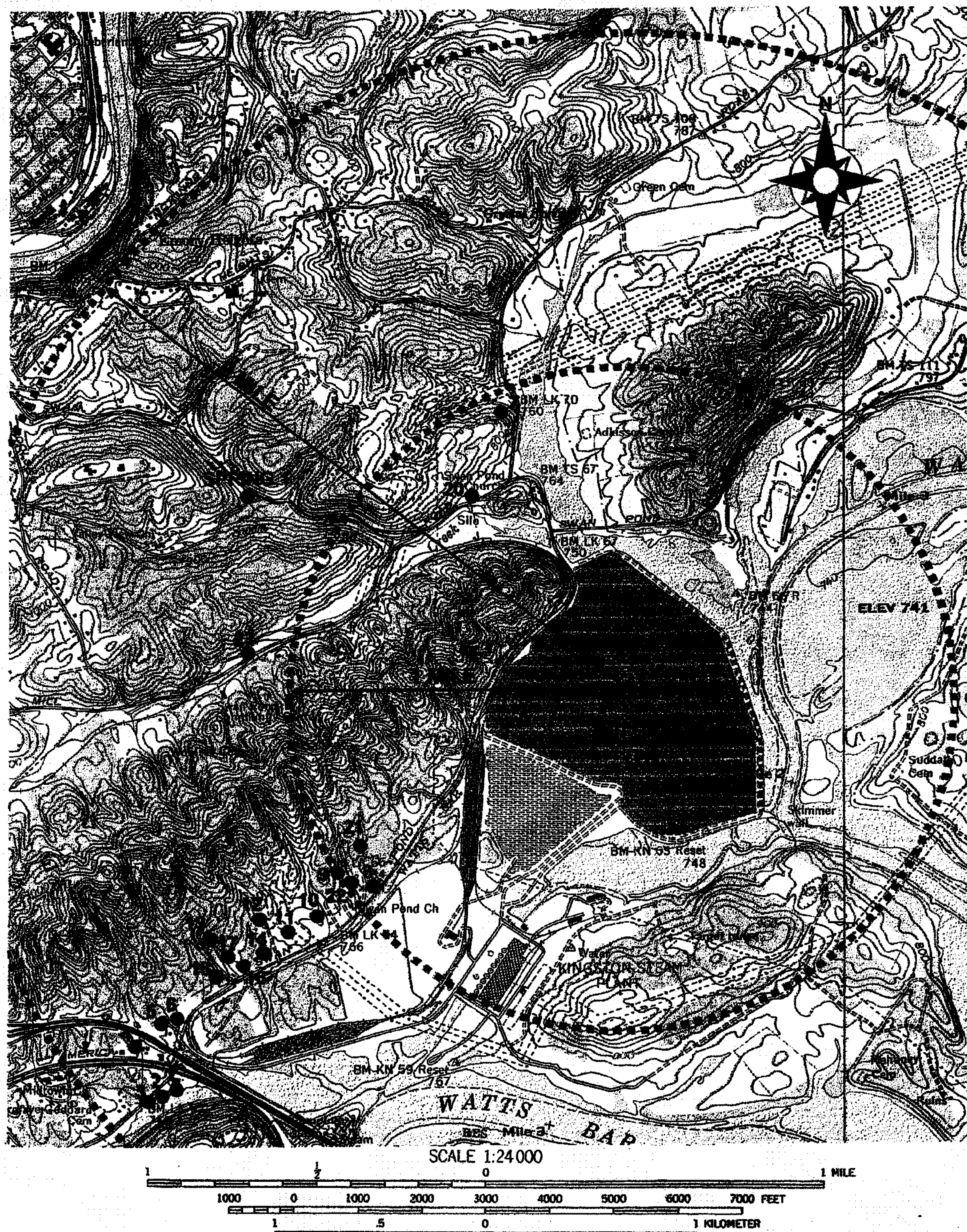
Table 3-7 presents a well-by-well summary of all the analyses considered herein to gauge potential impacts to groundwater at Kingston Fossil Plant. The percentage of samples that exceeded MCLs for primary (1°) drinking water standards (based on Table 3-2) and the percentage of samples that exceeded MCLs for secondary (2°) parameters pH, SO4, and TDS (based on Table 3-3) are shown. Also listed in Table 3-7 are non-regulated ash leachate indicator parameters that were found at elevated levels, ionic distribution effects, and the nearest possible source. Ash leachate contamination was indicated by acidic pH, high levels of sulfate, TDS, boron, and strontium, and ionic distribution effects. The wells in the active ash pond area exhibiting most of these indicators were 2, 4A, 4B, 5, 6A, 17, and 19. Possible decreasing trends were apparent for iron and pH in well 4A, iron and sulfate in well 6A, and arsenic in well 13A. Unusual levels of sodium were observed in wells 9B and 13B, but this is not considered to be an indicator of ash leachate. Turbid samples persist in several wells. However, analysis of data from filtered and unfiltered samples suggested that sample filtration is not warranted for the purpose of monitoring ash leachate effects in groundwater at Kingston.

4. LOCAL GROUNDWATER USE

A survey of local groundwater use within an approximate two-mile radius of the center of the ash pond area was conducted in March 1995. The survey included interviews with local residents and utility district managers. Water well records maintained by the State of Tennessee were also examined for wells within the survey region.

A total of 22 residential wells were identified during the survey (Figure 4-1). A listing of these wells and their coordinate locations is given in Table 4-1. Note that wells are numbered 1 through 23 with no well 15. Spring 1 is an untreated water source for 10 to 12 residences along Swan Pond Road and for several residents of the Kingston Heights subdivision. The spring emanates from aquifers of the Knox Group. This spring appears to be the only spring in the survey region used for water supply. There are six wells (numbers 7, 8, 9, 20, 21, and 22) located within approximately one mile of the center of the disposal site and another 15 wells situated between one and two miles of the site. The depths of these residential wells are unknown; however, it is likely that most are completed in the Conasauga formation at relatively shallow depths (i.e., less than 300 ft).

Other residents within the survey region are served by one of the four local water utilities listed in Table 4-1. These utilities provide treated water from intakes on Watts Bar Lake or the Emory River.



CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 4-1. Wells and Springs Within Two Miles of Ash Pond Area

TABLE 4-1

List of Wells, Springs, and Water Supplies in Site Vicinity

Location Identifier	Location Description	Longitude (dg-mn-sc) est	Latitude (dg-mn-sc) est	Inside 1 mile radius	Inside 2 mile radius	Outside 2 mile radius
Well 1	Swan Pond Rd south of Hwy 70	35-53-35 N	84-32-05.5 W		X	
Well 2	Swan Pond Rd south of Hwy 70	35-53-34 N	84-32-09 W		X	
Well 3	Swan Pond Rd south of Hwy 70	35-53-33-N	84-32-10.5 W		X	
Well 4	North of Hwy 70, South of I-40	35-53-41.5 N	84-32-14 W		X	
Well 5	Swan Pond Rd north of Hwy 70	35-53-44.5 N	84-32-09.5 W		X	
Well 6	Swan Pond Rd north of Hwy 70	35-53-45-N	84-32-06 W		X	
Well 7	Swan Pond Circle north of Swan Pond Rd	35-55-18 N	84-31-04.5 W	X		
Well 8	Swan Pond Rd north of Hwy 70	35-54-06 N	84-31-31 W	X		
Well 9	Swan Pond Rd north of Hwy 70	35-54-07 N	84-31-37 W	X		
Well 10	Swan Pond Rd north of Hwy 70	35-54-00.5 N	84-31-41 W		X	
Well 11	Swan Pond Rd north of Hwy 70	35-53-58.5 N	84-31-46 W		X	
Well 12	Swan Pond Rd north of Hwy 70	35-54-00.5 N	84-31-50.5 W		X	
Well 13	Swan Pond Rd north of Hwy 70	35-53-52 N	84-31-47 W		X	
Well 14	Swan Pond Rd north of Hwy 70	35-53-55 N	84-31-50 W		X	
Well 16	Swan Pond Rd north of Hwy 70	35-53-53 N	84-31-53 W		X	
Well 17	Swan Pond Rd north of Hwy 70	35-53-55 N	84-31-56 W		X	
Well 18	Swan Pond Rd north of Hwy 70	35-53-52 N	84-31-58.5 W		X	
Well 19	Swan Pond Rd north of Hwy 70	35-53-56 N	84-32-00 W		X	
Well 20	Swan Pond Rd west of Swan Pond circle	35-55-06.5 N	84-31-09 W	X		
Well 21(N)	Swan Pond Rd north of Hwy 70	35-54-11 N	84-31-31.5 W	X		
Well 22(N)	Swan Pond Rd north of Hwy 70	35-54-05 N	84-31-05 W	X		
Well 23(N)	Hassler Mill Rd west of Swan Pond Rd	35-54-43 N	84-31-54 W		X	
Spring 1	Near intersection of Swan Pond Rd and Frost Hollow Rd (used for portion of municipal supply by City of Kingston)	35-55-07 N	84-31-54 W		X	
City of Kingston	Intake off Hwy 58 south of Kingston on Watts Bar Lake	n/a	n/a			X
Swan Pond U.D.	Purchase water from City of Harriman	n/a	n/a			X
Midtown Utilities	Purchase water from City of Rockwood	n/a	n/a			X
City of Harriman	Intake on Emory River near Mile 13	n/a	n/a			X
City of Rockwood	Intake on Watts Bar Lake near Post Oak Creek	n/a	n/a			X

5. EVALUATION OF POTENTIAL WATER QUALITY IMPACTS

The potential impacts of the closed ash pond area on adjacent groundwater and surface water resources are examined in this section. The focus of the evaluation is on the effect of the facility on reservoir water quality since all shallow groundwater originating on, or flowing beneath, the site ultimately discharges to the reservoir without traversing private property. Estimates of ash leachate flowrates generated during a 30-year post-closure period are compared with historical flows in Watts Bar Reservoir to quantify potential water quality impacts. In evaluating potential impacts to groundwater users, consideration is given to the location of existing residential wells in relation to groundwater flow patterns in the site vicinity.

Post-Closure Ash Fill Water Budget Analysis

EPA's HELP2 code [Schroeder et al., 1989] was used to estimate the overall water balance, including leachate production, for the ash fill during a 30-yr period following closure. For purposes of the simulation, the ash fill was divided into three regions as shown schematically on Figure 5-1. Region 1 corresponds to what is now the active ash pond area. This region is 114.6 acres in area and will have a final average grade of elevation of about 770 ft and surface slope of 5 percent. Region 2 comprises the 3:1 side-slope area of the dredge cells and will be approximately 36 acres in size. The area on top of the dredge cells at closure is represented by Region 3. This region will encompass 58.8 acres and will be sloped at a 5 percent grade. The entire surface of ash fill will be covered with one foot of 10^{-7} cm/s clay followed by one foot of vegetated topsoil.

Table 5-1 lists the hydraulic properties required by HELP2 for each material type shown in Figure 5-1. The hydraulic properties of the Kingston fly ash were obtained from laboratory-measured data for three samples presented in Appendix A of Young et al. [1993]. The field capacity, wilting point, and porosity for the clay cap were those given by Schroeder et al. [1989] for a soil liner. The values for the top soil were those given by Schroeder et al. [1989] for a soil loam. The top soil was represented in the model as a lateral/vertical percolation layer, the clay cap a barrier layer, and the ash a vertical percolation layer. The initial moisture contents for the top soil and clay cap were arbitrarily set at field capacity. Field-measured moisture contents for ash samples collected at TVA's Bull Run [Young, 1992] and John Sevier [Velasco and Boggs, 1992] plants were used to estimate the initial ash moisture content for the simulation.

In addition to the properties in Table 5-1, HELP2 requires a Soil Conservation Service (SCS) curve number, an evaporation depth, and a leaf area index for the vegetative cover. Using information given by Schroeder et al. [1989], the SCS curve number for the top soil was estimated as 75. An evaporation depth of 18 inches was selected for the analysis. These values are consistent with those used in water budget analyses for other ash fills [e.g., Young and Velasco, 1991; Velasco and Boggs, 1992]. A leaf area index of 3.3, corresponding to a "good" grass cover, was assumed.

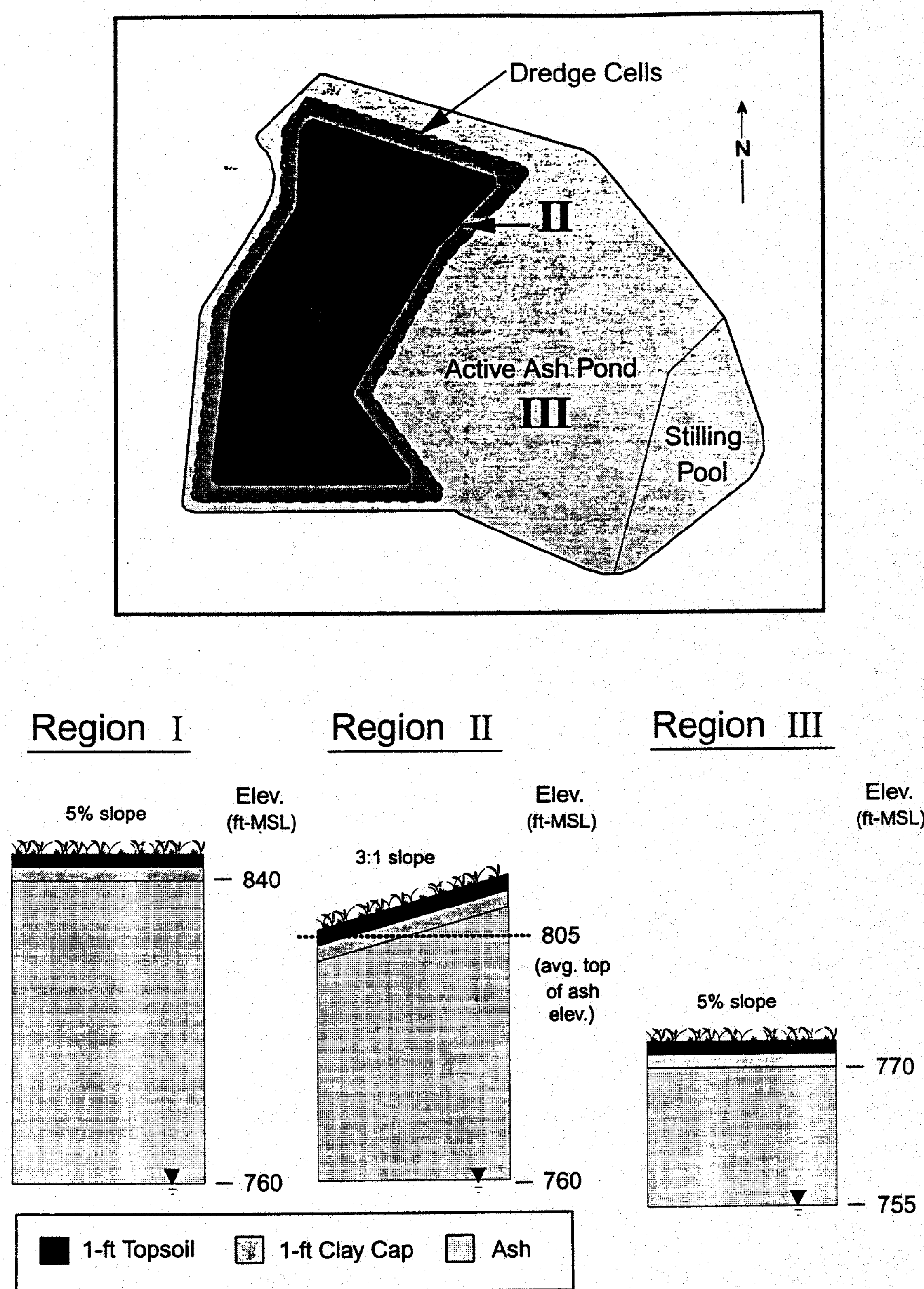


Figure 5-1. Subregion Areas and Profiles Used in HELP2 Simulations

TABLE 5-1 Material Properties Used in the HELP2 Simulations					
Soil Type	Porosity	Field Capacity	Wilting Point	Initial Moisture Content (%)	Hydraulic Conductivity (cm/s)
Top Soil*	.46	.23	.12	.23	3.7×10^{-4}
Clay Cap	.43	.37	.28	.37	1.0×10^{-7}
Fly Ash	.47	.40	.12	.25	2.1×10^{-5}
*Evaporation coefficient α is 5.1 mm/day $^{0.5}$					

Meteorological data was compiled from a National Oceanographic and Atmospheric Administration (NOAA) station located in Oak Ridge, Tennessee. This station was selected because of its close proximity to the Kingston plant and because high quality data was available for a continuous 20-year period. The data include daily rainfalls and mean daily temperatures from 1968 to 1987. In order to provide 30 years of rainfall/temperature data for the water budget simulation, data for years 1968-77 were added to the end of the 1968-87 record. Daily solar radiation values were generated using a HELP2 subroutine that incorporates several factors including latitude and daily rainfall.

The yearly combined leachate flowrates from the three subregions of the ash disposal area are shown on Figure 5-2. Leachate discharge gradually increases during the first 10 years of the post-closure period reaching a quasi-steady rate of approximately 6.3 million cfy (cubic feet per year) thereafter. The average leachate discharge for the 30-yr simulation was approximately 5.7 million cfy. The overall water balance for the ash fill in terms of percent of total incident precipitation was as follows: surface runoff, 18.8 percent; evapotranspiration, 64.1 percent; lateral seepage from top-soil layer, 1.0 percent; net change in water storage, 2.3 percent; and leachate reaching the water table, 13.8 percent.

Potential Impacts to Reservoir Water Quality

Groundwater flow patterns indicate that all leachate produced in the ash pond area will ultimately discharge into Watts Bar Reservoir. To assess the impact of ash leachate on reservoir water quality, a dilution ratio was estimated by comparing the predicted average leachate flowrate to the mean flow in the reservoir just downstream of the plant outfall. Full mixing of leachate influx and reservoir water was assumed. Considering that stream flow and leachate production from the ash fill are both functions of meteorological conditions, comparison of their mean flows appears to be a reasonable basis for calculating a dilution ratio. The mean flow in the Clinch River immediately below the plant outfall (approximate river mile 2.5) is estimated to be approximately 7,000 cfs. This estimate was based on the combined drainage-area adjusted mean flows for the Emory River (at Oakdale for the period 1927-93 as reported by Flohr et al.,

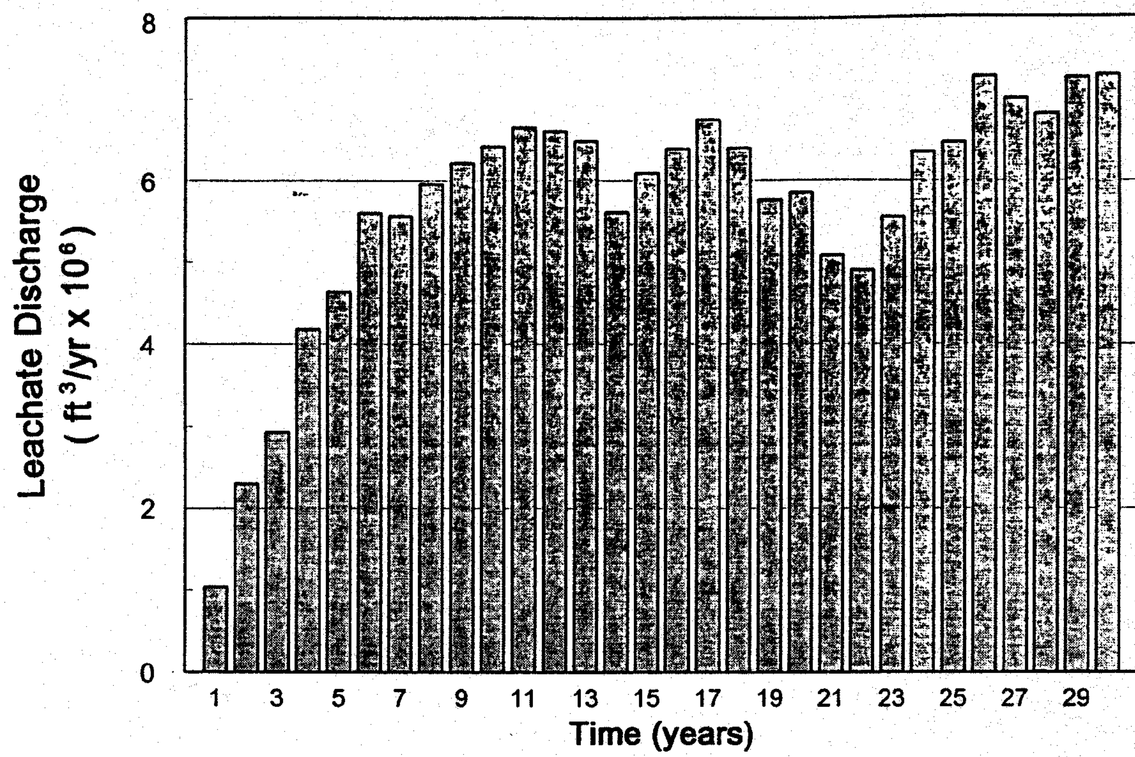


Figure 5-2. Predicted Leachate Discharge From Ash Pond Area During 30-Year Post-Closure Period

1993) and the Clinch River (at Melton Hill Dam for the period 1964-94). The resulting dilution ratio for the quasi-steady leachate discharge predicted during the last 20 years of the water budget simulation of 6.3 million cfy (0.20 cfs) is 1:35,000.

Incremental increases in chemical concentrations in Watts Bar Reservoir due to the influx of ash-leachate effected groundwater were estimated by multiplying the dilution ratio by the mean parameter concentrations. Groundwater quality data for wells located on the perimeter of the disposal area which exhibited exceedances for primary and secondary drinking water standards were selected for the calculation. Parameters exceeding drinking water MCLs included arsenic, nickel, iron, manganese, sulfate, and TDS. The analysis conservatively assumed all ash leachate was contaminated to the highest observed levels. In addition, the method did not account for groundwater dilution of ash leachate, which would reduce constituent concentrations before reaching the reservoir. The results presented in Table 5-2 indicate the predicted incremental increases (ΔC) in reservoir are negligible for all constituents iron which showed a slight increase of 29 μg/L.

TABLE 5-2

Predicted Increases in Arsenic, Nickel, Iron, Manganese, Sulfate, and TDS in Reservoir Due to Ash Leachate Influx

Well	Parameter	Units	N[a]	MCL	Mean	ΔC[b]
13A	Total Arsenic	μg/L	21	50	92	0.003
4A	Total Nickel	μg/L	4	100	125	0.004
6A	Total Iron	μg/L	17	300	1.01E06	29
6A	Total Manganese	μg/L	17	50	61,282	1.8
6A	Sulfate	mg/L	17	250	2,513	0.072
6A	TDS	mg/L	17	500	4,453	0.13

[a]N = number of MCL exceedances
[b]ΔC = mean concentration x dilution ratio

The small predicted increase in iron entering the reservoir via groundwater should not represent a problem. Dissolved iron accounts for essentially all of the total iron measurement for well 6A. The iron is expected to be present in a reduced (Fe-II) state given the mean oxidation-reduction potential (77 mV) and mean pH (5.5) [Freeze and Cherry, 1979, page 124] observed at this well. Upon entering the oxidizing environment of the reservoir, iron present in groundwater would be expected to precipitate out of solution.

Potential Impacts to Groundwater Users

There are six residential wells (numbers 7, 8, 9, 20, 21, and 22) located within approximately one mile of the center of the ash pond area (Figure 4-1). Wells 7 and 20 lie north of Swan Creek embayment and are hydrologically isolated from the disposal site. The remaining four wells (numbers 8, 9, 21, 22), located southwest of the site along Swan Pond Road, lie off-gradient of the ash pond area (Figure 5-3). There is no evidence that pumping from these wells and the other 15 residential wells located south of Pine Ridge has induced ash leachate movement from the site. As indicated on Figure 5-3, these wells are generally situated up-gradient of the Kingston plant reservation. No adverse off-site groundwater impacts associated with the ash pond are indicated under present conditions or expected under post-closure conditions.

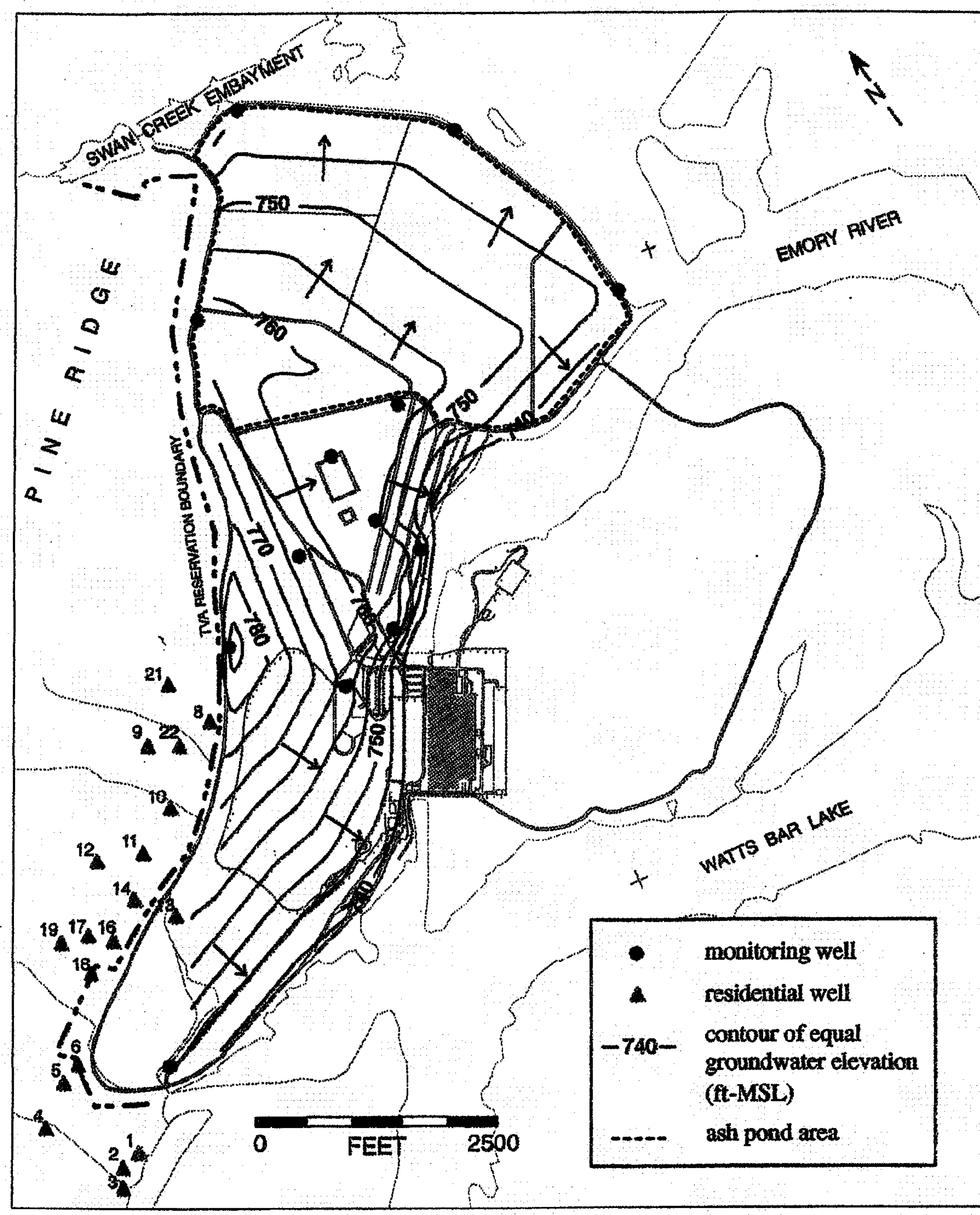


Figure 5-3. Locations of Residential Wells in Relation of Groundwater Flow Patterns in Ash Pond Area

6. REFERENCES

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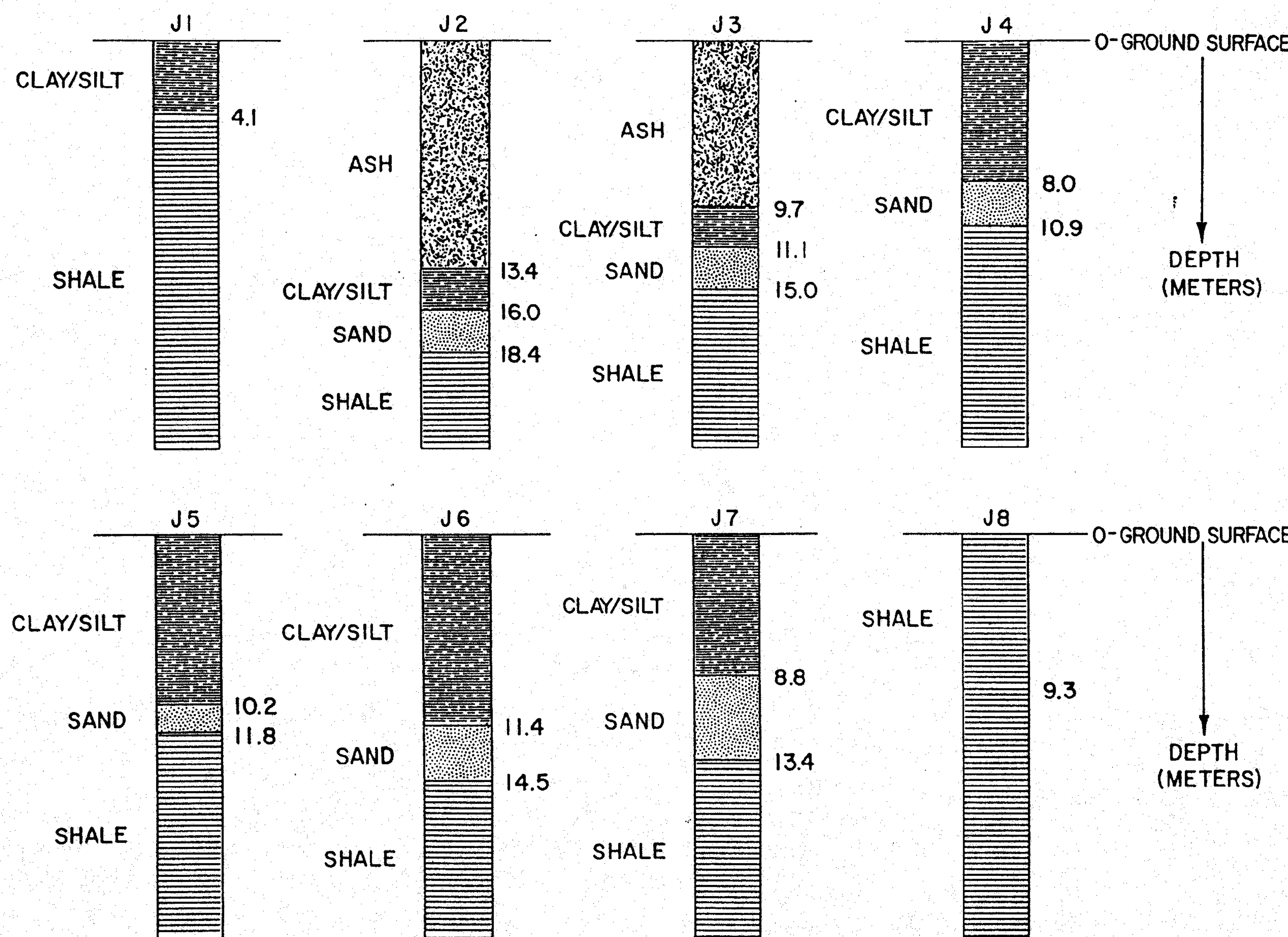
APPENDIX I

LITHOLOGIC LOGS

VERTICAL PROFILE OF THE SUBSTRATUM AT PLANT J's MONITORING WELL LOCATIONS



[from Milligan and Ruane, 1980]

Law Engineering

BORING NUMBER J-9A
DATE DRILLED 10-3-88
JOB NUMBER K-88195
PAGE 1 OF 2

Boring Record

DEPTH (FT.)	DESCRIPTION		ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0	GRAY FLY ASH WHICH CONTAINS COAL FRAGMENTS AND CINDERS. MOISTURE CONTENT INCREASED IN SAMPLES TO A DEPTH OF 13 FEET AT WHICH TIME THE SAMPLES BECAME SATURATED.			
		≡	13.0	
40.0				

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

TVA-00014496

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Boring Record

BORING NUMBER J - 9A
DATE DRILLED 10-3-88
JOB NUMBER K-88195
PAGE 2 OF 2

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
40.0	GRAY FLY ASH WHICH CONTAINS COAL FRAGMENTS AND CINDERS. MOISTURE CONTENT INCREASED IN SAMPLES TO A DEPTH OF 13 FEET AT WHICH TIME THE SAMPLES BECAME SATURATED.		
67.7	REFUSAL		

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

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Boring Record

BORING NUMBER J-9B
DATE DRILLED 10-3-88
JOB NUMBER K-88195
PAGE 1 OF 3

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0	DRY GRAY ASH		
35.0	ALLUVIAL CLAY, SAND AND GRAVEL WITH WEATHERED SHALE FRAGMENTS		
40.0			

REMARKS: BORING DRILLED USING AIR ROTARY EQUIPMENT
* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

BORING NUMBER J-9B
DATE DRILLED 10-3-88
JOB NUMBER K-88195
PAGE 2 OF 3

Boring Record

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
40.0	ALLUVIAL CLAY, SAND AND GRAVEL WITH WEATHERED SHALE FRAGMENTS		
67.5	BLUE GRAY SHALE WITH CALCITE JOINTS		
80.0			

REMARKS:

Law Engineering

BORING NUMBER J-9B
DATE DRILLED 10-3-88
JOB NUMBER K-88195
PAGE 3 OF 3

Boring Record

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
80.0	BLUE GRAY SHALE WITH CALCITE JOINTS		
82.4	BORING TERMINATED		

REMARKS:

Law Engineering

BORING NUMBER J-10
DATE DRILLED 9-27-88
JOB NUMBER K-88195
PAGE 1 OF 1

Boring Record

DEPTH (FT.)	DESCRIPTION			ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0	WASH BORING TO A PREDETERMINED DEPTH				
		≡	12.0		
15.0	BORING TERMINATED				

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

BORING NUMBER J-10A
DATE DRILLED 9-27-88
JOB NUMBER K-88195
PAGE 1 OF 1

Boring Record

DEPTH (FT.)	DESCRIPTION	ELEV *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0	WASH BORING TO A PREDETERMINED DEPTH		
29.9	BORING TERMINATED		

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

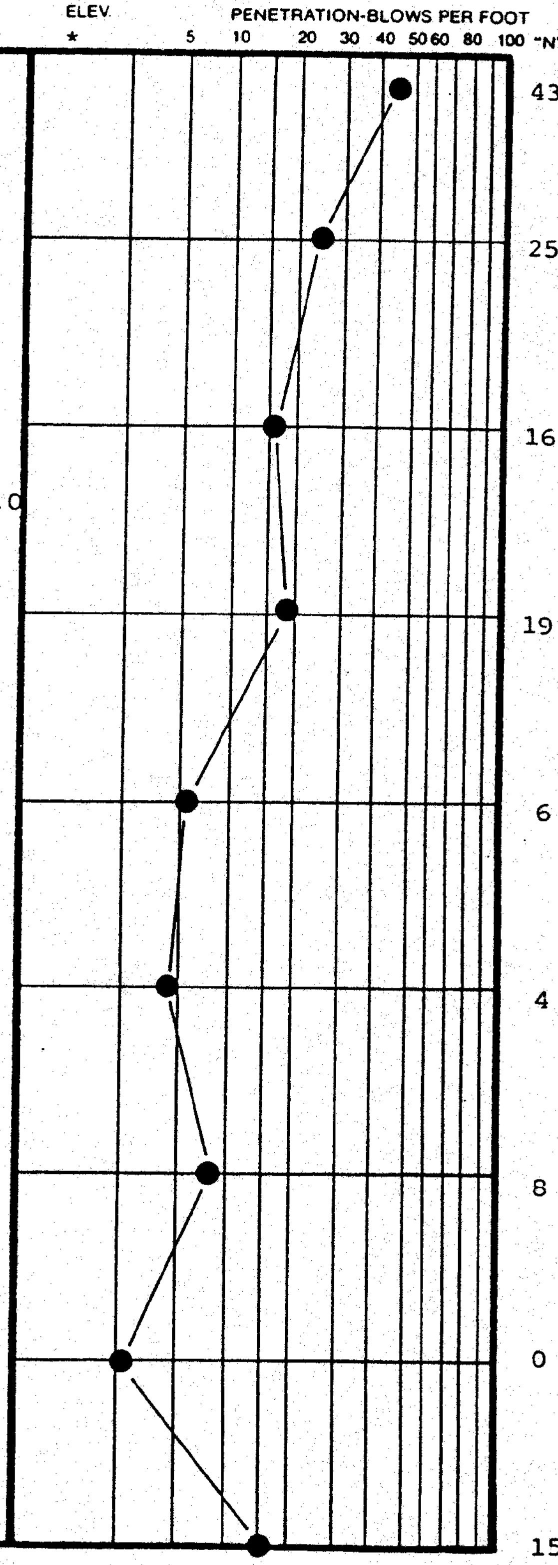
Law Engineering

Soil Test Boring Record

BORING NUMBER J-10B
DATE DRILLED 9-27-88
JOB NUMBER K-88195
PAGE 1 OF 2

DEPTH (FT.)	DESCRIPTION		ELEV. *
0.0	HARD TO VERY STIFF DARK GRAY, BROWN AND BLACK SILTY CLAY - FILL		
12.5	VERY STIFF WEATHERED GRAY SHALE WITH ASH - FILL		13.0
17.5	FIRM TO SOFT LIGHT BROWN AND GRAY WEATHERED SHALE (WET) - FILL		
27.5	LIGHT GRAY AND BROWN SILTY CLAY RANGING FROM STIFF TO VERY SOFT - FILL		
40.0			

PENETRATION-BLOWS PER FOOT



"N"
43
25
16
19
6
4
8
0
15

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

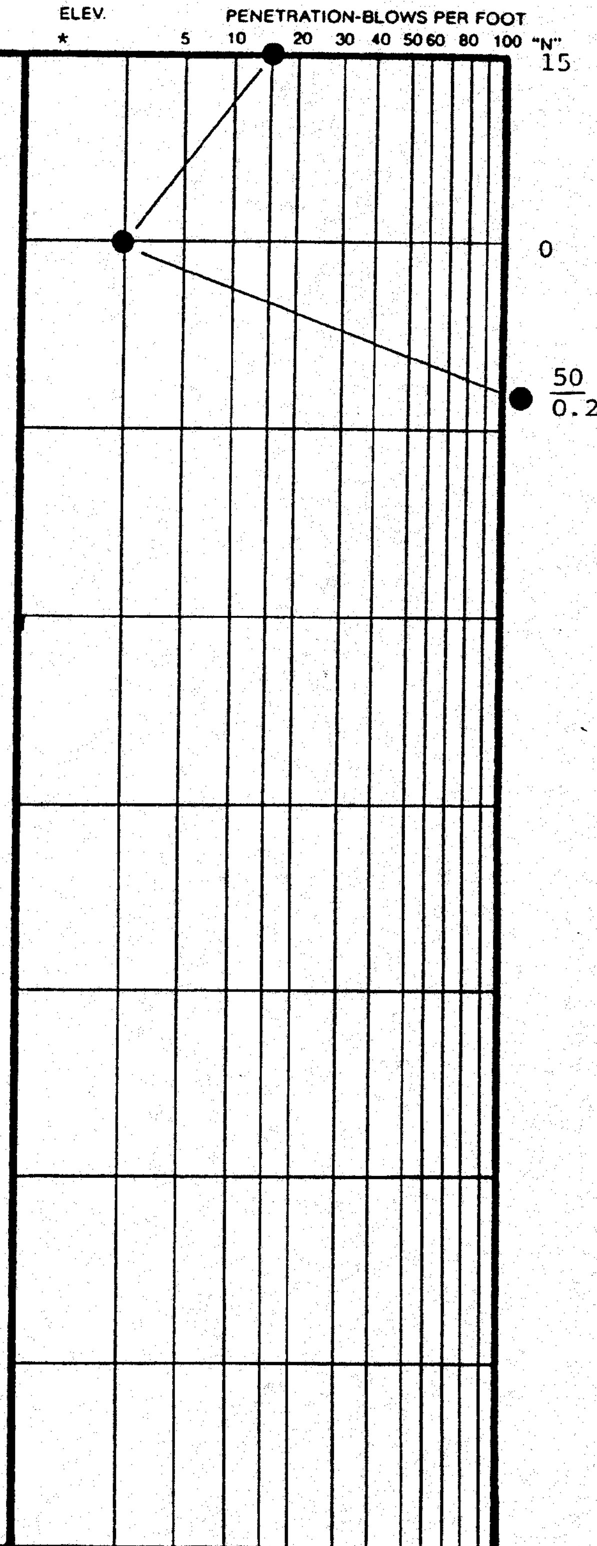
Law Engineering

Soil Test Boring Record

BORING NUMBER J-10 B
DATE DRILLED 9-27-88
JOB NUMBER K-88195
PAGE 2 OF 2

DEPTH (FT.)	DESCRIPTION
40.0	LIGHT GRAY AND BROWN SILTY CLAY RANGING FROM STIFF TO VERY SOFT - FILL
49.4	REFUSAL

ELEV. *



REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-11B
DATE DRILLED 9-19-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT (5, 10, 20, 30, 40, 50, 60, 80, 100 "N")
0.0			
1.0	RED SILTY CLAY-POSSIBLE FILL		
	TANNISH-BROWN SHALEY SILTY CLAY - RESIDUUM		
5.0			
	DARK BROWN AND GRAYISH GREEN SHALE		
31.5			
	BORING TERMINATED		

REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

Law Engineering

Soil Test Boring Record

BORING NUMBER J-11B
DATE DRILLED 9-23-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT (5, 10, 20, 30, 40, 50, 60, 80, 100)	"N"
0.0				
0.2	TOPSOIL			
	VERY STIFF BROWN CLAYEY DESICATED SHALE - RESIDUUM			21
2.5				
	VERY HARD GRAY VERY WEATHERED SHALE - RESIDUUM			50/0.2
5.2				
	REFUSAL			

REMARKS: *ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Soil Test Boring Record

BORING NUMBER J-12A
DATE DRILLED 9-22-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT "N"
0.0	STIFF MOTTLED BROWN SILTY CLAY WITH TRACE OF CHERT- FILL		14
2.5	FIRM GRAY FLY ASH WITH TRACE ORGANICS - FILL	8.0	7
9.0	VERY SOFT MOTTLED BROWN SILTY CLAY WITH ORGANICS - RESIDUUM		1
12.5	SOFT TO VERY SOFT SATURATED GRAYISH BROWN SILTY CLAY WITH WEATHERED SHALE FRAGMENTS - RESIDUUM		5 2 50/0.3
24.8	REFUSAL		

Penetration scale: 5 10 20 30 40 50 60 80 100

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-12B
DATE DRILLED 9-26-88
JOB NUMBER K-88195
PAGE 1 OF 2

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT (5, 10, 20, 30, 40, 50, 60, 80, 100 "N")
0.0	RED-BROWN SILTY CLAY WITH CHERT FRAGMENTS		
3.0	DARK GRAY ASH AND ASH AND ASH CLAY MIXTURE		
20.0	GREENISH GRAY SHALE SLURRY WITH LIMESTONE FRAGMENTS		
28.0	DUE TO A CAVE-IN AT 28.0 FEET THE BORING WAS OFFSET AND RE-DRILLED GRAY SHALE		
40.0			

REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT
* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-12B
DATE DRILLED 9-26-88
JOB NUMBER K-88195
PAGE 2 OF 2

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
40.0	GRAY SHALE		
54.2	BORING TERMINATED		

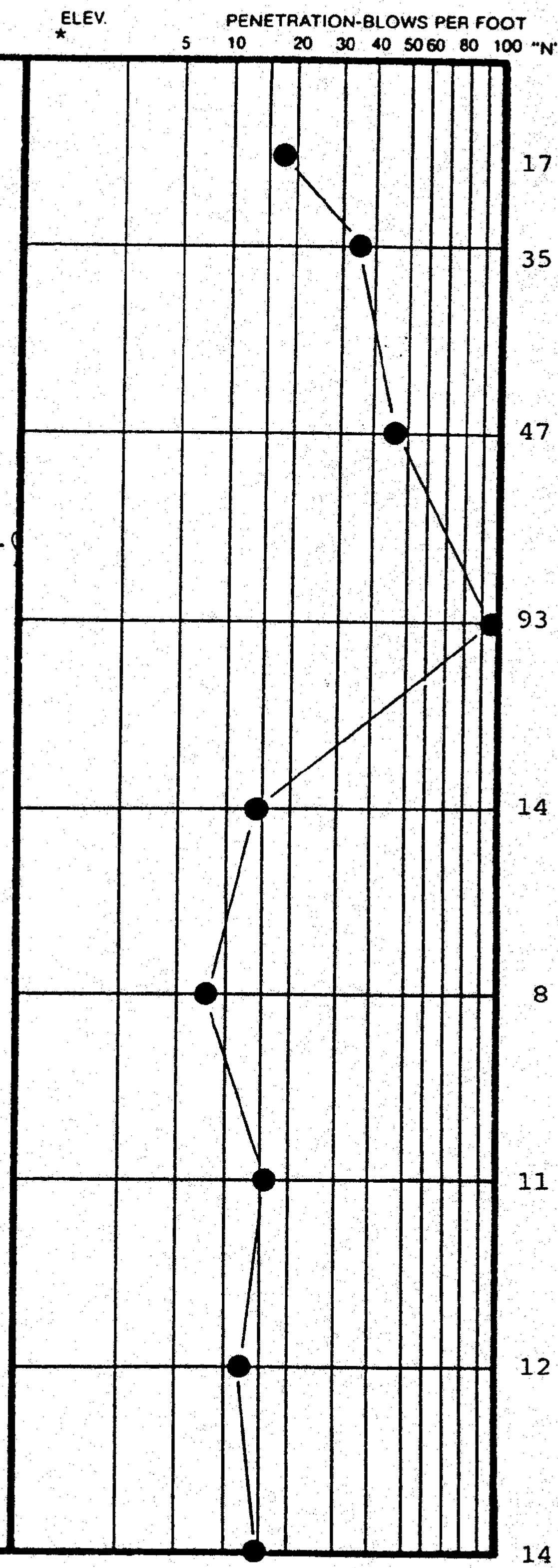
REMARKS:

Law Engineering

Soil Test Boring Record

BORING NUMBER J-13 A
DATE DRILLED 9-28-88
JOB NUMBER K-88195
PAGE 1 OF 2

DEPTH (FT.)	DESCRIPTION		ELEV. *
1.5	VERY STIFF MOTTLED BROWN SILTY CLAY - FILL		
40.0	BLACK FLY ASH	(water level symbol)	14.0



REMARKS: * ELEVATION TO BE PROVIDED BY TVA

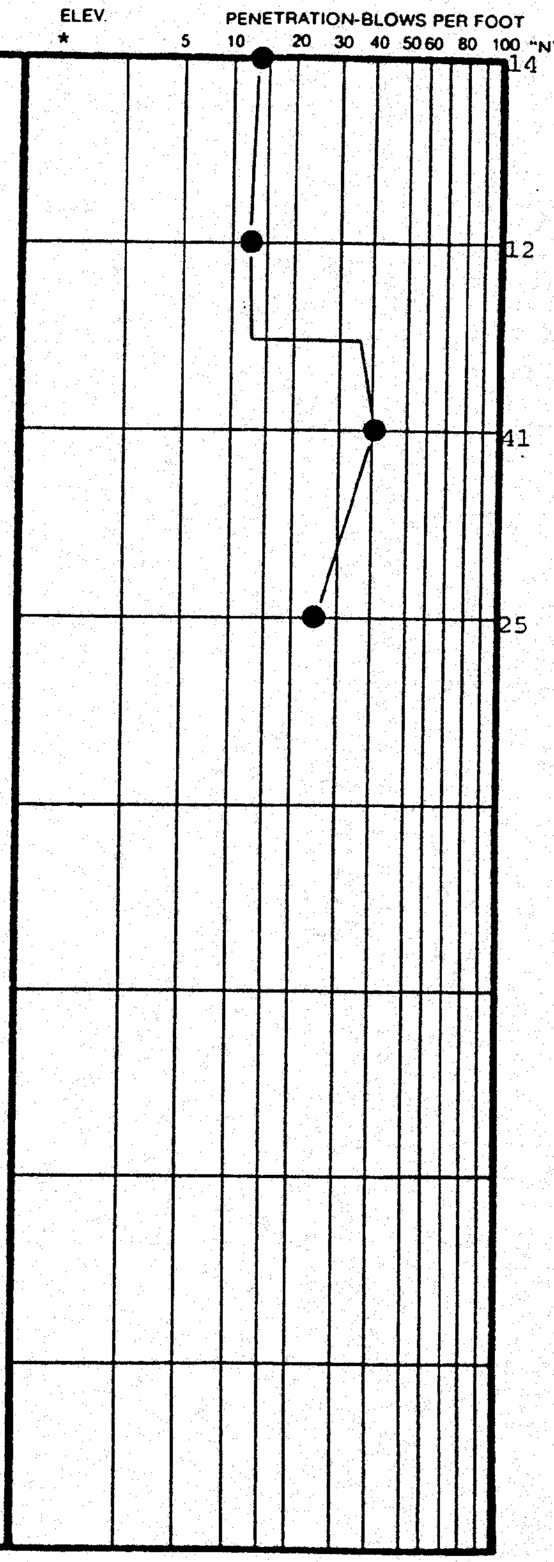
Law Engineering

Soil Test Boring Record

BORING NUMBER J-13 A
DATE DRILLED 9-28-88
JOB NUMBER K-88195
PAGE 2 OF 2

DEPTH (FT.)	DESCRIPTION
40.0	BLACK FLY ASH
47.5	DENSE SAND AND GRAVEL -ALLUVIUM
52.5	FIRM VERY SILTY CLAY - ALLUVIUM
64.0	REFUSAL

ELEV. *



REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-13B
DATE DRILLED 9/29 - 30/88
JOB NUMBER K-88195
PAGE 1 OF 3

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0			
0.5	TOPSOIL		
	BROWN SILTY CLAY AND WEATHERED SHALE		
4.0			
	GRAY ASH		
40.0			

REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT
* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

BORING NUMBER J-13B
DATE DRILLED 9/29-30/88
JOB NUMBER K-88195
PAGE 2 OF 3

Boring Record

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
40.0	GRAY ASH		
45.0	ASH AND SAND (VERY WET)		
65.0	GRAY SHALE WITH ZONES OF LIMESTONE AND SANDSTONE		
80.0			

REMARKS:

Law Engineering

Boring Record

BORING NUMBER J-13B
DATE DRILLED 9/29 -30/88
JOB NUMBER K-88195
PAGE 3 OF 3

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
80.0	GRAY SHALE WITH ZONES OF LIMESTONE AND SANDSTONE		
82.0	BORING TERMINATED		

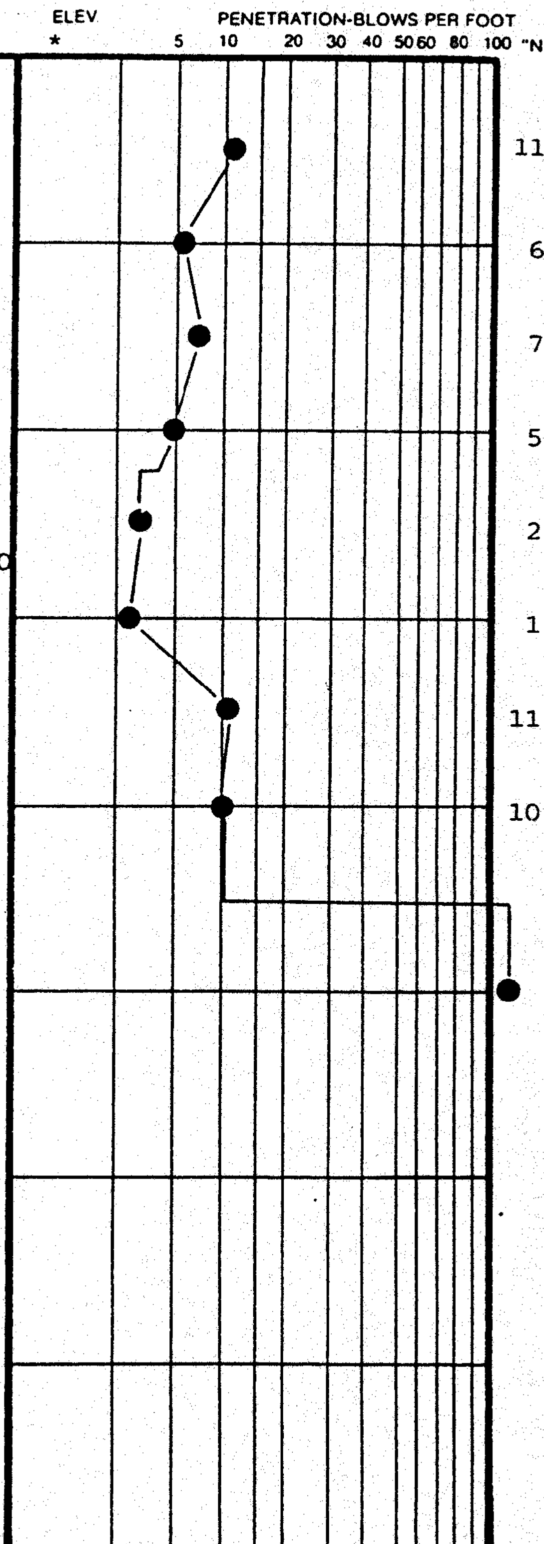
REMARKS:

Law Engineering

Soil Test Boring Record

BORING NUMBER J-14
DATE DRILLED 9-23-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV *	PENETRATION-BLOWS PER FOOT "N"
0.0 – 1.0	GRAVEL		
1.0 – 3.5	STIFF RED-BROWN SILTY CLAY- FILL		11
3.5 – 6.0	FIRM MOTTLED DARK BROWN SILTY CLAY FILL		6
6.0 – 8.5	FIRM RED-BROWN SILTY CLAY WITH TRACE ORGANICS - FILL		7
8.5 – 11.0	FIRM MOTTLED DARK BROWN SILTY CLAY - FILL		5
11.0 – 16.0	VERY LOOSE BLACK SILTY SAND AND GRAVEL - ALLUVIUM	14.0 (water level)	2, 1
16.0 – 22.5	LOOSE BROWN AND GRAY SILTY CLAY WITH BLACK STAINING - ALLUVIUM		11, 10
22.5 – 25.3	VERY HARD GRAY WEATHERED SHALE		50/0.3
25.3	BORING TERMINATED		



REMARKS: *ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-14A
DATE DRILLED 9-22-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT (5 10 20 30 40 50 60 80 100 "N")
0.0	RED-BROWN AND DARK BROWN SILTY CLAY WITH ROCK FRAGMENTS-FILL (FILL USED FOR CONSTRUCTING THE RAILROAD)		
17.0	TANISH GRAY SILT WITH TRACE OF ASH - FILL		
19.0	WEATHERED BROWN AND TAN SHALE		
25.0	BORING TERMINATED		

REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT
* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-14B
DATE DRILLED 9-22-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0	RED BROWN SILTY CLAY -FILL (FILL USED FOR CONSTRUCTING THE RAILROAD)		
18.0	GRAY BROWN SILTY CLAY WITH A TRACE OF ASH REFUSAL		
24.5	BROWN AND GRAY TO GRAY SHALE WITH CALCITE SEAMS		
40.0			

BORING TERMINATED

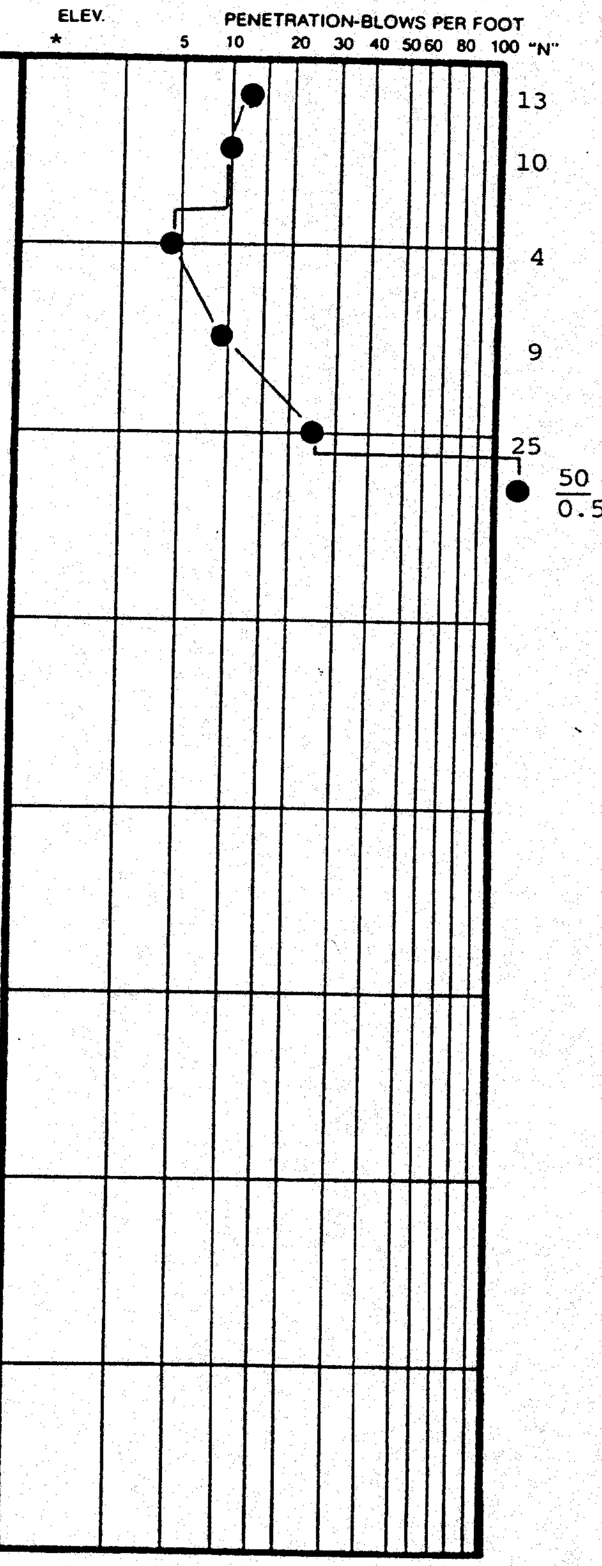
REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT
* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Soil Test Boring Record

BORING NUMBER J-15
DATE DRILLED 9-23-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV. *
0.0 – 2.0	STIFF MOTTLED REDDISH-BROWN SILTY CLAY - FILL	
2.0 – 4.0	STIFF MOTTLED BROWN SILTY CLAY WITH ROCK FRAGMENT - FILL	
4.0 – 10.5	SOFT TO FIRM REDDISH BROWN SILTY CLAY - RESIDUUM	
10.5 – 12.0	LIGHT BROWN VERY WEATHERED SHALE-RESIDUUM	
12.0	REFUSAL	



REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-15A
DATE DRILLED 9-21-88
JOB NUMBER K-88195
PAGE 1 OF 1

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0	TANISH-BROWN TO BROWN SILTY CLAY		
8.0	GRAY-BROWN SILT WITH SHALE FRAGMENTS		
13.5	REFUSAL GRAY SHALE		
25.2	BORING TERMINATED		
40.0			

REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT
* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

BORING NUMBER J-15B
DATE DRILLED 9-21-88
JOB NUMBER K-88195
PAGE 1 OF 2

Boring Record

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0	WEATHERED SHALE		
3.0	BROWN AND GRAY-BROWN SILTY CLAY WITH TRACE SHALE FRAGMENTS		
14.0	GRAY SHALE		
40.0			

REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT
* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-15B
DATE DRILLED 9-21-88
JOB NUMBER K-88195
PAGE 2 OF 2

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
40.0	GRAY SHALE		
44.2	BORING TERMINATED		

REMARKS:

Law Engineering

Boring Record

BORING NUMBER J-16A
DATE DRILLED 10-5-88
JOB NUMBER K-88195
PAGE 1 OF 2

DEPTH (FT.)	DESCRIPTION		ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
0.0				
0.2	TOPSOIL			
	RED-BROWN AND BROWN SILTY CLAY - FILL			
13.0	GRAY BROWN SILTY CLAY - FILL (SOME OF THE SOILS APPEAR TO BE ASSOICIATED WITH AN OLD ROAD SURFACE)		14.0	
18.0	RED BROWN SANDY CLAY (SLURRY) - POSSIBLE RESIDUUM			
40.0				

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

BORING NUMBER J-16A
DATE DRILLED 10-5-88
JOB NUMBER K-88195
PAGE 2 OF 2

Boring Record

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
40.0	GRAY BROWN SANDY CLAYEY SILT WHICH GRADES TO GRAY CLAY-SAND -RESIDUUM		
61.0	GRAY SANDY CLAY CONTAINING WEATHERED SHALE FRAGMENTS -RESIDUUM		
64.7	REFUSAL		

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

BORING NUMBER J-16B
DATE DRILLED 9-23-88
JOB NUMBER K-88195
PAGE 1 **OF** 2

Boring Record

DEPTH (FT.)	DESCRIPTION	ELEV. *	PENETRATION-BLOWS PER FOOT (5, 10, 20, 30, 40, 50, 60, 80, 100 "N")
0.0	RED-BROWN SILTY CLAY WITH SMALL ROCK FRAGMENTS - FILL		
10.0	RED TO RED-BROWN TO BROWN SILTY CLAY - FILL		
20.5	BROWN SILTY CLAY - POSSIBLE TOPSOIL		
22.0	GRAY AND BROWN SLURRY WITH ROCK FRAGMENTS		
40.0			

REMARKS: BORING ADVANCED USING AIR ROTARY EQUIPMENT

* ELEVATION TO BE PROVIDED BY TVA

Law Engineering

Boring Record

BORING NUMBER J-16B
DATE DRILLED 9-23-88
JOB NUMBER K-88195
PAGE 2 OF 2

DEPTH (FT.)	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FOOT 5 10 20 30 40 50 60 80 100 "N"
40.0			
41.0	CASING "BLEW-OUT" AROUND 41 FEET. THE BORING WAS OFFSET AND REDRILLED RED-BROWN, BROWN AND GRAY SILTY CLAY WITH SHALE FRAGMENTS		
56.0	BROWN AND GRAY SHALE		
73.0	BORING TERMINATED		

REMARKS:

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-1 STATION:
RANGE:
SURFACE EL: 752.0
DATE DRILLED: 7/28/94
PREPARED BY: mhd
CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	750							
5			CL	12.4	31	12	5	TN & GY SI CL, D
	745							
10			CL	19.2	26	8	9	LT BRN SI CL W/TR GY TS, MST
	740							
15			CL	17.0	26	8	6	BRN SI CL, D
	735							
20			CL	27.1	26	8	9	BRN & GY SI CL, V MST
	730							
25			CL	24.1	26	8	9	BRN & GY SI CL, V MST
	725							
30			SM	19.5	NP	NP	10	GY SI SC TR GV, MST (FA)
	720							
35								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP　FEATURE: DREDGE CELLS
BORING: SS-1　STATION:　RANGE:　SURFACE EL: 752.0
DATE DRILLED: 7/28/94　PREPARED BY: mhd　CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
			SM	27.6	NP	NP	10	GY SI SD, V MST (FA)
	715							
40								REFUSAL
								GROUND WATER LEVEL = 8'9"
	710							
45								
	705							
50								
	700							
55								
	695							
60								
	690							
65								
	685							
70								
1''=5'		* LAB CLASSIF.						

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP FEATURE: DREDGE CELLS
BORING: SS-2 STATION: RANGE: SURFACE EL: 764.0
DATE DRILLED: 7/27/94 PREPARED BY: mhd CHECKED BY: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
5	760	14	MH-CH	21.9	59	28	2	BRN SI CL w/GV, TR TS, D
10	755	10	MH-CH	22.8	59	28	2	R-BRN SI CL, TR GV, D
15	750	8	MH-CH	28.0	59	28	2	R-BRN SI CL, TR GV, MST
20	745	13	SM	25.6	NP	NP	10	GY SI SD w/TR GV (FA), V MST
25	740	-	SM	19.0	NP	NP	10	GY SI SD w/GV (FA), W
30	735	-	SM	28.1	NP	NP	3	BRN SD WI CL (FA), W
35	730							

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 2 OF 2

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-2 STATION:
RANGE:
SURFACE EL: 764.0
DATE DRILLED: 7/27/94
PREPARED BY: mhd
CHECKED BY: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
		-	CL	33.6	26	8	9	BRN SI CL w/GY SI (FA), V MST
	725							
40		3	CL	20.1	26	8	9	ORNG & GY SI CL, V MST
	720							
45		28	ML	14.0	NP	NP	8	GY SD mix w/PKTS GY CL, MST
	715							
50		50+	ML	15.8	NP	NP	8	GY SD mix w/PKTS GY CL, MST
								REFUSAL GROUND WATER LEVEL = 5'8"
	710							
55								
	705							
60								
	700							
65								
	695							
70								

1"=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 1 OF 2

PROJECT: KINGSTON FP FEATURE: DREDGE CELLS
BORING: SS-3 STATION: RANGE: SURFACE EL: 773.0
DATE DRILLED: 7/28/94 PREPARED BY: mhd CHECKED BY: TAC

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	770							
5		25	ML	23.3	NP	NP	12	GY CL SI (FA), MST
	765							
10		5	SM	23.0	NP	NP	10	GY SD CL, TR GV (FA), V MST
	760							
15		4	SM	28.6	NP	NP	10	GY SD CL, TR GV (FA), V MST
	755							
20		1	SM	28.6	NP	NP	10	GY SD SI CL, TR GV (FA), W
	750							
25		2	SM	27.1	NP	NP	10	GY SD SI CL, TR GV (FA), W
	745							
30		1	SM	27.0	NP	NP	10	GY SD SI CL, TR GV (FA), W
	740							
35								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-3
STATION:
RANGE:
SURFACE EL: 773.0
DATE DRILLED: 7/28/94
PREPARED BY: mhd
CHECKED BY: TAC

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
		2	ML	28.8	NP	NP	12	GY SD SI CL, TR GV (FA), W
	735							
40		2	SM	22.0	NP	NP	10	GY SD SI CL, TR GV (FA), W
	730							
45		-	ML	33.9	NP	NP	12	GY CL SI, TR GV (FA), W
	725							
50		-	ML	15.7	NP	NP	8	GY CL SI W/GV (FA), V MST
	720							
55		50+	ML	5.8	NP	NP	12	GY CL SI, TR GV
	715							REFUSAL GROUND WATER LEVEL = 9'8"
60								
	710							
65								
	705							
70								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-4 STATION:
RANGE:
SURFACE EL: 752.0
DATE DRILLED: 7/26/94
PREPARED BY: mhd
CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	750							
5		10	CL	14.2	26	8	6	LT BRN SI CL W/TS, D
	745							
10		3	CL-ML	23.8	26	4	1	BRN & GY SI CL W/TS, MST
	740							
15		8	CL	22.3	31	12	5	TN & GY SI CL (FA), V MST
	735							
20		4	SM	20.9	NP	NP	3	TN SI SD, MST
	730							
25		-	SM	34.8	NP	NP	3	TN SI SD, MST
	725							
30		7	SM	21.4	NP	NP	3	TN SI SD, MST
	720							
35								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-4 STATION:
RANGE:
SURFACE EL: 752.0
DATE DRILLED: 7/26/94
PREPARED BY: mhd
CHECKED BY: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	715	36	SM	20.4	NP	NP	3	TN SI SD, MST
40								REFUSAL GROUND WATER LEVEL = 9'0"
	710							
45								
	705							
50								
	700							
55								
	695							
60								
	690							
65								
	685							
70								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP FEATURE: DREDGE CELLS
BORING: SS-5 STATION: RANGE: SURFACE EL: 764.0
DATE DRILLED: 7/27/94 PREPARED BY: mhd CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
5	760	18	MH-CH	19.6	59	28	2	A-BRN SI CL w/TR CTH, D
10	755	14	MH-CH	24.2	59	28	2	BRN SI CL w/GV, D
15	750	54	CL-ML	23.5	26	4	1	BRN SI CL w/PKTS GY CL SI, TR CHT, MST
20	745	20	SM	24.3	NP	NP	10	GY SI SD, TR GV (FA), MST
25	740	3	CL	20.9	26	8	6	LT BRN SD SI CL, TR GV, V MST
30	735	14	CL	23.6	31	12	5	TN & GY SI CL, V MST
35	730							

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-5 STATION:
RANGE:
SURFACE EL: 764.0
DATE DRILLED: 7/27/94
PREPARED BY: mhd
CHECKED BY: TAC

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
		16	ML	21.5	NP	NP	7	BRN SI CL w/GY FA, V MST
40	725	2	SM	24.2	NP	NP	3	ORNG CL SD, V MST
45	720	2	CL	21.9	26	8	9	TN CL SI w/PKTS GY FA, V MST
50	715	30	SC/SM	10.8	NP	NP	4	LT BRN SI SD w/GV, V MST
55	710	50+	ML	13.9	NP	NP	12	BRN & GY CL SI, FA, MST
60	705							REFUSAL GROUND WATER LEVEL = 20'
65	700							
70	695							

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP FEATURE: DREDGE CELLS
BORING: SS-6 STATION: RANGE: SURFACE EL: 773.0
DATE DRILLED: 8/1/94 PREPARED BY: mhd CHECKED BY: TAC

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	770							
5		24	ML	25.2	NP	NP	12	GY SI (FA), MST
	765							
10		5	SM	19.7	NP	NP	10	GY SI (FA), MST
	760							
15		2	SM	28.8	NP	NP	11	GY SI SD (FA), MST
	755							
20		-	ML	25.8	NP	NP	12	GY SI (FA), MST
	750							
25		3	ML	23.3	NP	NP	8	BRN SI CL w/GY FA, TR GV, V MST
	745							
30		1	ML	32.7	NP	NP	12	GY SI (FA), W
	740							
35								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP FEATURE: DREDGE CELLS
BORING: SS-6 STATION: RANGE: SURFACE EL: 773.0
DATE DRILLED: 8/1/94 PREPARED BY: mhd CHECKED BY: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
		9	CL	19.6	26	8	9	BRN CL SI mix w/FA
	735							
40		12	SM	19.4	NP	NP	3	BRN SI SD, V MST
	730							
45		1	SM	29.3	NP	NP	3	BRN SI SD, V MST
	725							
50		3	SM	21.8	NP	NP	3	BRN SD CL, V MST
	720							
55		6	ML	22.3	NP	NP	8	GY SI SD w/FA, MST
	715							
60		50+	ML	9.9	NP	NP	12	GY SI, FA, MST
	710							REFUSAL GROUND WATER LEVEL = 16' 7"
65								
	705							
70								
1''=5'		* LAB CLASSIF.						

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 1 OF 3

PROJECT: KINGSTON FP — FEATURE: DREDGE CELLS

BORING: SS-8 — STATION: — RANGE: — SURFACE EL: 782.0

DATE DRILLED: 8/2/94 — PREPARED BY: mhd — CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	780							
5		50+	SM	17.6	NP	NP	10	GY SI (FA), TR GV, D
	775							
10		50+	SM	18.4	NP	NP	10	GY SI (FA), TR GV, D
	770							
15		50+	SM	21.9	NP	NP	10	GY SI (FA), TR GV, D
	765							
20		8	SM	43.9	NP	NP	11	GY SI SD (FA), MST
	760							
25		15	SM	17.9	NP	NP	10	GY SI SD W/GV (FA), MST
	755							
30		-	ML	31.7	NP	NP	12	GY SI (FA), W
	750							
35								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 2 OF 3

PROJECT: KINGSTON FP | FEATURE: DREDGE CELLS
BORING: SS-8 | STATION: | RANGE: | SURFACE EL: 782.0
DATE DRILLED: 8/2/94 | PREPARED BY: mhd | CHECKED BY: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	745	-	ML	24.4	NP	NP	12	GY SI (FA), MST
40	740	3	ML	23.8	NP	NP	12	GY SI (FA), MST
45	735	9	ML	31.2	NP	NP	12	GY SI (FA), MST
50	730	4	ML	22.3	NP	NP	8	GY CL SI W/LUMPS TN SI CL, MST
55	725	13	ML	18.2	NP	NP	7	MOTT BRN/TN/GY SI CL, MST
60	720	13	ML	18.6	NP	NP	7	MOTT BRN/TN/GY SI CL, MST
65	715	4	SC/SM	27.7	NP	NP	4	TN SI SD, W
70								

1''=5'

* LAB CLASSIF.

TVA-00014539

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 3 OF 3

PROJECT: KINGSTON FP　　FEATURE: DREDGE CELLS
BORING: SS-8　　STATION:　　RANGE:　　SURFACE EL: 782.0
DATE DRILLED: 8/2/94　　PREPARED BY: mhd　　CHECKED BY: 7A

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	710	5	SM	24.9	NP	NP	10	GY SD SI (FA), W
75	705	7	SC/SM	22.7	NP	NP	4	TN SI SD, V MST
80	700							REFUSAL GROUND WATER LEVEL = 11' 3"
85	695							
90	690							
95	685							
100	680							
105								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP | FEATURE: DREDGE CELLS
BORING: SS-9 | STATION: | RANGE: | SURFACE EL: 795.0
DATE DRILLED: 8/2/94 | PREPARED BY: mhd | CHECKED BY: TA

DEPTH ft.	EL 795	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
5	790	20	ML	17.8	NP	NP	12	GY SI (FA), MST
10	785	50+	ML	19.5	NP	NP	12	GY SI (FA), MST
15	780	44	ML	20.1	NP	NP	12	GY SI (FA), MST
20	775	46	ML	18.3	NP	NP	12	GY SI (FA), MST
25	770	6	ML	30.2	NP	NP	12	GY SI (FA), MST
30	765	5	ML	35.2	NP	NP	12	GY SI (FA), W
35	760							

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 2 OF 3

PROJECT: KINGSTON FP   FEATURE: DREDGE CELLS
BORING: SS-9   STATION: RANGE: SURFACE EL: 795.0
DATE DRILLED: 8/2/94   PREPARED BY: mhd   CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	760	2	ML	17.3	NP	NP	12	GY SI (FA), W
40	755	1	ML	31.0	NP	NP	12	GY SI (FA), W
45	750	-	ML	23.0	NP	NP	12	GY SI (FA), D
50	745	-	ML	31.7	NP	NP	12	GY SI (FA), TR GV, W
55	740	5	ML	30.0	NP	NP	12	GY SI (FA), TR GV, W
60	735	6	ML	32.6	NP	NP	12	GY SI (FA), TR GV, W
65	730	-	ML	26.9	NP	NP	8	BRN SI CL w/GY SI (FA), MST
70	725							

1''=5'

*LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 3 OF 3

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-9
STATION:
RANGE:
SURFACE EL: 795.0
DATE DRILLED: 8/2/94
PREPARED BY: mhd
CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	725	13	CL	19.2	26	8	9	BRN, TN & GY SI CL, TR CL, MST
75	720	19	CL	19.5	26	8	6	ORNG-BRN SI CL, MST
80	715	4	SM	20.5	NP	NP	10	GY SD SI, W
85	710	19	SC/SM	23.1	NP	NP	4	TN SI SD
90	705	8	SC/SM	23.1	NP	NP	4	GY SI SD
95	700							REFUSAL GROUND WATER LEVEL = 29'
100	695							
105	690							

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 1 OF 3

PROJECT: KINGSTON FP | FEATURE: DREDGE CELLS

BORING: SS-10 | STATION: | RANGE: | SURFACE EL: 797.5

DATE DRILLED: 8/8/94 | PREPARED BY: mhd | CHECKED BY: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	795							
5		50+	ML	17.3	NP	NP	12	GY SI (FA), MST
	790							
10		26	ML	24.7	NP	NP	12	GY SI (FA), MST
	785							
15		25	ML	15.0	NP	NP	12	GY SD SI, TR GV, MST
	780							
20		5	ML	22.1	NP	NP	12	GY SI (FA), MST
	775							
25		4	ML	27.4	NP	NP	12	GY SI (FA), MST
	770							
30		14	ML	29.1	NP	NP	12	GY SI (FA), MST
	765							
35								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

SHEET 2 OF 3

PROJECT: KINGSTON FP
FEATURE: DREDGE CELLS
BORING: SS-10 STATION:
RANGE:
SURFACE EL: 797.5
DATE DRILLED: 8/8/94
PREPARED BY: mhd
CHECKED BY: TA

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
		18	SM	31.2	NP	NP	11	GY SD SI (FA) w/GV, W
	760							
40		9	ML	31.4	NP	NP	12	GY SI (FA), V MST
	755							
45		-	ML	27.0	NP	NP	12	GY SD SI w/GV (FA), V MST
	750							
50		-	ML	27.2	NP	NP	12	GY SD SI w/GV (FA), V MST
	745							
55		6	SM	30.7	NP	NP	11	GY PGD SI SD (FA), V MST
	740							
60		9	SM	16.4	NP	NP	11	GY PGD SI SD (FA), V MST
	735							
65		25	SM	19.4	NP	NP	11	CRS PGD SI SD w/GV (FA)
	730							
70								

1''=5'

* LAB CLASSIF.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

PROJECT: KINGSTON FP | FEATURE: DREDGE CELLS
BORING: SS-10 | STATION: | RANGE: | SURFACE EL: 797.5
DATE DRILLED: 8/8/94 | PREPARED BY: mhd | CHECKED BY: TAC

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
		39	ML	19.0	NP	NP	8	BRN SI CL w/PKTS GY SI (FA), V MST
	725							
75								
		17	CL	19.2	26	8	9	BRN & GY SI CL, V MST
	720							
80								
		18	CL	16.9	26	8	6	ORNG-BRN SD SI CL, MST
	715							
85								
		16	ML	18.9	NP	NP	8	GY SI SD, MST
	710							
90								
		50+	ML	3.7	NP	NP	8	GY SI SD w/GV
	705							
95								
								REFUSAL
	700							GROUND WATER LEVEL =
100								
	695							
105								

1''=5'

* LAB CLASSIF.

APPENDIX II

INSTALLATION RECORDS FOR MONITORING WELLS 9A THROUGH 20

[from Velasco and Bohac, 1991]

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-9 A
INSTALLATION DATE: 10-3 TO 10-4-88

LOCATION: PLANT COORDINATES W 9+44 N 19+07

GROUND SURFACE ELEVATION: 769.4' MSL
TOP OF INNER CASING: 772.5' MSL

GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCHES

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: POWER AUGER
DRILLING CONTRACTOR: LAW ENGINEERING

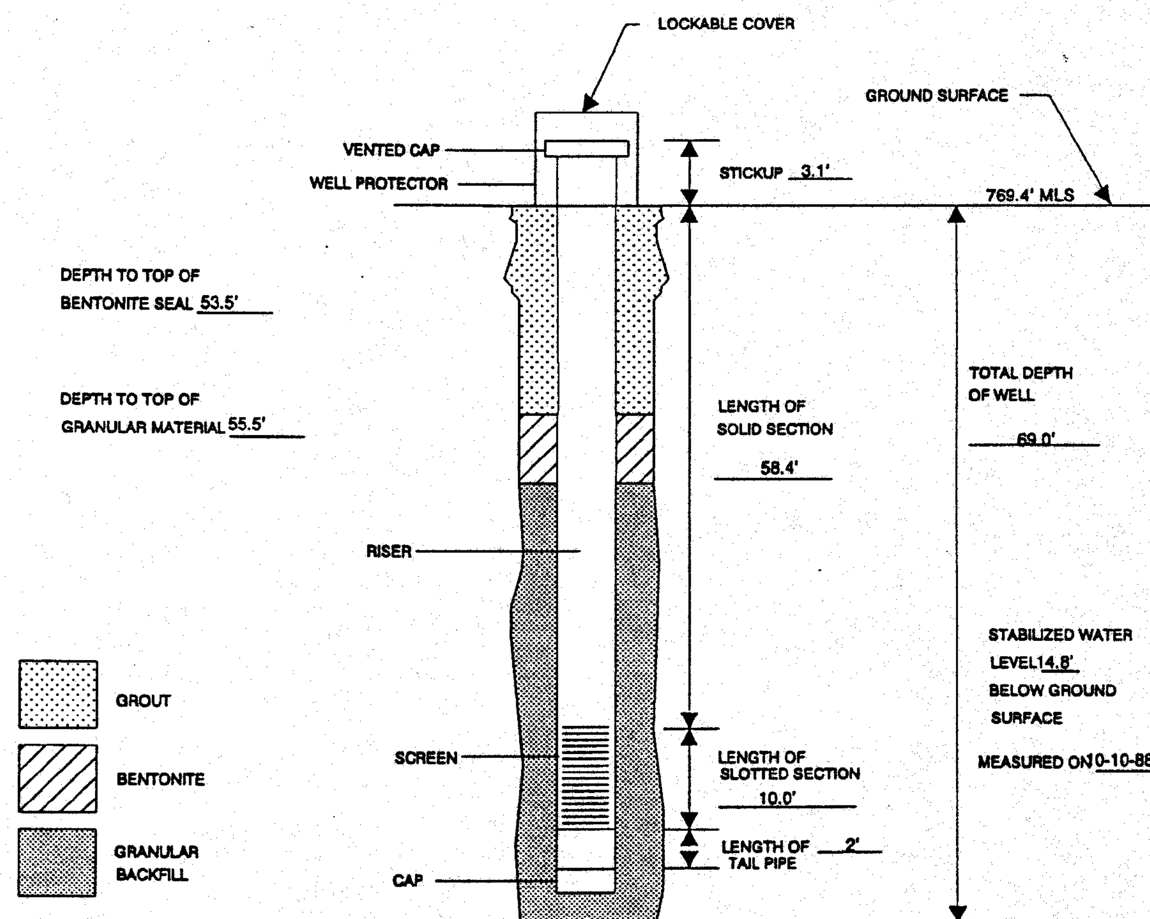
BOREHOLE DIAMETER: 11 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

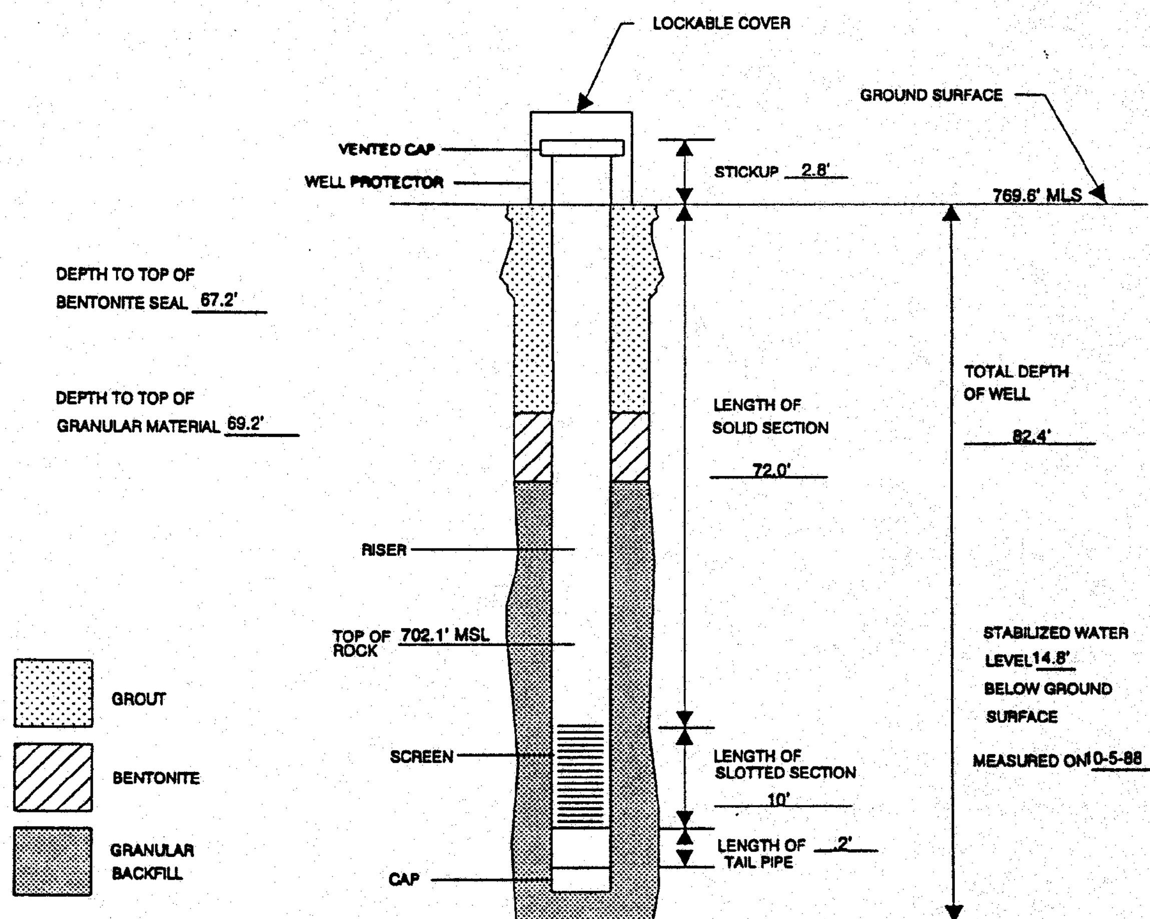
(NOT TO SCALE)



TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195
WELL NUMBER: J-9B
INSTALLATION DATE: 9-28 TO 9-29-88
LOCATION: PLANT COORDINATES W 9+42 , N 19+22
GROUND SURFACE ELEVATION: 769.6' MLS
TOP OF INNER CASING: 772.4' MLS
GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCHES
CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES
DRILLING TECHNIQUE: AIR ROTARY
DRILLING CONTRACTOR: HIGHLAND DRILLING
BOREHOLE DIAMETER: 5 7/8 (ROLLER CONE)
FIELD REPRESENTATIVE: H. W. ROBINSON
LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043
RISER MATERIAL: PVC
SCREEN MATERIAL: PVC
COMMENTS:

(NOT TO SCALE)



ENG LAB 10/2/90

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-10
INSTALLATION DATE: 9-27-88

LOCATION: PLANT COORDINATES W 4+79, N 16+36

GROUND SURFACE ELEVATION: 753.8' MLS
TOP OF INNER CASING: 756.8' MLS

GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCHES

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: POWER AUGER
DRILLING CONTRACTOR: LAW ENGINEERING

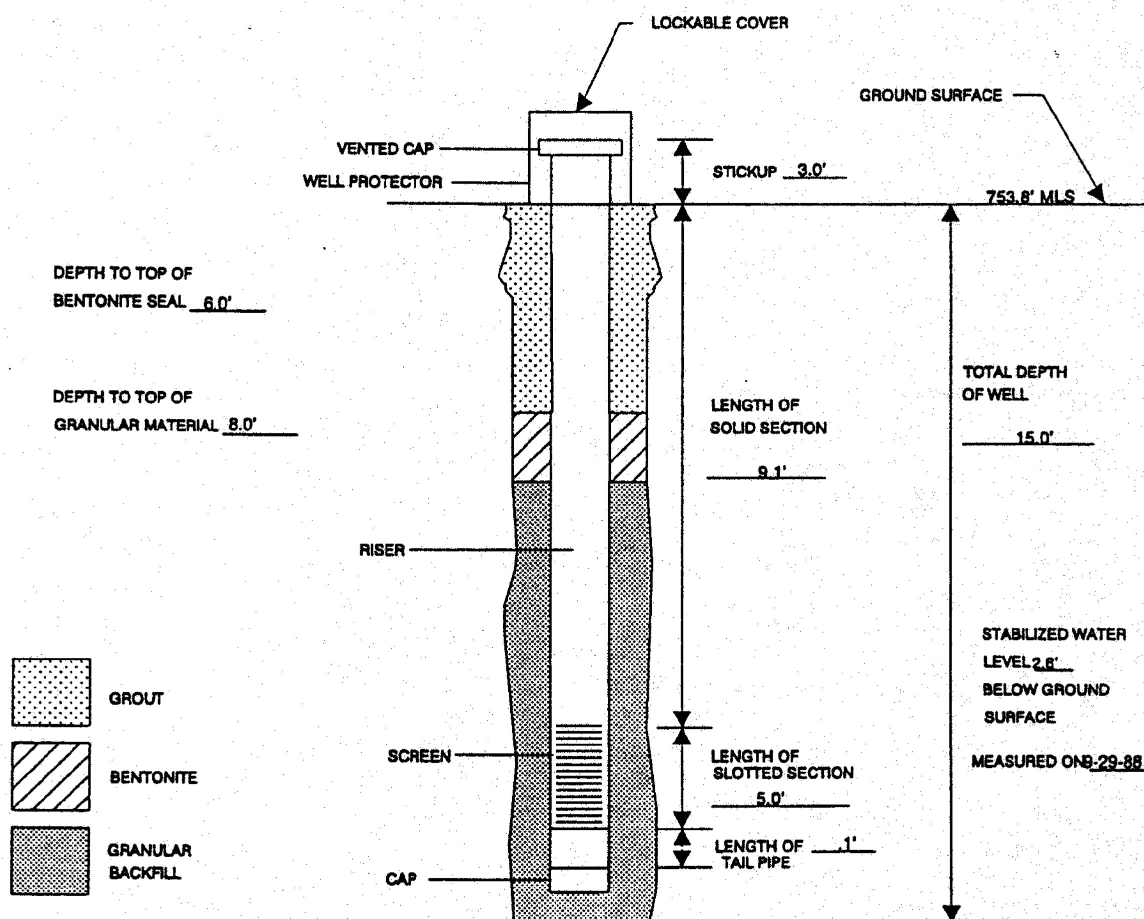
BOREHOLE DIAMETER: 11 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



ENG LAB 10/8/90

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J - 10A
INSTALLATION DATE: 9-19 TO 9-27-88

LOCATION: PLANT COORDINATES W 4+68, N 16+51

GROUND SURFACE ELEVATION: 753.5' MLS
TOP OF INNER CASING: 756.3' MLS

GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCHES

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: AIR ROTARY & POWER AUGER
DRILLING CONTRACTOR: HIGHLAND DRILLING & LAW ENGINEERING

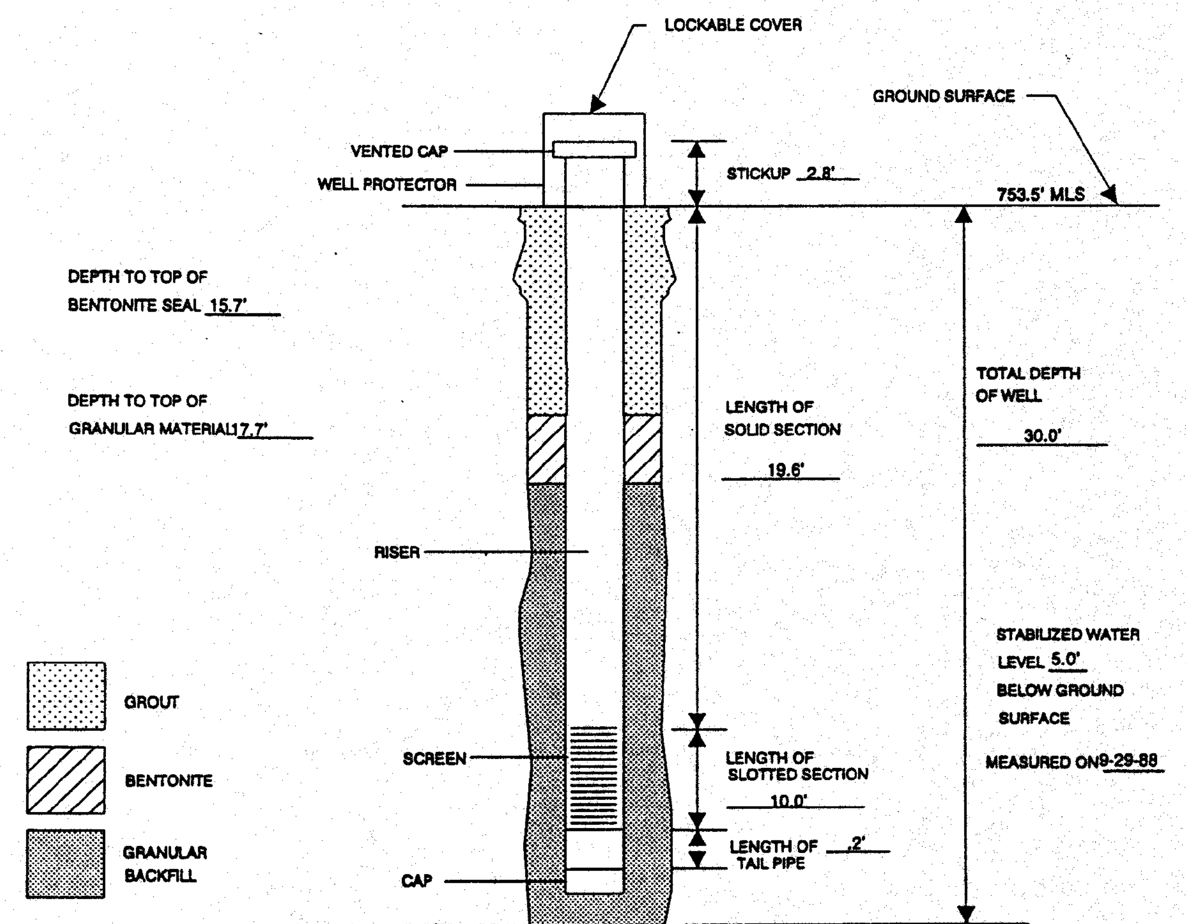
BOREHOLE DIAMETER: 11 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



SHG LAB 10/2/90

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-10 B
INSTALLATION DATE: 9-23-88

LOCATION: PLANT COORDINATES W 4+73, N 16+51

GROUND SURFACE ELEVATION: 753.6' MLS
TOP OF INNER CASING: 756.4' MLS

GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCHES

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: POWER AUGER
DRILLING CONTRACTOR: LAW ENGINEERING

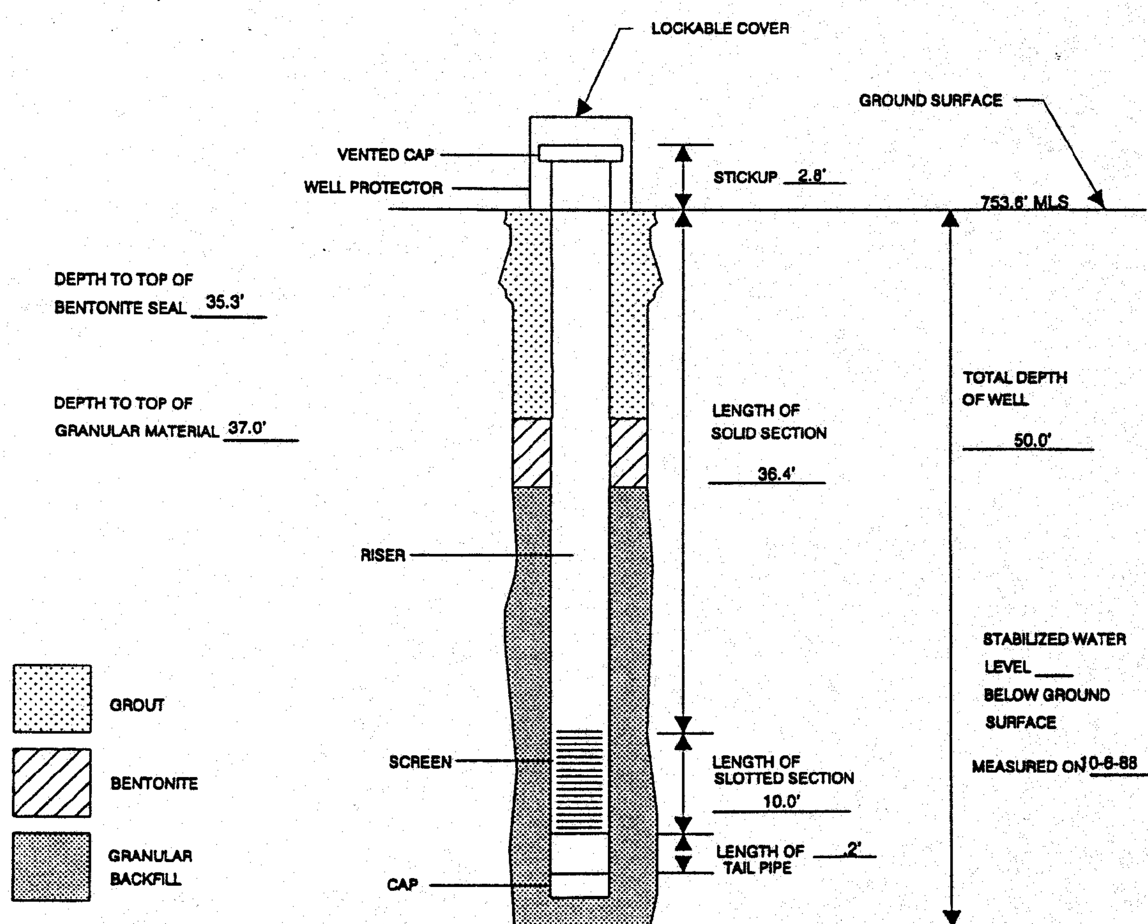
BOREHOLE DIAMETER: 11 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

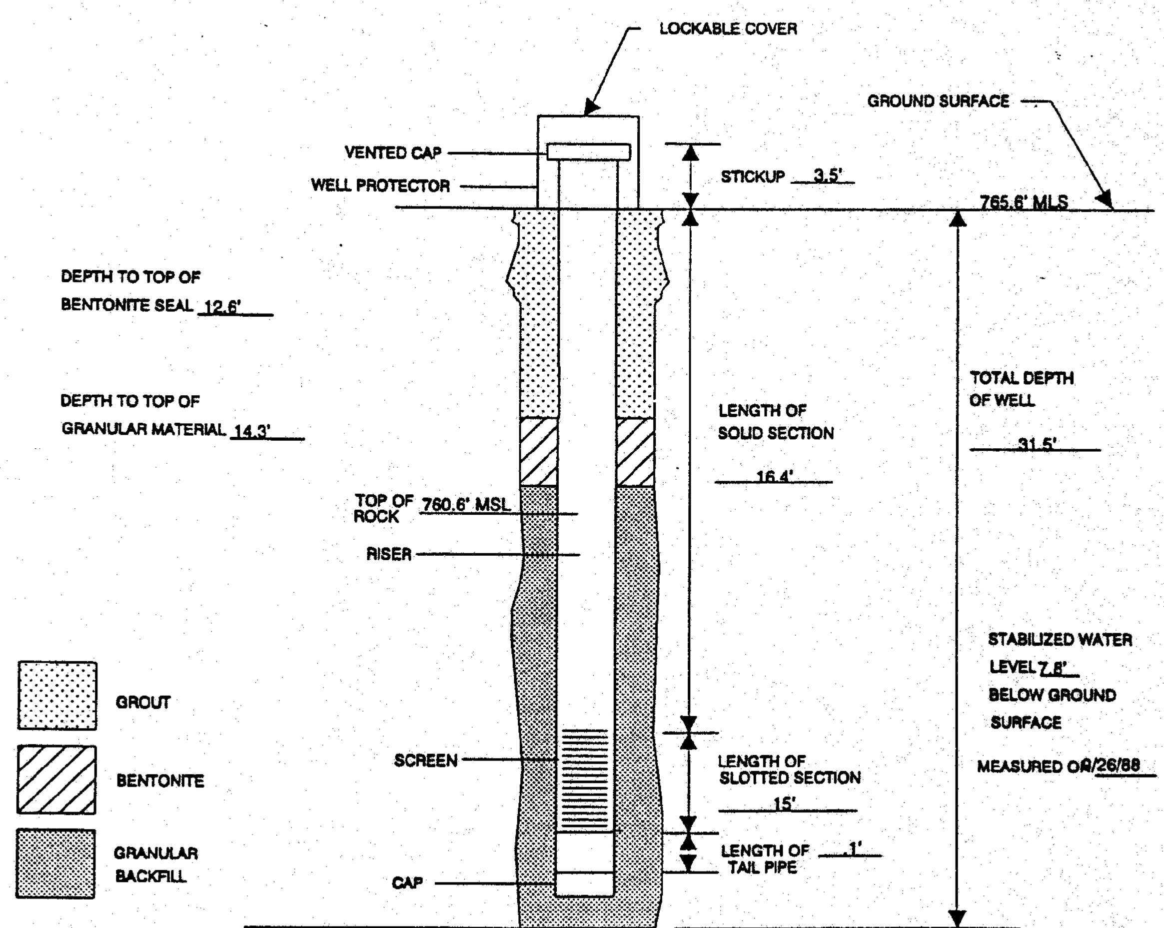
(NOT TO SCALE)



TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195
WELL NUMBER: J-11 B
INSTALLATION DATE: 9-19-88
LOCATION: PLANT COORDINATES W 7+84, N 7+97
GROUND SURFACE ELEVATION: 765.6' MLS
TOP OF INNER CASING: 769.1' MLS
GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: 0.10 INCHES
CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES
DRILLING TECHNIQUE: AIR/WATER ROTARY
DRILLING CONTRACTOR: HIGHLAND DRILLING
BOREHOLE DIAMETER: 8 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON
LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043
RISER MATERIAL: PVC
SCREEN MATERIAL: PVC
COMMENTS:

(NOT TO SCALE)



ENG LAB 10/3/90

TVA-00014553

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-12 A
INSTALLATION DATE: 9-22-88

LOCATION: PLANT COORDINATES W 17+40, N 15+57

GROUND SURFACE ELEVATION: 764.3' MLS
TOP OF INNER CASING: 767.3' MLS

GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCHES

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: POWER AUGER
DRILLING CONTRACTOR: LAW ENGINEERING

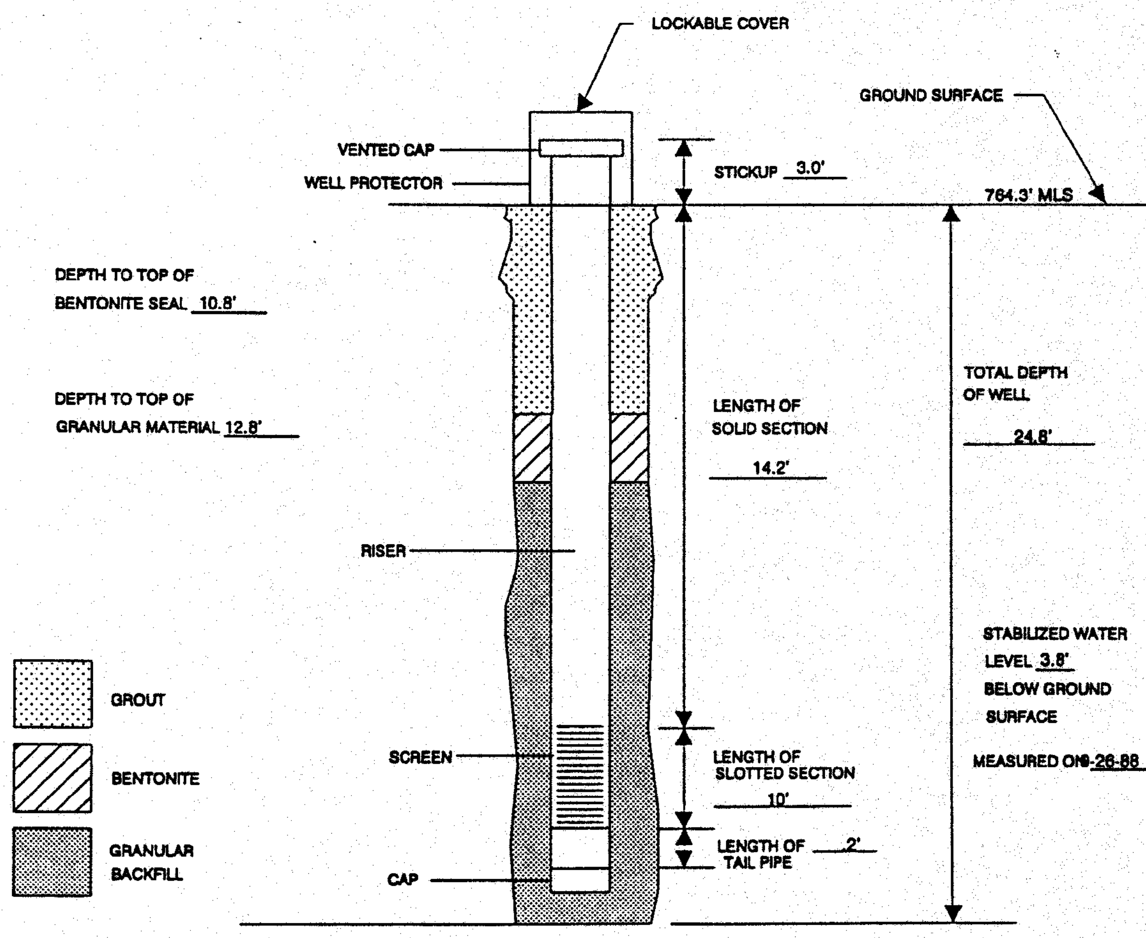
BOREHOLE DIAMETER: 10 1/4 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

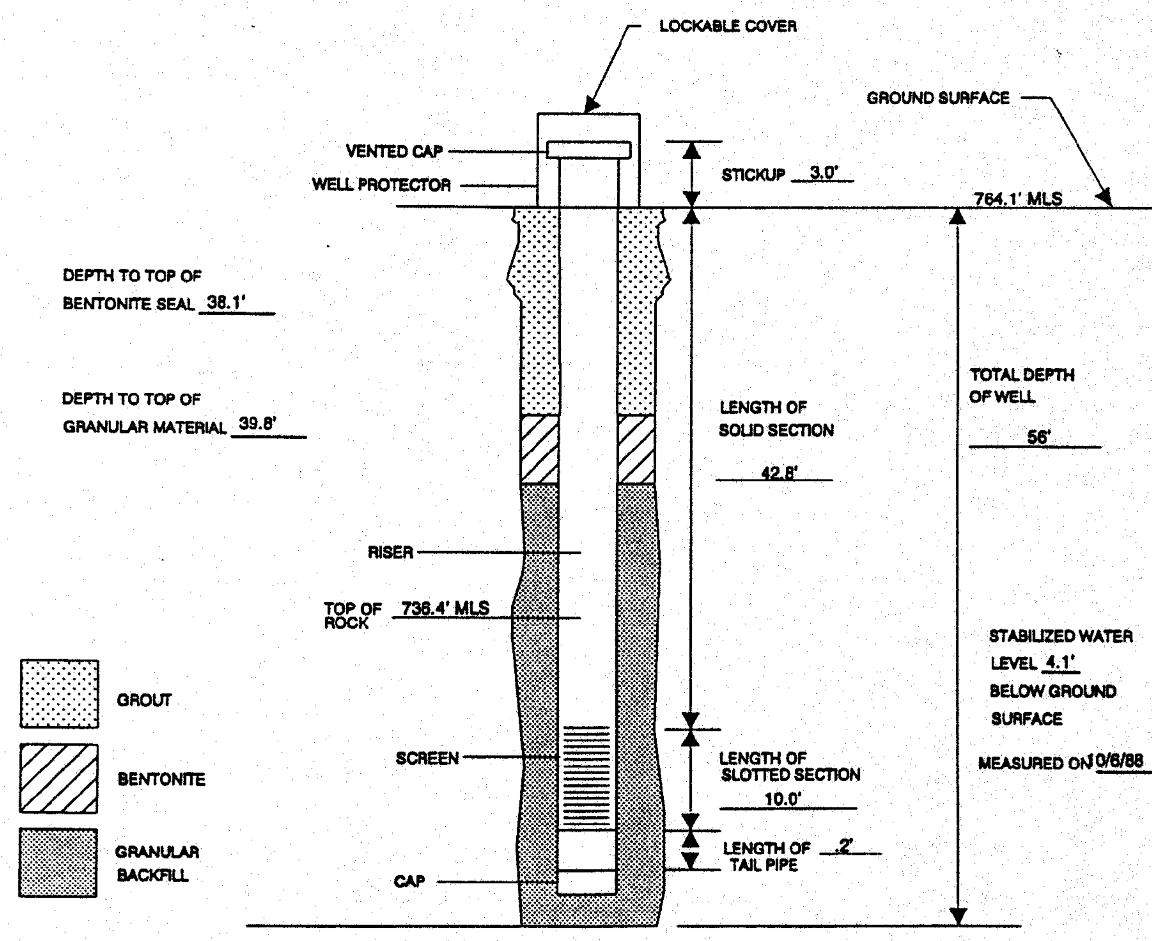
(NOT TO SCALE)



TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195
WELL NUMBER: J-12B
INSTALLATION DATE: 9-27-88
LOCATION: PLANT COORDINATES W 17+53, N 15+85
GROUND SURFACE ELEVATION: 764.1' MLS
TOP OF INNER CASING: 767.1' MLS
GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCHES
CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES
DRILLING TECHNIQUE: AUGER AND AIR ROTARY
DRILLING CONTRACTOR: HIGHLAND DRILLING
BOREHOLE DIAMETER: AUGER 8" ROTARY 5 7/8" DIA.
FIELD REPRESENTATIVE: H.W. ROBINSON
LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043
RISER MATERIAL: PVC
SCREEN MATERIAL: PVC
COMMENTS:

(NOT TO SCALE)



ENG LAB 10/8/90

TVA-00014555

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-13 A
INSTALLATION DATE: 9-28 TO 9-30-88

LOCATION: PLANT COORDINATES W 7+13, N 31+23

GROUND SURFACE ELEVATION: 766.5' M.L.S.
TOP OF INNER CASING: 769.2' M.L.S.

GRANULAR BACKFILL MATERIAL: QUARTZ SAND,COARSE
SLOT SIZE: .010 INCH

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: POWER AUGER
DRILLING CONTRACTOR: LAW ENGINEERING

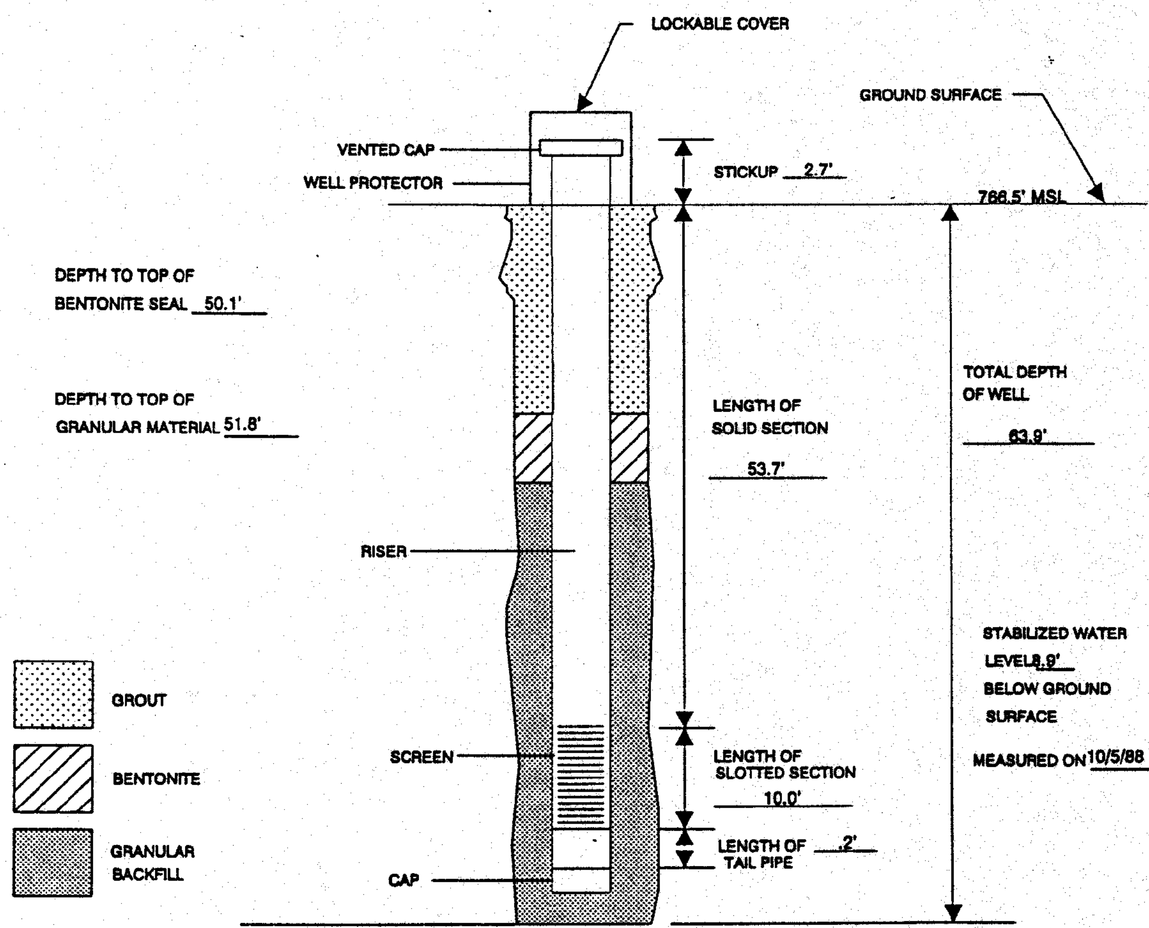
BOREHOLE DIAMETER: APPROXIMATELY 11 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)

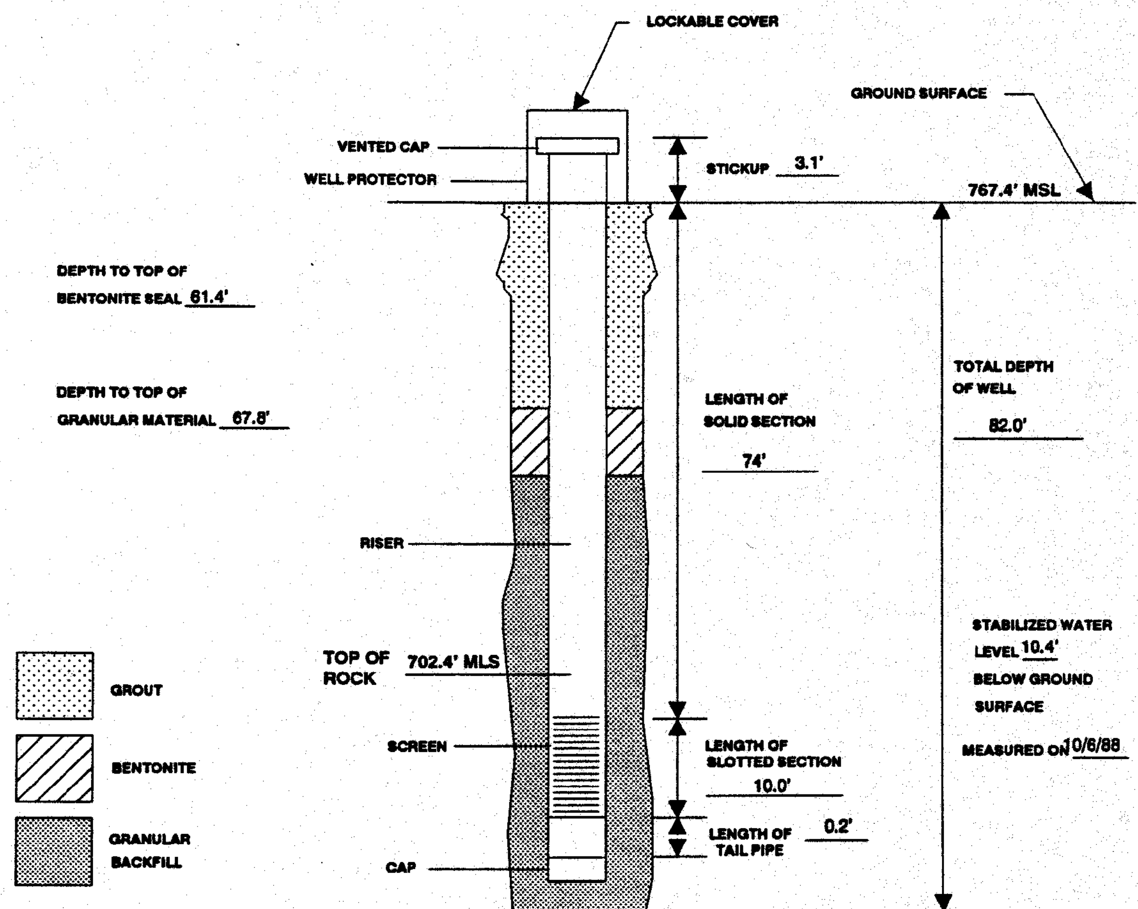


ENG LAB 10/5/90

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON STEAM PLANT
JOB NUMBER: K-88195
WELL NUMBER: J-13 B
INSTALLATION DATE: 9-29 TO 9-30-88
LOCATION: PLANT COORDINATES W 7+34, N 31+04
GROUND SURFACE ELEVATION: 767.4' MLS
TOP OF INNER CASING: 770.5' MLS
GRANULAR BACKFILL MATERIAL: QUARTZ SAND
SLOT SIZE: .010 INCH
CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES
DRILLING TECHNIQUE: AUGER AND AIR ROTARY
DRILLING CONTRACTOR: HIGHLAND DRILLING
BOREHOLE DIAMETER: 8" AUGER, 5 7/8" (ROLLER CONE)
FIELD REPRESENTATIVE: H.W. ROBINSON
LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043
RISER MATERIAL: PVC
SCREEN MATERIAL: PVC
COMMENTS:

(NOT TO SCALE)



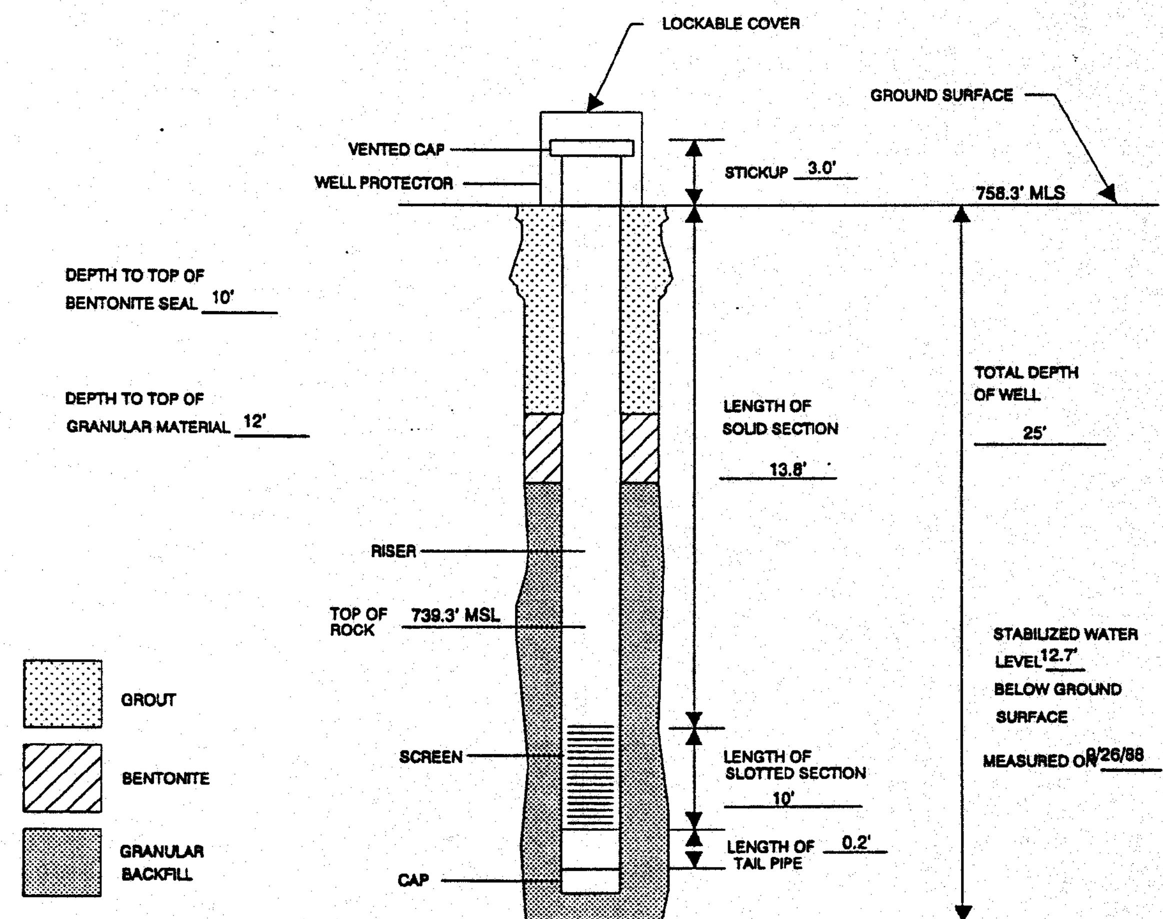
ENG LAB 10/2/90

TVA-00014557

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195
WELL NUMBER: J-14 A
INSTALLATION DATE: 9-22-88
LOCATION: PLANT COORDINATES W 30+46, N 37+49
GROUND SURFACE ELEVATION: 758.3' MLS
TOP OF INNER CASING: 761.3' MLS
GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCH
CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES
DRILLING TECHNIQUE: AIR/WATER ROTARY
DRILLING CONTRACTOR: HIGHLAND DRILLING
BOREHOLE DIAMETER: 8 INCHES
FIELD REPRESENTATIVE: H.W. ROBINSON
LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043
RISER MATERIAL: PVC
SCREEN MATERIAL: PVC
COMMENTS:

(NOT TO SCALE)



ENG LAB 10/2/90

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-14 B
INSTALLATION DATE: 9-22-88

LOCATION: PLANT COORDINATES W 30+56, S 37+60

GROUND SURFACE ELEVATION: 758.3' MSL
TOP OF INNER CASING: 761.3' MSL

GRANULAR BACKFILL MATERIAL: QUARTZ,SAND,COARSE
SLOT SIZE: .010 INCH

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: AIR/WATER ROTARY
DRILLING CONTRACTOR: HIGHLAND DRILLING

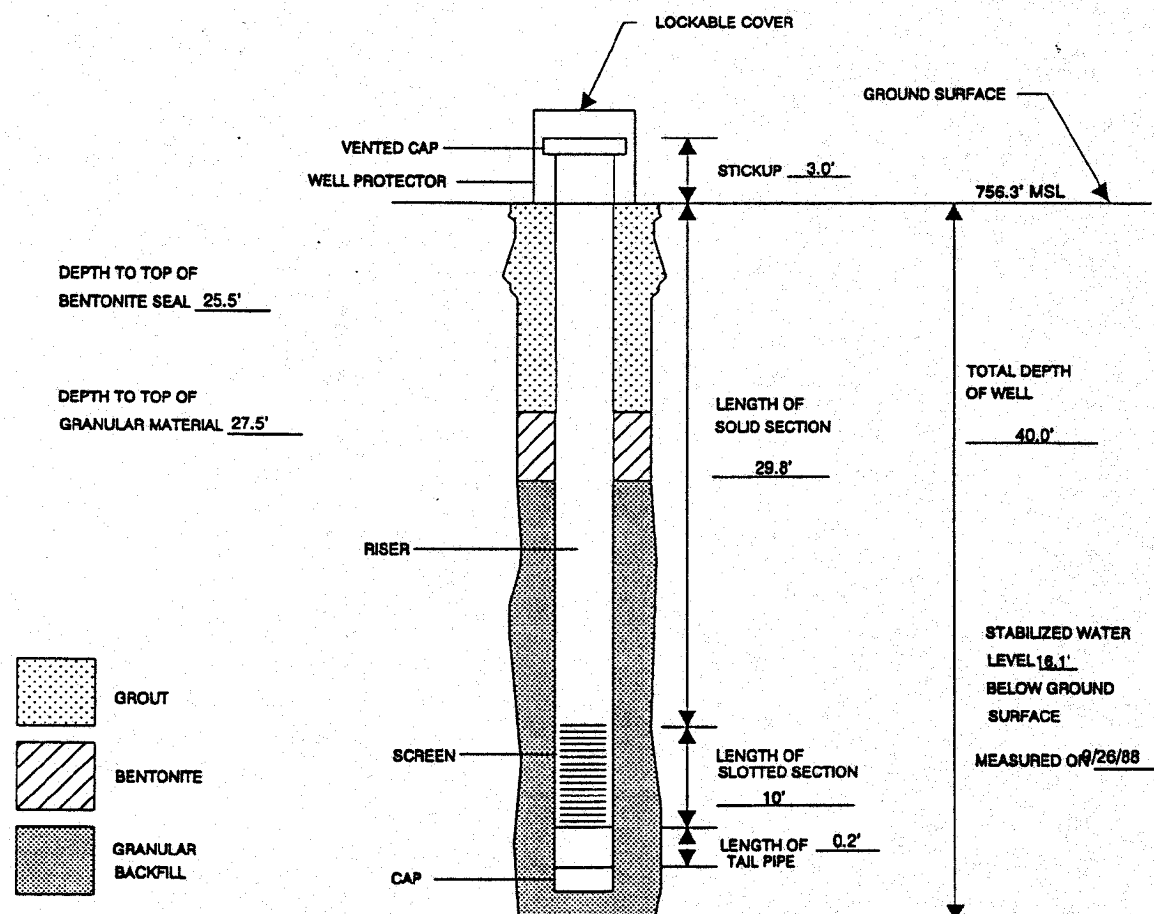
BOREHOLE DIAMETER: 8 INCHES
FIELD REPRESENTATIVE: H.W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



ENG LAB 10/8/90

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT KINGSTON FOSSIL PLANT JOB NUMBER K-88195

WELL NUMBER J-15 A INSTALLATION DATE 9-21-88

LOCATION PLANT COORDINATES W 24+39,N 6+35

GROUND SURFACE ELEVATION 793.1' MSL TOP OF INNER CASING 796.1' MSL

GRANULAR BACKFILL MATERIAL QUARTZ SAND, COARSE SLOT SIZE .010 INCH

CASING MATERIAL PVC CASING DIAMETER 2 INCHES

DRILLING TECHNIQUE AIR/WATER ROTARY DRILLING CONTRACTOR HIGHLAND DRILLING

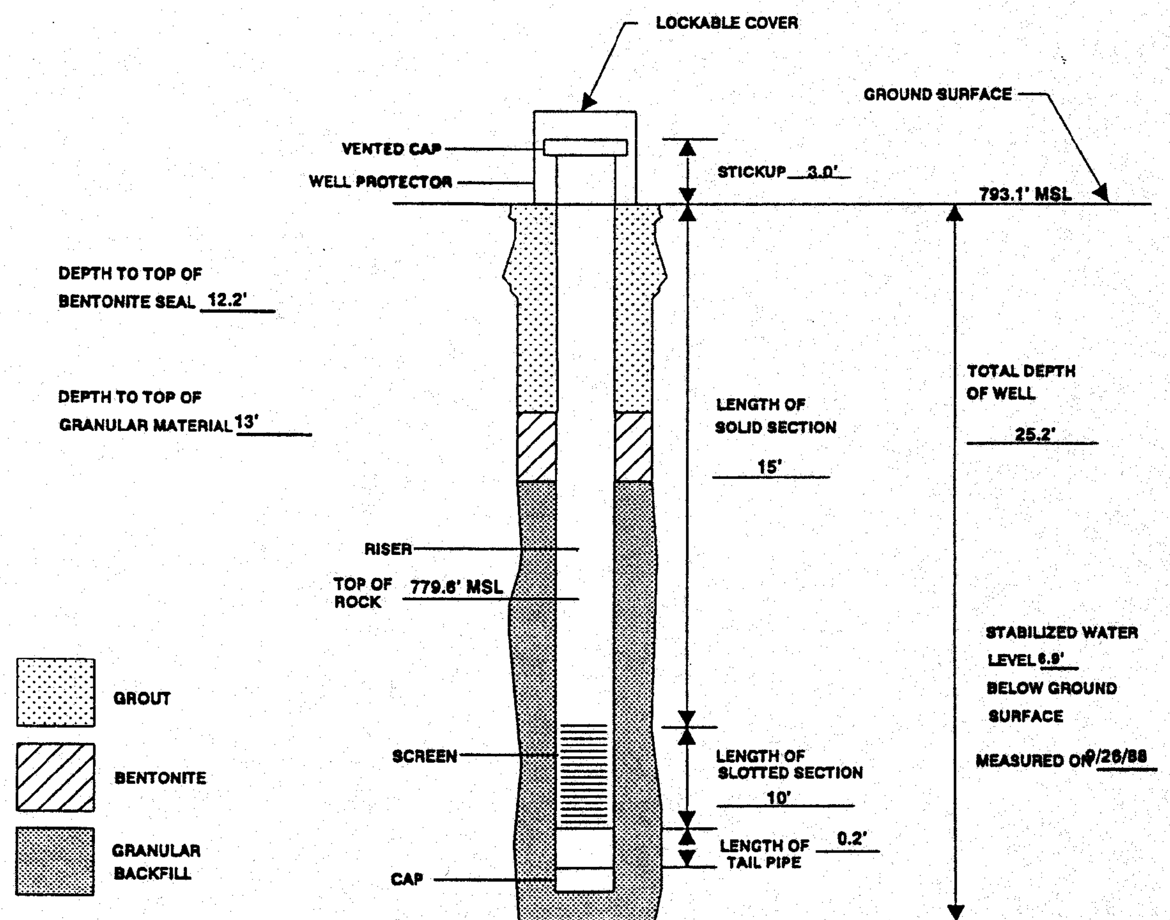
BOREHOLE DIAMETER 8 INCHES FIELD REPRESENTATIVE H.W. ROBINSON

LOCKABLE COVER ? YES KEY CODE/COMBINATION 2043

RISER MATERIAL PVC SCREEN MATERIAL PVC

COMMENTS

(NOT TO SCALE)



ENG LAB 10/8/88

TVA-00014560

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-15 B
INSTALLATION DATE: 9-21-88

LOCATION: PLANT COORDINATES W 24+38,N 6+50

GROUND SURFACE ELEVATION: 792.9' MSL
TOP OF INNER CASING: 795.9' MSL

GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCH

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: AIR/WATER ROTARY
DRILLING CONTRACTOR: HIGHLAND DRILLING

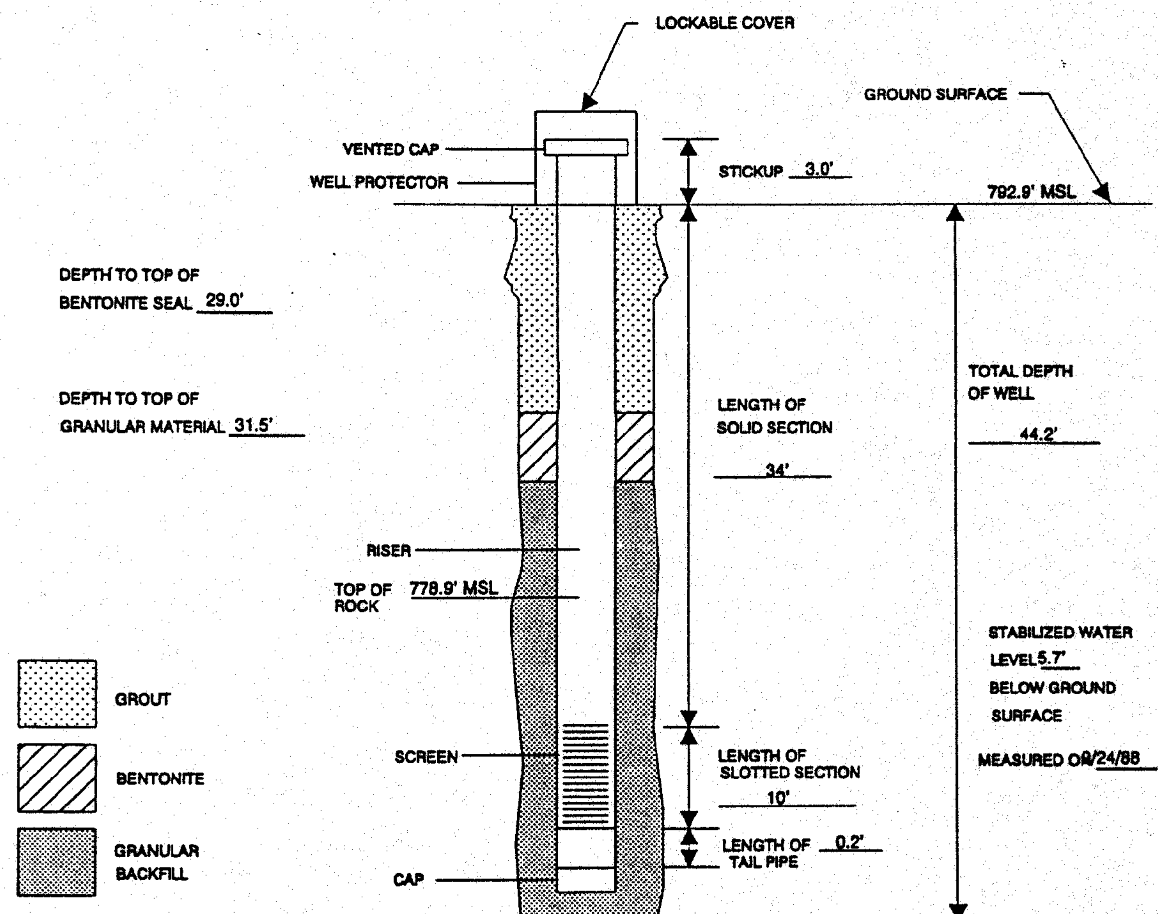
BOREHOLE DIAMETER: 8 INCHES
FIELD REPRESENTATIVE: H.W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

WELL NUMBER: J-16 A
INSTALLATION DATE: 10-5-88

LOCATION: PLANT COORDINATES W 27+87,N 40+08

GROUND SURFACE ELEVATION: 756.6'
TOP OF INNER CASING: 768.6'

GRANULAR BACKFILL MATERIAL: QUARTZ SAND, COARSE
SLOT SIZE: .010 INCH

CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: POWER AUGER
DRILLING CONTRACTOR: HIGHLAND DRILLING

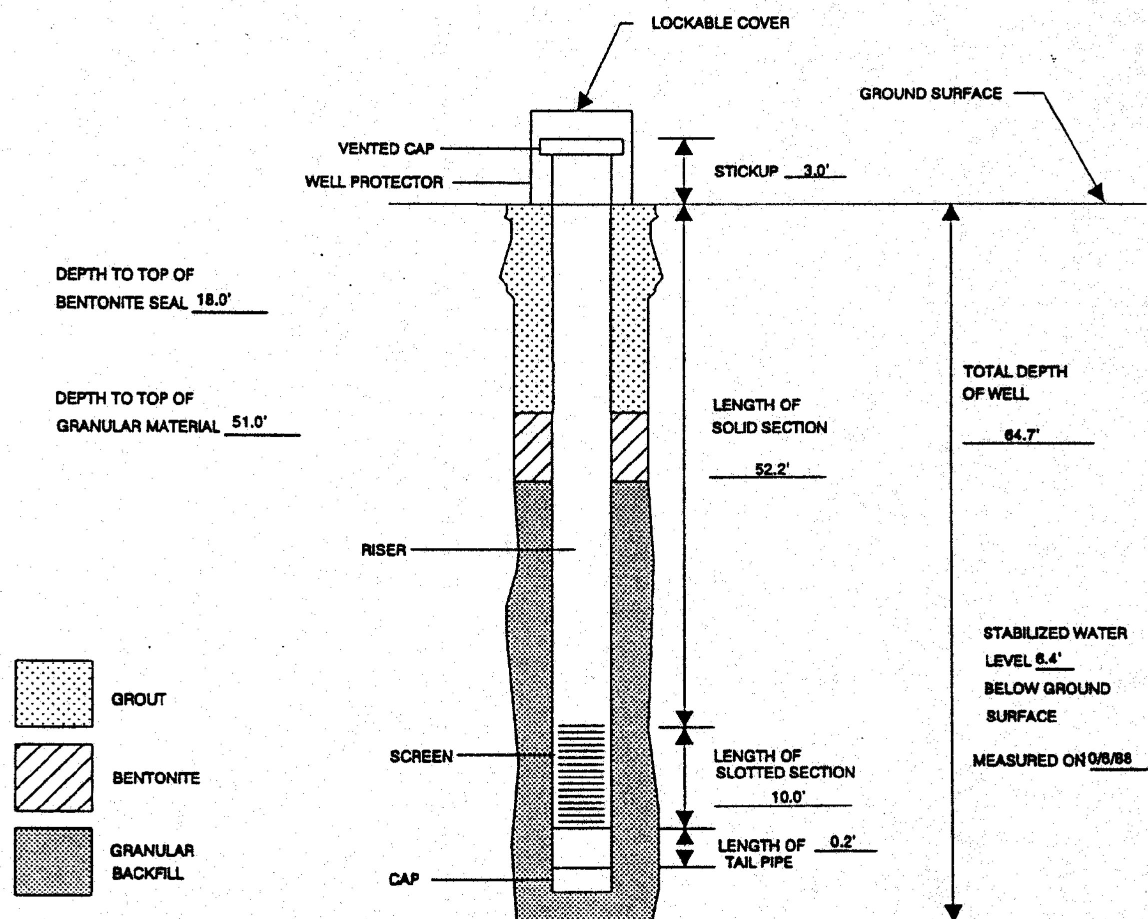
BOREHOLE DIAMETER: 11 INCHES
FIELD REPRESENTATIVE: H.W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



ENG LAB 10/3/80

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT — JOB NUMBER: K-88195

WELL NUMBER: J-16 B — INSTALLATION DATE: 9-23-88

LOCATION: PLANT COORDINATES W 27+80,N 40+34

GROUND SURFACE ELEVATION: 765.4' MSL — TOP OF INNER CASING: 768.1' MSL

GRANULAR BACKFILL MATERIAL: QUARTZ SAND,COARSE — SLOT SIZE: .010 INCHES

CASING MATERIAL: PVC — CASING DIAMETER: 2 INCHES

DRILLING TECHNIQUE: AUGER AND AIR ROTARY — DRILLING CONTRACTOR: HIGHLAND DRILLING

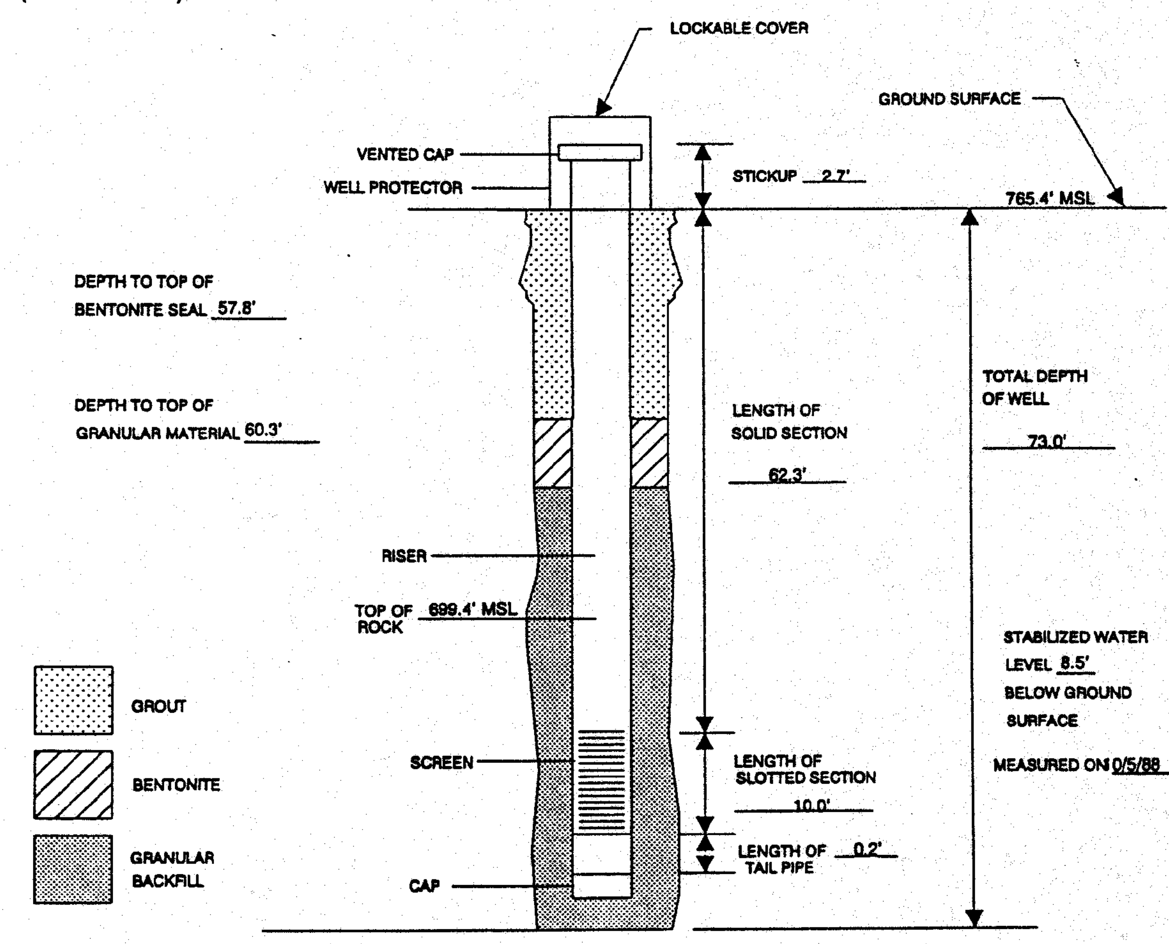
BOREHOLE DIAMETER: 8" AUGER,5 7/8" AIR ROTARY — FIELD REPRESENTATIVE: H.W. ROBINSON

LOCKABLE COVER ?: YES — KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC — SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT Kingston Fossil Plant

WELL NUMBER 17 **INSTALLATION DATE** July 8, 1992

LOCATION Plant coordinates W 1+81, N 58+80

GROUND SURFACE ELEVATION 762.42' MSL **TOP OF INNER CASING** 765.42' MSL

GRANULAR BACKFILL MATERIAL Sand **SLOT SIZE** 0.010"

CASING MATERIAL 4" SCH 40 PVC **CASING DIAMETER** 4" SCH 40 PVC

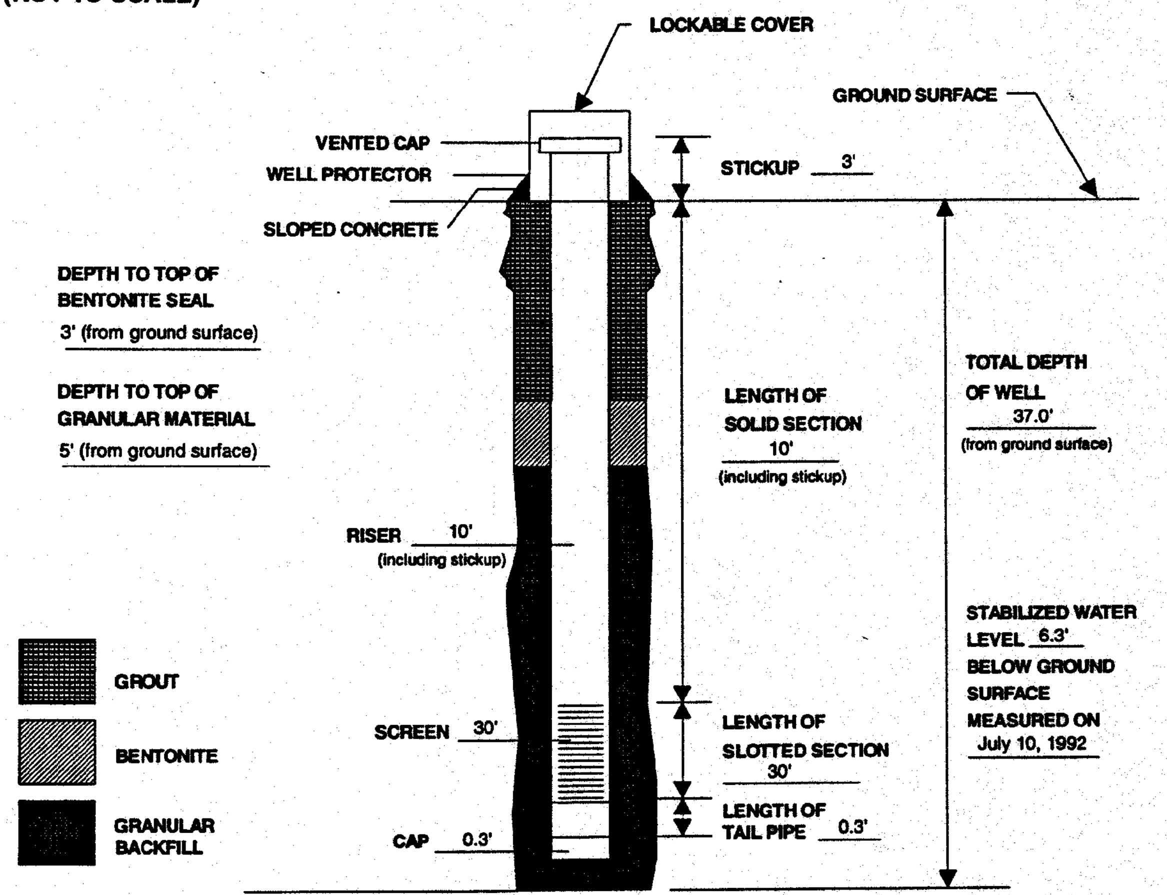
DRILLING TECHNIQUE HSA **DRILLING CONTRACTOR** John Voekel, Law Engr.

BOREHOLE DIAMETER 4.25" HSA (ID) **FIELD REPRESENTATIVE** Mel Wagner

LOCKABLE COVER ? Yes **FILTER CLOTH AROUND SCREEN?** No

COMMENTS The 4.25" HSA was used first with the continuous sampling barrel. Next, the 6.25" (ID) auger was used to provide room for the sand pack around the screen.

(NOT TO SCALE)



ENG LAB 6/19/86

TVA-00014564

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT Kingston Fossil Plant

WELL NUMBER 18 **INSTALLATION DATE** July 10, 1992

LOCATION Plant coordinates W 1+70, N 58+98

GROUND SURFACE ELEVATION 764.32' MSL **TOP OF INNER CASING** 767.32' MSL

GRANULAR BACKFILL MATERIAL Sand **SLOT SIZE** 0.010"

CASING MATERIAL 4" SCH 40 PVC **CASING DIAMETER** 4" SCH 40 PVC

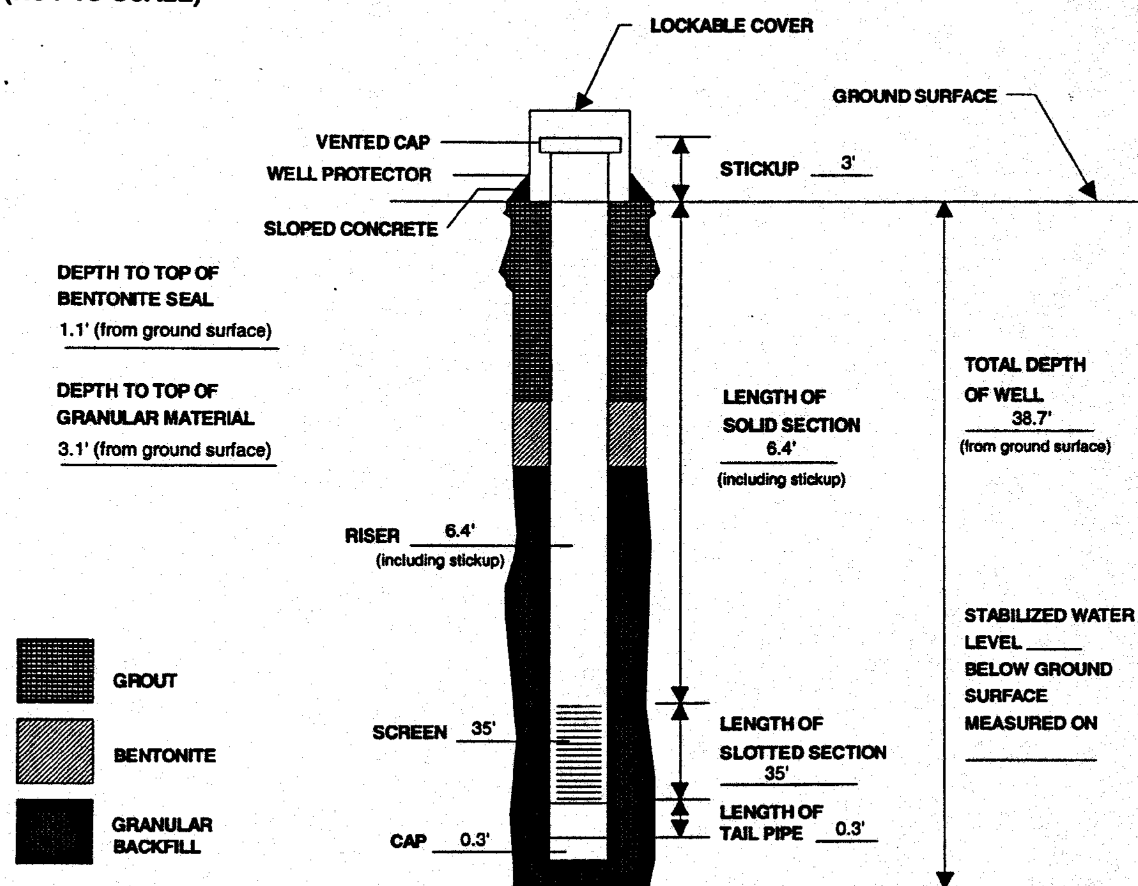
DRILLING TECHNIQUE HSA **DRILLING CONTRACTOR** John Voekel, Law Engr.

BOREHOLE DIAMETER 4.25" HSA (ID) **FIELD REPRESENTATIVE** Mel Wagner

LOCKABLE COVER ? Yes **FILTER CLOTH AROUND SCREEN?** No

COMMENTS The 4.25" HSA was used first with the continuous sampling barrel. Next, the 6.25" (ID) auger was used to provide room for the sand pack around the screen.

(NOT TO SCALE)



ENG LAB 6/18/85

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT Kingston Fossil Plant

WELL NUMBER 19 **INSTALLATION DATE** July 13, 1992

LOCATION Plant coordinates W 1+55, N 59+21

GROUND SURFACE ELEVATION 763.90' MSL **TOP OF INNER CASING** 766.90' MSL

GRANULAR BACKFILL MATERIAL Sand **SLOT SIZE** 0.010"

CASING MATERIAL 4" SCH 40 PVC **CASING DIAMETER** 4" SCH 40 PVC

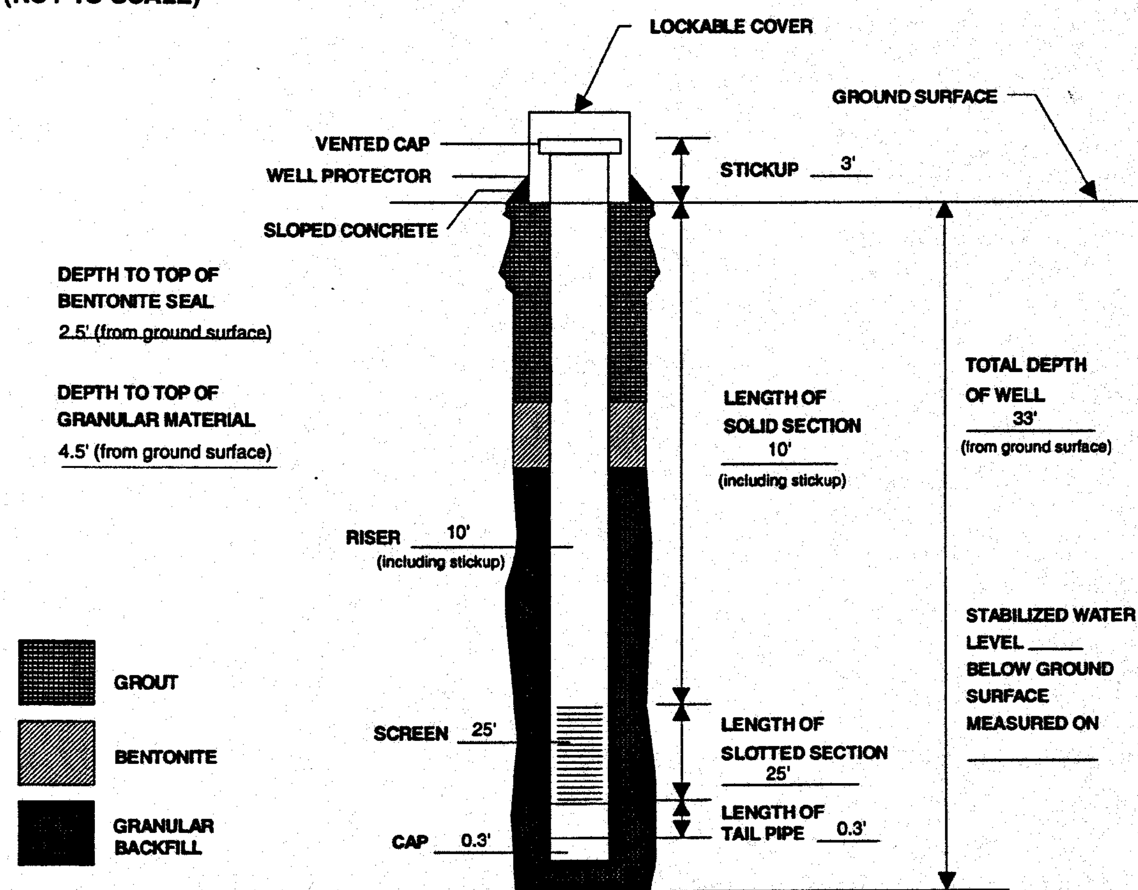
DRILLING TECHNIQUE HSA **DRILLING CONTRACTOR** John Voekel, Law Engr.

BOREHOLE DIAMETER 4.25" HSA (ID) **FIELD REPRESENTATIVE** Mel Wagner

LOCKABLE COVER ? Yes **FILTER CLOTH AROUND SCREEN?** No

COMMENTS The 4.25" HSA was used first with the continuous sampling barrel. Next, the 6.25" (ID) auger was used to provide room for the sand pack around the screen.

(NOT TO SCALE)



ENG LAB 6/19/86

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT Kingston Fossil Plant

WELL NUMBER 20 **INSTALLATION DATE** July 10, 1992

LOCATION Plant coordinates W 1+24, N 59+67

GROUND SURFACE ELEVATION 750.06' MSL **TOP OF INNER CASING** 753.06' MSL

GRANULAR BACKFILL MATERIAL Sand **SLOT SIZE** 0.010 "

CASING MATERIAL 4" SCH 40 PVC **CASING DIAMETER** 4" SCH 40 PVC

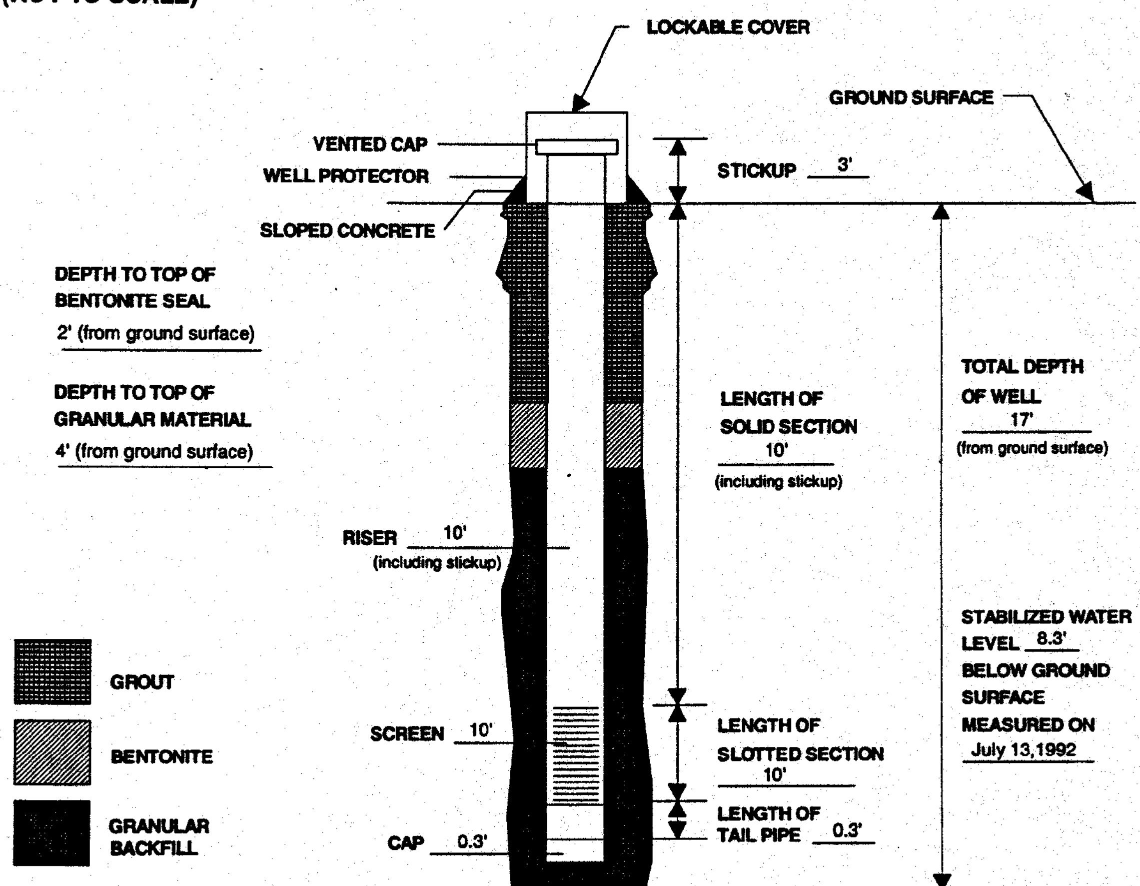
DRILLING TECHNIQUE HSA **DRILLING CONTRACTOR** John Voekel, Law Engr.

BOREHOLE DIAMETER 4.25" HSA (ID) **FIELD REPRESENTATIVE** Mel Wagner

LOCKABLE COVER ? Yes **FILTER CLOTH AROUND SCREEN?** No

COMMENTS The 4.25" HSA was used first with the continuous sampling barrel. The 6.25" HSA was not used because the well was drilled in a clay-filled berm.

(NOT TO SCALE)



ENG LAB 6/18/85

TVA-00014567

APPENDIX III

GROUNDWATER QUALITY DATA

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 94/12/06.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
2	ORP (MV)	18	-49.3	-78.5	-120	135	.
2	CONDUCTIVITY (UMHOS/CM)	18	840.7	847	756	914	.
2	DISSOLVED OXYGEN (MG/L)	18	0.3	0.3	0.1	1	.
2	TEMPERATURE (DEG C)	18	16.2	16.3	13.6	17.7	.
2	COD (MG/L)	1	22	22	22	22	.
2	PH (STANDARD UNITS)	18	6.6	6.6	6.3	6.8	2
2	ALKALINITY (MG/L)	17	430.8	470	42	535	.
2	PHEN-PH ALKALINITY (MG/L)	3	0	0	0	0	.
2	ACIDITY (MG/L)	9	199.6	223	0	282	.
2	CO2 ACIDITY (MG/L)	6	199.1	225.5	52	246	.
2	CO2 (MG/L)	7	196.9	196	154	248	.
2	CA/MG HARDNESS (MG/L)	20	415.9	411.5	377	489	.
2	NITRATE+NITRITE NITROGEN (MG/L)	13	0.1	0	0	0.6	0
2	TOTAL ORGANIC CARBON (MG/L)	20	6.8	7.5	0.9	11	.
2	TOTAL INORGANIC CARBON (MG/L)	20	148.2	149.5	68	310	.
2	SULFIDE (MG/L)	9	0.1	0.1	0	0.2	.
2	CALCIUM (MG/L)	20	97.6	96	87	110	.
2	DISSOLVED CALCIUM (MG/L)	3	102	99	97	110	.
2	MAGNESIUM (MG/L)	20	41.8	42	31	52	.
2	DISSOLVED MAGNESIUM (MG/L)	3	44	43	41	48	.
2	SODIUM (MG/L)	20	5.9	6.2	2.6	7.9	.
2	POTASSIUM (MG/L)	20	3.5	2.8	2.2	8.5	.
2	CHLORIDE (MG/L)	20	3.5	4	1	6	0
2	SULFATE (MG/L)	20	39.2	20.5	2	210	0
2	FLUORIDE (MG/L)	13	0.2	0.1	0.1	0.5	0
2	ALUMINUM (UG/L)	20	7785	5550	170	19000	19
2	DISSOLVED ALUMINUM (UG/L)	3	56.7	50	50	70	0
2	ANTIMONY (UG/L)	4	1.3	1	1	2	0
2	ARSENIC (UG/L)	20	225.9	210	73	440	20
2	DISSOLVED ARSENIC (UG/L)	3	176.7	180	150	200	3
2	BARIUM (UG/L)	18	551.1	530	200	770	0
2	DISSOLVED BARIUM (UG/L)	3	433.3	460	360	480	0
2	BERYLLIUM (UG/L)	4	2.3	1	1	6	1
2	BORON (UG/L)	20	4095	2800	1700	25000	.
2	DISSOLVED BORON (UG/L)	3	2433.3	2400	2100	2800	.
2	CADMIUM (UG/L)	20	0.4	0.3	0.1	1	0
2	DISSOLVED CADMIUM (UG/L)	3	0.7	0.6	0.1	1.4	0
2	CHROMIUM (UG/L)	18	7.2	6	2	17	0
2	DISSOLVED CHROMIUM (UG/L)	3	1	1	1	1	0
2	COPPER (UG/L)	20	18.5	10	10	70	0
2	DISSOLVED COPPER (UG/L)	3	20	20	10	30	0
2	IRON - TOTAL (UG/L)	20	48200	48500	4000	73000	20
2	DISSOLVED IRON (UG/L)	3	35666.7	36000	34000	37000	3
2	LEAD (UG/L)	18	11.6	9.5	1	25	0
2	DISSOLVED LEAD (UG/L)	3	1	1	1	1	0

Continued

2	LITHIUM (UG/L)	13	30	30	10	70 .	
2	DISSOLVED LITHIUM (UG/L)	3	20	20	20	20 .	
2	MANGANESE (UG/L)	20	5075	5200	2100	6500	20
2	DISSOLVED MANGANESE (UG/L)	3	4966.7	5100	4500	5300	3
2	MOLYBDENUM (UG/L)	6	63.3	35	20	180 .	
2	DISSOLVED MOLYBDENUM (UG/L)	1	20	20	20	20 .	
2	MERCURY (UG/L)	1	0.2	0.2	0.2	0.2	0
2	NICKEL (UG/L)	4	10.3	8	7	18	0
2	SELENIUM (UG/L)	13	1.2	1	1	3	0
2	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1	0
2	SILICON (UG/L)	16	21981.3	21000	8700	36000 .	
2	DISSOLVED SILICON (UG/L)	3	15666.7	16000	15000	16000 .	
2	STRONTIUM (UG/L)	18	1644.4	1500	1200	2700 .	
2	DISSOLVED STRONTIUM (UG/L)	3	1366.7	1400	1200	1500 .	
2	VANADIUM (UG/L)	18	17.2	10	10	30 .	
2	DISSOLVED VANADIUM (UG/L)	3	10	10	10	10 .	
2	ZINC (UG/L)	20	98.5	95	10	330	0
2	DISSOLVED ZINC (UG/L)	3	20	20	10	30	0
2	TOTAL DISSOLVED SOLIDS (MG/L)	20	428	455	240	540	2
2	TOTAL SUSPENDED SOLIDS (MG/L)	15	393.9	400	12	1000 .	
2	WATER SURF. FR MP (M)	21	3	3	2.5	5.1 .	
2	WATER SURF. ELVN (M, MSL)	12	230.3	230.9	224.7	231.3 .	
2	WATER SURF. ELVN (FT, MSL)	12	755.5	757.5	737.3	758.8 .	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 94/12/06.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
4A	ORP (MV)	18	349.8	373.5	170	632	.
4A	CONDUCTIVITY (UMHOS/CM)	19	2478.6	2825	1.5	3500	.
4A	DISSOLVED OXYGEN (MG/L)	19	0.7	0.6	0	1.7	.
4A	TEMPERATURE (DEG C)	19	16.6	16.3	13.6	21.2	.
4A	PH (STANDARD UNITS)	19	3.5	3.2	2.6	5.6	19
4A	ALKALINITY (MG/L)	18	14.3	0	0	179	.
4A	PHEN-PH ALKALINITY (MG/L)	6	0	0	0	0	.
4A	ACIDITY (MG/L)	7	497.9	680	0	830	.
4A	CO2 ACIDITY (MG/L)	7	679.3	832	0	943	.
4A	CO2 (MG/L)	6	608.7	616	440	730	.
4A	CA/MG HARDNESS (MG/L)	19	1089	1124.2	822	1285.6	.
4A	NITRATE+NITRITE NITROGEN (MG/L)	10	0.2	0	0	0.9	0
4A	TOTAL ORGANIC CARBON (MG/L)	18	1.6	1.4	0.7	2.6	.
4A	TOTAL INORGANIC CARBON (MG/L)	18	31.4	30	6	90	.
4A	SULFIDE (MG/L)	6	0	0	0	0	.
4A	CALCIUM (MG/L)	19	301.6	320	240	360	.
4A	DISSOLVED CALCIUM (MG/L)	5	302	300	270	340	.
4A	MAGNESIUM (MG/L)	19	81.6	84	51	101	.
4A	DISSOLVED MAGNESIUM (MG/L)	5	77	72	52	96	.
4A	SODIUM (MG/L)	19	9.1	9.2	4.5	12	.
4A	POTASSIUM (MG/L)	19	5.4	5.7	1.7	8	.
4A	CHLORIDE (MG/L)	19	3.4	3	1	8	0
4A	SULFATE (MG/L)	19	1626.3	1600	880	2400	19
4A	FLUORIDE (MG/L)	18	1.1	0.8	0.1	3.2	0
4A	ALUMINUM (UG/L)	19	8752.6	8800	3900	17000	19
4A	DISSOLVED ALUMINUM (UG/L)	5	8700	8500	8000	9800	5
4A	ANTIMONY (UG/L)	5	1.4	1	1	3	0
4A	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
4A	ARSENIC (UG/L)	19	3.1	2	1	13	0
4A	DISSOLVED ARSENIC (UG/L)	5	3.6	1	1	13	0
4A	BARIUM (UG/L)	17	107.1	90	10	470	0
4A	DISSOLVED BARIUM (UG/L)	5	106	20	10	300	0
4A	BERYLLIUM (UG/L)	5	1.6	2	1	2	0
4A	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
4A	BORON (UG/L)	19	1372.6	890	500	7300	.
4A	DISSOLVED BORON (UG/L)	5	852	720	500	1400	.
4A	CADMIUM (UG/L)	19	3.5	3.2	1.9	5.4	2
4A	DISSOLVED CADMIUM (UG/L)	5	3.8	3	2	6.1	2
4A	CHROMIUM (UG/L)	17	5.3	2	1	24	0
4A	DISSOLVED CHROMIUM (UG/L)	5	1.4	1	1	2	0
4A	COPPER (UG/L)	19	37.9	10	10	170	0
4A	DISSOLVED COPPER (UG/L)	5	76	80	10	190	0
4A	IRON - TOTAL (UG/L)	19	318211	320000	36000	490000	19
4A	DISSOLVED IRON (UG/L)	5	334000	280000	250000	470000	5

Continued

4A	LEAD (UG/L)	17	14	11	1	38		0
4A	DISSOLVED LEAD (UG/L)	5	7.2	5	2	12		0
4A	LITHIUM (UG/L)	12	24.8	30	10	30	.	
4A	DISSOLVED LITHIUM (UG/L)	5	22.8	24	10	40	.	
4A	MANGANESE (UG/L)	19	53473.7	56000	19000	87000		19
4A	DISSOLVED MANGANESE (UG/L)	5	53200	50000	42000	67000		5
4A	MOLYBDENUM (UG/L)	8	20	20	20	20	.	
4A	DISSOLVED MOLYBDENUM (UG/L)	5	20	20	20	20	.	
4A	NICKEL (UG/L)	6	124.7	115	98	180		4
4A	DISSOLVED NICKEL (UG/L)	1	52	52	52	52		0
4A	SELENIUM (UG/L)	10	1	1	1	1		0
4A	SILICON (UG/L)	14	17407.1	18500	8800	22000	.	
4A	DISSOLVED SILICON (UG/L)	4	20500	21000	18000	22000	.	
4A	STRONTIUM (UG/L)	17	1282.4	1300	900	1600	.	
4A	DISSOLVED STRONTIUM (UG/L)	5	1300	1400	1000	1500	.	
4A	VANADIUM (UG/L)	17	24.1	10	10	90	.	
4A	DISSOLVED VANADIUM (UG/L)	5	14	10	10	30	.	
4A	ZINC (UG/L)	19	727.4	690	440	1200		0
4A	DISSOLVED ZINC (UG/L)	5	780	660	520	1200		0
4A	TOTAL DISSOLVED SOLIDS (MG/L)	19	2678.9	2800	1700	3600		19
4A	TOTAL SUSPENDED SOLIDS (MG/L)	13	63.8	27	10	240	.	
4A	WATER SURF. FR MP (M)	21	4.4	4.6	2.3	6.3	.	
4A	WATER SURF. ELVN (M, MSL)	10	225.7	225.8	223.4	227.9	.	
4A	WATER SURF. ELVN (FT, MSL)	10	740.5	740.8	733.1	747.8	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 94/12/06.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
4B	ORP (MV)	21	260.3	278	20	470	.
4B	CONDUCTIVITY (UMHOS/CM)	21	1072.3	1074	770	1550	.
4B	DISSOLVED OXYGEN (MG/L)	21	4.4	4	0.4	8.8	.
4B	TEMPERATURE (DEG C)	20	16.5	16.5	13.2	22	.
4B	PH (STANDARD UNITS)	21	6.6	6.7	5.2	7	5
4B	ALKALINITY (MG/L)	20	229.3	228.5	125	360	.
4B	PHEN-PH ALKALINITY (MG/L)	6	0	0	0	0	.
4B	ACIDITY (MG/L)	8	33.6	25	0	87	.
4B	CO2 ACIDITY (MG/L)	9	83.7	71	37	185	.
4B	CO2 (MG/L)	8	36.7	32.5	16.7	76.6	.
4B	CA/MG HARDNESS (MG/L)	21	645.8	656.6	445	923	.
4B	NITRATE+NITRITE NITROGEN (MG/L)	12	0.2	0	0	1.3	0
4B	TOTAL ORGANIC CARBON (MG/L)	20	3.4	3	1.8	6.4	.
4B	TOTAL INORGANIC CARBON (MG/L)	21	89.5	89	41	150	.
4B	SULFIDE (MG/L)	8	0	0	0	0	.
4B	CALCIUM (MG/L)	21	222.9	230	150	320	.
4B	DISSOLVED CALCIUM (MG/L)	7	235.7	220	170	310	.
4B	MAGNESIUM (MG/L)	21	21.7	20	17	32	.
4B	DISSOLVED MAGNESIUM (MG/L)	7	21.9	18	16	31	.
4B	SODIUM (MG/L)	21	2.9	2.8	1.7	6.8	.
4B	POTASSIUM (MG/L)	21	4	3.7	2.3	8.2	.
4B	CHLORIDE (MG/L)	21	2.9	2	1	7	0
4B	SULFATE (MG/L)	21	441.6	430	54	800	20
4B	FLUORIDE (MG/L)	20	0.2	0.2	0.1	0.7	0
4B	ALUMINUM (UG/L)	21	1016.2	400	50	4200	16
4B	DISSOLVED ALUMINUM (UG/L)	7	51.4	50	50	60	0
4B	ANTIMONY (UG/L)	5	1.6	1	1	4	0
4B	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
4B	ARSENIC (UG/L)	21	3.6	2	1	11	0
4B	DISSOLVED ARSENIC (UG/L)	7	1.2	1	1	2	0
4B	BARIUM (UG/L)	19	39.5	30	10	80	0
4B	DISSOLVED BARIUM (UG/L)	7	20	10	10	40	0
4B	BERYLLIUM (UG/L)	5	1	1	1	1	0
4B	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
4B	BORON (UG/L)	21	533.3	500	500	1200	.
4B	DISSOLVED BORON (UG/L)	7	500	500	500	500	.
4B	CADMIUM (UG/L)	20	0.3	0.3	0.1	0.8	0
4B	DISSOLVED CADMIUM (UG/L)	7	0.4	0.2	0.1	1.5	0
4B	CHROMIUM (UG/L)	18	6.4	2	1	58	0
4B	DISSOLVED CHROMIUM (UG/L)	7	1	1	1	1	0
4B	COPPER (UG/L)	21	16.7	10	10	60	0
4B	DISSOLVED COPPER (UG/L)	7	17.1	10	10	60	0
4B	IRON - TOTAL (UG/L)	21	5077.6	3600	380	16000	21
4B	DISSOLVED IRON (UG/L)	7	172.9	180	10	340	2

Continued

4B	LEAD (UG/L)	19	6.2	3	1	38		0
4B	DISSOLVED LEAD (UG/L)	7	1	1	1	1		0
4B	LITHIUM (UG/L)	14	10	10	10	10	.	
4B	DISSOLVED LITHIUM (UG/L)	7	10	10	10	10	.	
4B	MANGANESE (UG/L)	21	3171.9	2600	760	11000		21
4B	DISSOLVED MANGANESE (UG/L)	7	382.1	420	5	800		6
4B	MOLYBDENUM (UG/L)	8	20	20	20	20	.	
4B	DISSOLVED MOLYBDENUM (UG/L)	5	20	20	20	20	.	
4B	NICKEL (UG/L)	6	14.3	15.5	3	23		0
4B	DISSOLVED NICKEL (UG/L)	1	2	2	2	2		0
4B	SELENIUM (UG/L)	12	1	1	1	1		0
4B	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1		0
4B	SILICON (UG/L)	16	7825	7050	3500	13000	.	
4B	DISSOLVED SILICON (UG/L)	6	8116.7	7750	6400	11000	.	
4B	STRONTIUM (UG/L)	19	357.9	360	240	500	.	
4B	DISSOLVED STRONTIUM (UG/L)	7	314.3	280	190	490	.	
4B	VANADIUM (UG/L)	19	10	10	10	10	.	
4B	DISSOLVED VANADIUM (UG/L)	7	10	10	10	10	.	
4B	ZINC (UG/L)	21	46.7	40	10	110		0
4B	DISSOLVED ZINC (UG/L)	7	15.7	10	10	30		0
4B	TOTAL DISSOLVED SOLIDS (MG/L)	21	811	800	590	1200		21
4B	TOTAL SUSPENDED SOLIDS (MG/L)	15	47.2	15	6	420	.	
4B	WATER SURF. FR MP (M)	23	4.1	3.2	1.6	10.1	.	
4B	WATER SURF. ELVN (M, MSL)	11	225.2	224.9	223.4	227.3	.	
4B	WATER SURF. ELVN (FT, MSL)	11	738.9	737.8	732.9	745.7	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 92/09/01

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
5	ORP (MV)	15	91.1	60	20	320	.
5	CONDUCTIVITY (UMHOS/CM)	15	2949.1	3300	386	4530	.
5	DISSOLVED OXYGEN (MG/L)	15	0.4	0.4	0	0.9	.
5	TEMPERATURE (DEG C)	15	17.5	17	14.6	23	.
5	PH (STANDARD UNITS)	15	5.6	5.6	5.3	6.1	15
5	ALKALINITY (MG/L)	13	84.4	80	34	195	.
5	PHEN-PH ALKALINITY (MG/L)	2	0	0	0	0	.
5	ACIDITY (MG/L)	5	1194.4	1500	0	1692	.
5	CO2 ACIDITY (MG/L)	4	1085.3	1090	365	1796	.
5	CO2 (MG/L)	4	1314	1346.5	1074	1489	.
5	CA/MG HARDNESS (MG/L)	15	1079.7	1111	572.9	1352	.
5	NITRATE+NITRITE NITROGEN (MG/L)	10	0.6	0.1	0	3.6	0
5	TOTAL ORGANIC CARBON (MG/L)	14	3.6	3.5	1.1	5.9	.
5	TOTAL INORGANIC CARBON (MG/L)	14	37.7	33	4	130	.
5	SULFIDE (MG/L)	6	0	0	0	0	.
5	CALCIUM (MG/L)	15	285.3	290	180	360	.
5	DISSOLVED CALCIUM (MG/L)	4	285	290	210	350	.
5	MAGNESIUM (MG/L)	15	89.2	95	30	120	.
5	DISSOLVED MAGNESIUM (MG/L)	4	71.8	65.5	46	110	.
5	SODIUM (MG/L)	14	9	9.2	6.5	12	.
5	POTASSIUM (MG/L)	14	6.2	5.7	3.5	12	.
5	CHLORIDE (MG/L)	14	3.4	4	1	6	0
5	SULFATE (MG/L)	15	2189.3	2400	610	3200	15
5	FLUORIDE (MG/L)	10	0.2	0.1	0.1	0.8	0
5	ALUMINUM (UG/L)	15	4657.3	1900	210	22000	15
5	DISSOLVED ALUMINUM (UG/L)	4	50	50	50	50	0
5	ARSENIC (UG/L)	14	6.9	4	2	17	0
5	DISSOLVED ARSENIC (UG/L)	4	7.3	7.5	3	11	0
5	BARIUM (UG/L)	12	305.8	330	50	480	0
5	DISSOLVED BARIUM (UG/L)	4	222.5	190	30	480	0
5	BORON (UG/L)	14	6064.3	4000	500	40000	.
5	DISSOLVED BORON (UG/L)	4	2125	1900	500	4200	.
5	CADMIUM (UG/L)	14	0.4	0.3	0.1	1.3	0
5	DISSOLVED CADMIUM (UG/L)	4	0.3	0.2	0.1	0.6	0
5	CHROMIUM (UG/L)	12	3.4	2.5	1	11	0
5	DISSOLVED CHROMIUM (UG/L)	4	1	1	1	1	0
5	COPPER (UG/L)	15	36	30	10	80	0
5	DISSOLVED COPPER (UG/L)	4	17.5	10	10	40	0
5	IRON - TOTAL (UG/L)	15	896267	1100000	61000	1E+06	15
5	DISSOLVED IRON (UG/L)	4	588000	497500	57000	1E+06	4
5	LEAD (UG/L)	12	7.1	5	1	19	0
5	DISSOLVED LEAD (UG/L)	4	1	1	1	1	0
5	LITHIUM (UG/L)	8	15.5	10	10	40	.
5	DISSOLVED LITHIUM (UG/L)	4	19	13	10	40	.
5	MANGANESE (UG/L)	15	54000	51000	40000	91000	15

Continued

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
5	DISSOLVED MANGANESE (UG/L)	4	67000	66500	44000	91000	4
5	MOLYBDENUM (UG/L)	4	35	20	20	80	.
5	DISSOLVED MOLYBDENUM (UG/L)	4	67.5	20	20	210	.
5	NICKEL (UG/L)	1	33	33	33	33	0
5	SELENIUM (UG/L)	10	1	1	1	1	0
5	SILICON (UG/L)	14	7821.4	4250	2100	36000	.
5	DISSOLVED SILICON (UG/L)	4	10100	10100	4200	16000	.
5	STRONTIUM (UG/L)	12	2094.2	2300	690	2900	.
5	DISSOLVED STRONTIUM (UG/L)	4	1825	1520	660	3600	.
5	VANADIUM (UG/L)	12	103.3	35	10	290	.
5	DISSOLVED VANADIUM (UG/L)	4	60	10	10	210	.
5	ZINC (UG/L)	15	149.3	140	30	310	0
5	DISSOLVED ZINC (UG/L)	4	62.5	40	20	150	0
5	TOTAL DISSOLVED SOLIDS (MG/L)	14	4121.4	4350	1600	5300	14
5	TOTAL SUSPENDED SOLIDS (MG/L)	8	370.3	145	82	1500	.
5	WATER SURF. FR MP (M)	17	4.2	4.6	1.4	6.3	.
5	WATER SURF. ELVN (M, MSL)	10	225.4	225.4	223.9	226.3	.
5	WATER SURF. ELVN (FT, MSL)	10	739.6	739.4	734.7	742.3	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/03/28 to 92/08/20

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
5A	ORP (MV)	9	235.7	266	54	369	.
5A	CONDUCTIVITY (ŨMHOS/CM)	9	774.9	361	300	2310	.
5A	DISSOLVED OXYGEN (MG/L)	9	1.9	1.1	0.4	7	.
5A	TEMPERATURE (DEG C)	9	17.6	17.9	15.9	19.4	.
5A	PH (STANDARD UNITS)	9	5	5.4	3.4	5.7	9
5A	ALKALINITY (MG/L)	6	15.7	13	7	27	.
5A	PHEN-PH ALKALINITY (MG/L)	1	0	0	0	0	.
5A	ACIDITY (MG/L)	6	73.2	77	0	112	.
5A	CO2 ACIDITY (MG/L)	1	85	85	85	85	.
5A	CO2 (MG/L)	5	77.5	70	61	99	.
5A	CA/MG HARDNESS (MG/L)	9	275.8	137	83	979.6	.
5A	NITRATE+NITRITE NITROGEN (MG/L)	6	0	0	0	0.1	0
5A	TOTAL ORGANIC CARBON (MG/L)	7	1.2	0.9	0.3	3.8	.
5A	TOTAL INORGANIC CARBON (MG/L)	7	24.8	12	3.3	98	.
5A	SULFIDE (MG/L)	5	0	0	0	0	.
5A	CALCIUM (MG/L)	9	81.2	35	22	300	.
5A	DISSOLVED CALCIUM (MG/L)	1	40	40	40	40	.
5A	MAGNESIUM (MG/L)	9	17.7	12	6.9	56	.
5A	DISSOLVED MAGNESIUM (MG/L)	1	13	13	13	13	.
5A	SODIUM (MG/L)	7	6.8	6.8	6.4	7.2	.
5A	POTASSIUM (MG/L)	7	1.8	1.8	1.8	1.9	.
5A	CHLORIDE (MG/L)	7	1.7	2	1	2	0
5A	SULFATE (MG/L)	8	343.3	160	96	1700	1
5A	FLUORIDE (MG/L)	6	0.1	0.1	0.1	0.1	0
5A	ALUMINUM (UG/L)	9	29998.9	180	50	250000	2
5A	DISSOLVED ALUMINUM (UG/L)	1	50	50	50	50	0
5A	ARSENIC (UG/L)	7	2.9	2	1	8	0
5A	DISSOLVED ARSENIC (UG/L)	1	2	2	2	2	0
5A	BARIUM (UG/L)	6	78.3	80	60	90	0
5A	DISSOLVED BARIUM (UG/L)	1	50	50	50	50	0
5A	BORON (UG/L)	7	500	500	500	500	.
5A	DISSOLVED BORON (UG/L)	1	500	500	500	500	.
5A	CADMIUM (UG/L)	7	0.6	0.5	0.3	1.2	0
5A	DISSOLVED CADMIUM (UG/L)	1	0.5	0.5	0.5	0.5	0
5A	CHROMIUM (UG/L)	6	2	2	1	3	0
5A	DISSOLVED CHROMIUM (UG/L)	1	1	1	1	1	0
5A	COPPER (UG/L)	9	41.1	10	10	190	0
5A	DISSOLVED COPPER (UG/L)	1	10	10	10	10	0
5A	IRON - TOTAL (UG/L)	9	140156	4800	2300	820000	9
5A	DISSOLVED IRON (UG/L)	1	7500	7500	7500	7500	1
5A	LEAD (UG/L)	6	5.3	5	1	10	0
5A	DISSOLVED LEAD (UG/L)	1	1	1	1	1	0
5A	LITHIUM (UG/L)	5	10	10	10	10	.
5A	DISSOLVED LITHIUM (UG/L)	1	10	10	10	10	.
5A	MANGANESE (UG/L)	9	9566.7	3100	1800	37000	9
5A	DISSOLVED MANGANESE (UG/L)	1	3200	3200	3200	3200	1

Continued

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
5A	MOLYBDENUM (UG/L)	1	20	20	20	20	.
5A	DISSOLVED MOLYBDENUM (UG/L)	1	20	20	20	20	.
5A	SELENIUM (UG/L)	6	1	1	1	1	0
5A	SILICON (UG/L)	7	4742.9	5500	2400	6000	.
5A	DISSOLVED SILICON (UG/L)	1	5200	5200	5200	5200	.
5A	STRONTIUM (UG/L)	6	268.3	270	220	300	.
5A	DISSOLVED STRONTIUM (UG/L)	1	50	50	50	50	.
5A	VANADIUM (UG/L)	6	16.7	10	10	40	.
5A	DISSOLVED VANADIUM (UG/L)	1	10	10	10	10	.
5A	ZINC (UG/L)	9	355.6	90	10	1300	0
5A	DISSOLVED ZINC (UG/L)	1	74	74	74	74	0
5A	TOTAL DISSOLVED SOLIDS (MG/L)	7	250	250	200	360	0
5A	TOTAL SUSPENDED SOLIDS (MG/L)	5	12.4	12	8	16	.
5A	WATER SURF. FR MP (M)	11	5.9	4.3	3	8.7	.
5A	WATER SURF. ELVN (M, MSL)	6	221.6	221.1	219.6	225.3	.
5A	WATER SURF. ELVN (FT, MSL)	6	727	725.5	720.6	739	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 92/09/01

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
5B	ORP (MV)	15	199	200	90	323 .	
5B	CONDUCTIVITY (UMHOS/CM)	15	698	365	290	2180 .	
5B	DISSOLVED OXYGEN (MG/L)	15	0.5	0.3	0	3.3 .	
5B	TEMPERATURE (DEG C)	15	16.7	16.4	14.8	19.2 .	
5B	PH (STANDARD UNITS)	15	5.6	5.6	5.3	5.9	15
5B	ALKALINITY (MG/L)	13	30.2	30	24	42 .	
5B	PHEN-PH ALKALINITY (MG/L)	2	0	0	0	0 .	
5B	ACIDITY (MG/L)	6	65.8	76.5	0	85 .	
5B	CO2 ACIDITY (MG/L)	4	393.3	368.5	75	761 .	
5B	CO2 (MG/L)	5	69.6	69	65.1	74.8 .	
5B	CA/MG HARDNESS (MG/L)	16	278.9	166.5	153	921.7 .	
5B	NITRATE+NITRITE NITROGEN (MG/L)	11	1	0	0	10.3	1
5B	TOTAL ORGANIC CARBON (MG/L)	15	1	0.5	0.2	3.1 .	
5B	TOTAL INORGANIC CARBON (MG/L)	15	32.3	29	10	62 .	
5B	SULFIDE (MG/L)	7	0	0	0	0 .	
5B	CALCIUM (MG/L)	16	79.2	43	40	290 .	
5B	DISSOLVED CALCIUM (MG/L)	4	137	107.5	43	290 .	
5B	MAGNESIUM (MG/L)	16	19.8	14	13	48 .	
5B	DISSOLVED MAGNESIUM (MG/L)	4	27	23	14	48 .	
5B	SODIUM (MG/L)	15	6.3	6.4	5	7.5 .	
5B	POTASSIUM (MG/L)	15	2.3	1.7	1.5	7 .	
5B	CHLORIDE (MG/L)	15	2.3	2	1	4	0
5B	SULFATE (MG/L)	16	410	165	110	1900	4
5B	FLUORIDE (MG/L)	11	0.1	0.1	0.1	0.3	0
5B	ALUMINUM (UG/L)	16	9607.5	510	50	74000	12
5B	DISSOLVED ALUMINUM (UG/L)	4	90	80	50	150	0
5B	ARSENIC (UG/L)	15	4.9	1	1	47	0
5B	DISSOLVED ARSENIC (UG/L)	4	1.3	1	1	2	0
5B	BARIUM (UG/L)	13	90	70	50	300	0
5B	DISSOLVED BARIUM (UG/L)	4	50	40	30	90	0
5B	BORON (UG/L)	15	606.7	500	500	1500 .	
5B	DISSOLVED BORON (UG/L)	4	655	560	500	1000 .	
5B	CADMIUM (UG/L)	15	0.3	0.2	0.1	1	0
5B	DISSOLVED CADMIUM (UG/L)	4	0.3	0.1	0.1	0.7	0
5B	CHROMIUM (UG/L)	13	8.8	1	1	52	0
5B	DISSOLVED CHROMIUM (UG/L)	4	1	1	1	1	0
5B	COPPER (UG/L)	16	75.6	10	10	1000	0
5B	DISSOLVED COPPER (UG/L)	4	12.5	10	10	20	0
5B	IRON - TOTAL (UG/L)	16	89753.8	1850	660	600000	16
5B	DISSOLVED IRON (UG/L)	4	125128	125170	170	250000	3
5B	LEAD (UG/L)	13	6.2	2	1	35	0
5B	DISSOLVED LEAD (UG/L)	4	1	1	1	1	0
5B	LITHIUM (UG/L)	9	11.6	10	10	20 .	
5B	DISSOLVED LITHIUM (UG/L)	4	10	10	10	10 .	

Continued

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
5B	MANGANESE (UG/L)	16	5487.5	1550	310	29000	16
5B	DISSOLVED MANGANESE (UG/L)	4	10050	9100	2000	20000	4
5B	MOLYBDENUM (UG/L)	4	20	20	20	20	.
5B	DISSOLVED MOLYBDENUM (UG/L)	4	20	20	20	20	.
5B	NICKEL (UG/L)	1	12	12	12	12	0
5B	SELENIUM (UG/L)	11	1	1	1	1	0
5B	SILICON (UG/L)	15	11466.7	8000	4100	43000	.
5B	DISSOLVED SILICON (UG/L)	4	7750	8450	5400	8700	.
5B	STRONTIUM (UG/L)	13	426.2	290	230	1400	.
5B	DISSOLVED STRONTIUM (UG/L)	4	600	475	50	1400	.
5B	VANADIUM (UG/L)	13	22.3	10	10	80	.
5B	DISSOLVED VANADIUM (UG/L)	4	10	10	10	10	.
5B	ZINC (UG/L)	16	74.4	30	10	260	0
5B	DISSOLVED ZINC (UG/L)	4	42.5	40	10	80	0
5B	TOTAL DISSOLVED SOLIDS (MG/L)	15	535.3	260	180	2400	2
5B	TOTAL SUSPENDED SOLIDS (MG/L)	9	448.6	16	4	2100	.
5B	WATER SURF. FR MP (M)	18	3.7	3.8	2.2	6.1	.
5B	WATER SURF. ELVN (M, MSL)	11	225.5	225.9	223.1	227	.
5B	WATER SURF. ELVN (FT, MSL)	11	739.7	741	731.9	744.7	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
6A	ORP (MV)	17	77.2	20	-27	429	.
6A	CONDUCTIVITY (UMHOS/CM)	17	3274.8	3680	428	4330	.
6A	DISSOLVED OXYGEN (MG/L)	17	0.5	0.4	0	1.7	.
6A	TEMPERATURE (DEG C)	17	17.7	17.2	14.9	24.4	.
6A	COD (MG/L)	1	56	56	56	56	.
6A	PH (STANDARD UNITS)	17	5.5	5.8	3.1	6	17
6A	ALKALINITY (MG/L)	15	181.9	191	58	250	.
6A	PHEN-PH ALKALINITY (MG/L)	5	0	0	0	0	.
6A	ACIDITY (MG/L)	6	1514.3	1935	0	2600	.
6A	CO2 ACIDITY (MG/L)	7	1532.6	1586	584	2184	.
6A	CO2 (MG/L)	4	1912.8	1911.5	1540	2288	.
6A	CA/MG HARDNESS (MG/L)	17	1152.2	1161.8	855	1335	.
6A	NITRATE+NITRITE NITROGEN (MG/L)	10	0.1	0.1	0	0.2	0
6A	TOTAL ORGANIC CARBON (MG/L)	17	9	9.1	2.9	19	.
6A	TOTAL INORGANIC CARBON (MG/L)	17	80.9	65	4	260	.
6A	SULFIDE (MG/L)	6	0	0	0	0	.
6A	CALCIUM (MG/L)	17	332.4	340	260	390	.
6A	DISSOLVED CALCIUM (MG/L)	2	350	350	320	380	.
6A	MAGNESIUM (MG/L)	17	78.3	83	31	110	.
6A	DISSOLVED MAGNESIUM (MG/L)	2	74.5	74.5	64	85	.
6A	SODIUM (MG/L)	17	8.4	8.2	7.6	9.7	.
6A	POTASSIUM (MG/L)	17	17.2	17	13	26	.
6A	CHLORIDE (MG/L)	17	3.6	4	1	6	0
6A	SULFATE (MG/L)	17	2513.5	2800	630	3700	17
6A	FLUORIDE (MG/L)	10	0.2	0.1	0.1	0.8	0
6A	ALUMINUM (UG/L)	17	2017.6	890	50	10000	15
6A	DISSOLVED ALUMINUM (UG/L)	8	356.3	50	50	2500	1
6A	ANTIMONY (UG/L)	5	1.6	1	1	4	0
6A	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
6A	ARSENIC (UG/L)	17	4.6	4	1	13	0
6A	DISSOLVED ARSENIC (UG/L)	8	2.3	2.5	1	4	0
6A	BARIUM (UG/L)	15	284.7	310	30	630	0
6A	DISSOLVED BARIUM (UG/L)	8	351.3	370	40	470	0
6A	BERYLLIUM (UG/L)	5	1	1	1	1	0
6A	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
6A	BORON (UG/L)	17	5176.5	3500	500	42000	.
6A	DISSOLVED BORON (UG/L)	8	3737.5	3650	2200	5000	.
6A	CADMIUM (UG/L)	16	0.5	0.5	0.1	1.9	0
6A	DISSOLVED CADMIUM (UG/L)	8	1	0.5	0.1	3	0
6A	CHROMIUM (UG/L)	14	4	3.5	1	13	0
6A	DISSOLVED CHROMIUM (UG/L)	8	4.3	3	1	14	0
6A	COPPER (UG/L)	17	34.7	30	10	70	0
6A	DISSOLVED COPPER (UG/L)	2	10	10	10	10	0
6A	IRON - TOTAL (UG/L)	17	1007177	1200000	92000	2E+06	17
6A	DISSOLVED IRON (UG/L)	8	1055000	1050000	120000	2E+06	8

Continued

6A	LEAD (UG/L)	15	5.7	2	1	37		0
6A	DISSOLVED LEAD (UG/L)	8	2.5	1	1	12		0
6A	LITHIUM (UG/L)	10	43.1	50	21	60	.	
6A	DISSOLVED LITHIUM (UG/L)	2	45	45	40	50	.	
6A	MANGANESE (UG/L)	17	61282.4	71000	7800	86000		17
6A	DISSOLVED MANGANESE (UG/L)	8	65375	64500	59000	73000		8
6A	MOLYBDENUM (UG/L)	6	43.3	20	20	160	.	
6A	DISSOLVED MOLYBDENUM (UG/L)	2	60	60	20	100	.	
6A	NICKEL (UG/L)	6	4.5	3	1	12		0
6A	DISSOLVED NICKEL (UG/L)	1	5	5	5	5		0
6A	SELENIUM (UG/L)	11	1	1	1	1		0
6A	DISSOLVED SELENIUM (UG/L)	6	1.2	1	1	2		0
6A	SILICON (UG/L)	12	13808.3	12000	5100	42000	.	
6A	DISSOLVED SILICON (UG/L)	7	9014.3	9600	5300	11000	.	
6A	STRONTIUM (UG/L)	15	2200	2000	1100	3700	.	
6A	DISSOLVED STRONTIUM (UG/L)	8	2025	2000	1400	2900	.	
6A	VANADIUM (UG/L)	15	58	10	10	310	.	
6A	DISSOLVED VANADIUM (UG/L)	8	77.5	45	10	200	.	
6A	ZINC (UG/L)	17	141.2	140	10	260		0
6A	DISSOLVED ZINC (UG/L)	8	153.5	150	18	280		0
6A	TOTAL DISSOLVED SOLIDS (MG/L)	17	4452.9	4900	1500	5500		17
6A	TOTAL SUSPENDED SOLIDS (MG/L)	11	188.7	170	63	470	.	
6A	WATER SURF. FR MP (M)	19	3.3	3.1	2.3	5.8	.	
6A	WATER SURF. ELVN (M, MSL)	10	225.6	225.9	222.3	227	.	
6A	WATER SURF. ELVN (FT, MSL)	10	740.1	741	729.2	744.7	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 89/03/29.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
6B	ORP (MV)	2	210	210	140	280	.
6B	CONDUCTIVITY (UMHOS/CM)	2	2030	2030	2020	2040	.
6B	DISSOLVED OXYGEN (MG/L)	2	0.2	0.2	0	0.4	.
6B	TEMPERATURE (DEG C)	2	15.5	15.5	14	17	.
6B	PH (STANDARD UNITS)	2	5.2	5.2	5.1	5.3	2
6B	ALKALINITY (MG/L)	1	17	17	17	17	.
6B	CA/MG HARDNESS (MG/L)	2	1366	1366	1343	1389	.
6B	NITRATE+NITRITE NITROGEN (MG/L)	2	0.1	0.1	0	0.1	0
6B	TOTAL ORGANIC CARBON (MG/L)	2	3.1	3.1	3	3.2	.
6B	TOTAL INORGANIC CARBON (MG/L)	2	4.6	4.6	4.5	4.8	.
6B	CALCIUM (MG/L)	2	495	495	480	510	.
6B	MAGNESIUM (MG/L)	2	31.5	31.5	28	35	.
6B	SODIUM (MG/L)	2	8.3	8.3	7.5	9.1	.
6B	POTASSIUM (MG/L)	2	33.5	33.5	33	34	.
6B	CHLORIDE (MG/L)	2	3.5	3.5	3	4	0
6B	SULFATE (MG/L)	2	915	915	730	1100	2
6B	FLUORIDE (MG/L)	2	0.2	0.2	0.1	0.3	0
6B	ALUMINUM (UG/L)	2	21000	21000	12000	30000	2
6B	ARSENIC (UG/L)	2	70	70	40	100	1
6B	BARIUM (UG/L)	2	215	215	180	250	0
6B	BORON (UG/L)	2	1700	1700	1600	1800	.
6B	CADMIUM (UG/L)	2	0.2	0.2	0.1	0.3	0
6B	CHROMIUM (UG/L)	2	15	15	8	22	0
6B	COPPER (UG/L)	2	15	15	10	20	0
6B	IRON - TOTAL (UG/L)	2	150000	150000	110000	190000	2
6B	LEAD (UG/L)	2	25	25	20	30	0
6B	MANGANESE (UG/L)	2	6500	6500	5900	7100	2
6B	SELENIUM (UG/L)	2	1.5	1.5	1	2	0
6B	SILICON (UG/L)	2	50500	50500	45000	56000	.
6B	STRONTIUM (UG/L)	2	3000	3000	3000	3000	.
6B	VANADIUM (UG/L)	2	60	60	20	100	.
6B	ZINC (UG/L)	2	100	100	60	140	0
6B	TOTAL DISSOLVED SOLIDS (MG/L)	2	2100	2100	1900	2300	2
6B	WATER SURF. FR MP (M)	4	0.8	0.8	0.6	0.9	.
6B	WATER SURF. ELVN (M, MSL)	2	228.2	228.2	228.2	228.3	.
6B	WATER SURF. ELVN (FT, MSL)	2	748.9	748.9	748.8	748.9	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 94/12/06.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
8	ORP (MV)	19	117.9	50	-56	372 .	
8	CONDUCTIVITY (UMHOS/CM)	19	1300.1	1293	1020	1680 .	
8	DISSOLVED OXYGEN (MG/L)	19	0.8	0.6	0.3	1.8 .	
8	TEMPERATURE (DEG C)	19	17.7	17.4	15.6	20 .	
8	PH (STANDARD UNITS)	19	7	7	6.8	7.1	0
8	ALKALINITY (MG/L)	18	257	260	211	296 .	
8	PHEN-PH ALKALINITY (MG/L)	4	0	0	0	0 .	
8	ACIDITY (MG/L)	8	39.6	43	0	60 .	
8	CO2 ACIDITY (MG/L)	7	46.1	47	35	55 .	
8	CO2 (MG/L)	8	38.2	37.8	22	53 .	
8	CA/MG HARDNESS (MG/L)	20	803.6	784.8	581	1067.1 .	
8	NITRATE+NITRITE NITROGEN (MG/L)	12	0	0	0	0	0
8	TOTAL ORGANIC CARBON (MG/L)	19	0.9	0.8	0.4	1.8 .	
8	TOTAL INORGANIC CARBON (MG/L)	20	94.7	81	42	290 .	
8	SULFIDE (MG/L)	8	0	0	0	0 .	
8	CALCIUM (MG/L)	20	253.5	250	180	340 .	
8	DISSOLVED CALCIUM (MG/L)	3	316.7	310	300	340 .	
8	MAGNESIUM (MG/L)	20	41.5	39.5	26	56 .	
8	DISSOLVED MAGNESIUM (MG/L)	3	54	54	53	55 .	
8	SODIUM (MG/L)	20	13.5	13.5	12	16 .	
8	POTASSIUM (MG/L)	20	4.5	4.5	3.8	5.4 .	
8	CHLORIDE (MG/L)	20	5.8	6	4	9	0
8	SULFATE (MG/L)	19	581.1	480	300	1700	19
8	FLUORIDE (MG/L)	12	0.1	0.1	0.1	0.5	0
8	ALUMINUM (UG/L)	20	1323	350	50	15000	12
8	DISSOLVED ALUMINUM (UG/L)	3	50	50	50	50	0
8	ANTIMONY (UG/L)	6	1.2	1	1	2	0
8	ARSENIC (UG/L)	20	3	1	1	12	0
8	DISSOLVED ARSENIC (UG/L)	3	5.7	2	2	13	0
8	BARIUM (UG/L)	18	35.6	10	10	250	0
8	DISSOLVED BARIUM (UG/L)	3	26.7	30	10	40	0
8	BERYLLIUM (UG/L)	6	1	1	1	1	0
8	BORON (UG/L)	20	500	500	500	500 .	
8	DISSOLVED BORON (UG/L)	3	500	500	500	500 .	
8	CADMIUM (UG/L)	19	0.2	0.1	0.1	0.6	0
8	DISSOLVED CADMIUM (UG/L)	3	0.9	0.6	0.5	1.5	0
8	CHROMIUM (UG/L)	17	2.7	2	1	13	0
8	DISSOLVED CHROMIUM (UG/L)	3	1	1	1	1	0
8	COPPER (UG/L)	20	11.5	10	10	20	0
8	DISSOLVED COPPER (UG/L)	3	13.3	10	10	20	0
8	IRON - TOTAL (UG/L)	20	2413	1300	290	21000	19
8	DISSOLVED IRON (UG/L)	3	373.3	220	10	890	1
8	LEAD (UG/L)	18	6.4	2	1	41	0
8	DISSOLVED LEAD (UG/L)	3	1	1	1	1	0

Continued

8	LITHIUM (UG/L)	13	34.3	40	20	40	.	
8	DISSOLVED LITHIUM (UG/L)	3	33.3	30	30	40	.	
8	MANGANESE (UG/L)	20	1321	1150	220	2500		20
8	DISSOLVED MANGANESE (UG/L)	3	1800	2000	1300	2100		3
8	MOLYBDENUM (UG/L)	7	20	20	20	20	.	
8	DISSOLVED MOLYBDENUM (UG/L)	1	20	20	20	20	.	
8	NICKEL (UG/L)	6	2	1.5	1	5		0
8	SELENIUM (UG/L)	13	1.2	1	1	2		0
8	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1		0
8	SILICON (UG/L)	14	13142.9	12000	6200	34000	.	
8	DISSOLVED SILICON (UG/L)	3	12000	12000	11000	13000	.	
8	STRONTIUM (UG/L)	18	823.3	815	650	1000	.	
8	DISSOLVED STRONTIUM (UG/L)	3	860	860	840	880	.	
8	VANADIUM (UG/L)	18	11.7	10	10	30	.	
8	DISSOLVED VANADIUM (UG/L)	3	10	10	10	10	.	
8	ZINC (UG/L)	20	24	10	10	60		0
8	DISSOLVED ZINC (UG/L)	3	10	10	10	10		0
8	TOTAL DISSOLVED SOLIDS (MG/L)	20	1041.5	1100	580	1400		20
8	TOTAL SUSPENDED SOLIDS (MG/L)	14	43	11	2	360	.	
8	WATER SURF. FR MP (M)	21	3.3	2.5	2.1	7	.	
8	WATER SURF. ELVN (M, MSL)	12	230.5	231.7	225.6	232.9	.	
8	WATER SURF. ELVN (FT, MSL)	12	756.1	760	740.1	764	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/05 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
9A	ORP (MV)	18	-6.8	-40	-93	207	.
9A	CONDUCTIVITY (UMHOS/CM)	18	1346.6	1180.5	840	2273	.
9A	DISSOLVED OXYGEN (MG/L)	18	0.3	0.3	0.1	0.5	.
9A	TEMPERATURE (DEG C)	18	18.1	18.1	16.4	19.9	.
9A	5-DAY BOD (MG/L)	7	3.5	3.8	2.3	4.1	.
9A	PH (STANDARD UNITS)	18	6.3	6.2	5.8	6.7	13
9A	ALKALINITY (MG/L)	18	73.4	74	40	103	.
9A	PHEN-PH ALKALINITY (MG/L)	3	0	0	0	0	.
9A	ACIDITY (MG/L)	10	135.7	139	83	188	.
9A	CO2 ACIDITY (MG/L)	7	277.6	190	151	840	.
9A	CO2 (MG/L)	8	123.4	122.3	96	165	.
9A	CA/MG HARDNESS (MG/L)	18	734.1	627	373	1531.4	.
9A	NITRATE+NITRITE NITROGEN (MG/L)	12	0.1	0.1	0	0.5	0
9A	AMMONIA NITROGEN (MG/L)	7	0.2	0.2	0	0.3	.
9A	TOTAL KJELDAHL NITROGEN (MG/L)	8	0.4	0.3	0.2	0.9	.
9A	TOTAL ORTHO PHOSPHORUS (MG/L)	4	0.1	0.1	0	0.1	.
9A	TOTAL ORGANIC CARBON (MG/L)	17	0.8	0.6	0.3	2.4	.
9A	TOTAL INORGANIC CARBON (MG/L)	18	42.9	41.5	7	140	.
9A	SULFIDE (MG/L)	8	0	0	0	0.1	.
9A	CALCIUM (MG/L)	18	221.1	190	110	460	.
9A	DISSOLVED CALCIUM (MG/L)	3	226.7	220	210	250	.
9A	MAGNESIUM (MG/L)	18	44.2	37	24	93	.
9A	DISSOLVED MAGNESIUM (MG/L)	3	42.3	44	32	51	.
9A	SODIUM (MG/L)	18	14	14	9.1	18	.
9A	POTASSIUM (MG/L)	18	11.2	9.3	6.8	35	.
9A	CHLORIDE (MG/L)	17	11.6	9	3	26	0
9A	SULFATE (MG/L)	18	798.9	615	400	2000	18
9A	FLUORIDE (MG/L)	12	0.2	0.2	0.1	0.4	0
9A	ALUMINUM (UG/L)	18	4375	2250	950	25000	18
9A	DISSOLVED ALUMINUM (UG/L)	3	60	50	50	80	0
9A	ANTIMONY (UG/L)	4	1	1	1	1	0
9A	DISSOLVED ANTIMONY (UG/L)	1	5	5	5	5	0
9A	ARSENIC (UG/L)	18	104.8	92.5	34	190	17
9A	DISSOLVED ARSENIC (UG/L)	3	61.3	87	1	96	2
9A	BARIUM (UG/L)	16	111.3	105	10	310	0
9A	DISSOLVED BARIUM (UG/L)	3	130	170	30	190	0
9A	BERYLLIUM (UG/L)	4	2.3	1	1	6	1
9A	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
9A	BORON (UG/L)	18	2161.1	1500	1000	13000	.
9A	DISSOLVED BORON (UG/L)	3	1433.3	1400	1400	1500	.
9A	CADMIUM (UG/L)	17	0.3	0.2	0.1	1	0
9A	DISSOLVED CADMIUM (UG/L)	3	0.8	0.8	0.1	1.4	0
9A	CHROMIUM (UG/L)	15	4.5	3	1	18	0
9A	DISSOLVED CHROMIUM (UG/L)	3	1	1	1	1	0

Continued

9A	COPPER (UG/L)	18	32.2	10	10	260		0
9A	DISSOLVED COPPER (UG/L)	3	93.3	10	10	260		0
9A	IRON - TOTAL (UG/L)	18	40833.3	37500	20000	79000		18
9A	DISSOLVED IRON (UG/L)	3	38000	38000	35000	41000		3
9A	LEAD (UG/L)	16	2.8	1	1	17		0
9A	DISSOLVED LEAD (UG/L)	3	1	1	1	1		0
9A	LITHIUM (UG/L)	11	35.4	30	19	60	.	
9A	DISSOLVED LITHIUM (UG/L)	3	36.7	30	30	50	.	
9A	MANGANESE (UG/L)	18	26044.4	20500	9800	69000		18
9A	DISSOLVED MANGANESE (UG/L)	3	27666.7	26000	25000	32000		3
9A	MOLYBDENUM (UG/L)	5	20	20	20	20	.	
9A	DISSOLVED MOLYBDENUM (UG/L)	1	20	20	20	20	.	
9A	NICKEL (UG/L)	4	52	48.5	43	68		0
9A	DISSOLVED NICKEL (UG/L)	1	35	35	35	35		0
9A	SELENIUM (UG/L)	13	1.2	1	1	3		0
9A	DISSOLVED SELENIUM (UG/L)	1	1	1	1	1		0
9A	SILICON (UG/L)	14	16042.9	15000	6800	38000	.	
9A	DISSOLVED SILICON (UG/L)	2	11500	11500	11000	12000	.	
9A	STRONTIUM (UG/L)	16	2593.8	2150	1700	4200	.	
9A	DISSOLVED STRONTIUM (UG/L)	3	2500	2500	2100	2900	.	
9A	VANADIUM (UG/L)	16	25	10	10	110	.	
9A	DISSOLVED VANADIUM (UG/L)	3	43.3	10	10	110	.	
9A	ZINC (UG/L)	18	52.2	50	10	120		0
9A	DISSOLVED ZINC (UG/L)	3	50	30	20	100		0
9A	TOTAL DISSOLVED SOLIDS (MG/L)	18	1157.8	965	670	2100		18
9A	TOTAL SUSPENDED SOLIDS (MG/L)	15	162.9	100	24	790	.	
9A	FECAL COLIFORM (#/100ML)	3	7	10	1	10	.	
9A	WATER SURF. FR MP (M)	20	5.2	5.1	4.5	6.9	.	
9A	WATER SURF. ELVN (M, MSL)	13	229	230.1	222.2	230.8	.	
9A	WATER SURF. ELVN (FT, MSL)	13	751.3	754.9	729.1	757	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/05 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
9B	ORP (MV)	18	-33.3	-85.5	-190	454	.
9B	CONDUCTIVITY (UMHOS/CM)	18	453.4	455	380	534	.
9B	DISSOLVED OXYGEN (MG/L)	18	0.4	0.3	0.2	0.8	.
9B	TEMPERATURE (DEG C)	18	17.9	18	16.2	19.5	.
9B	5-DAY BOD (MG/L)	7	1	1	1	1.1	.
9B	PH (STANDARD UNITS)	18	8.2	8	7.8	9.1	5
9B	ALKALINITY (MG/L)	17	171.8	170	155	192	.
9B	PHEN-PH ALKALINITY (MG/L)	2	0	0	0	0	.
9B	ACIDITY (MG/L)	9	1.6	0.2	0	7	.
9B	CO2 ACIDITY (MG/L)	5	3.4	3	1	8	.
9B	CO2 (MG/L)	4	2.9	2.6	0	6.2	.
9B	CA/MG HARDNESS (MG/L)	17	105.1	110.8	61	145.7	.
9B	NITRATE+NITRITE NITROGEN (MG/L)	11	0	0	0	0.1	0
9B	AMMONIA NITROGEN (MG/L)	6	0.1	0.1	0	0.1	.
9B	TOTAL KJELDAHL NITROGEN (MG/L)	7	0.1	0.1	0.1	0.2	.
9B	TOTAL ORTHO PHOSPHORUS (MG/L)	4	0.1	0	0	0.2	.
9B	TOTAL ORGANIC CARBON (MG/L)	16	0.6	0.4	0.2	2.7	.
9B	TOTAL INORGANIC CARBON (MG/L)	17	68.8	57	11	160	.
9B	SULFIDE (MG/L)	7	0	0	0	0	.
9B	CALCIUM (MG/L)	17	31.1	33	16	44	.
9B	DISSOLVED CALCIUM (MG/L)	1	35	35	35	35	.
9B	MAGNESIUM (MG/L)	17	6.7	7.2	4	8.7	.
9B	DISSOLVED MAGNESIUM (MG/L)	1	6.5	6.5	6.5	6.5	.
9B	SODIUM (MG/L)	17	59.8	62	5.7	78	.
9B	POTASSIUM (MG/L)	17	6.4	5.4	3.4	13	.
9B	CHLORIDE (MG/L)	17	3.5	3	1	12	0
9B	SULFATE (MG/L)	17	147.3	74	18	650	3
9B	FLUORIDE (MG/L)	11	0.2	0.2	0.1	0.4	0
9B	ALUMINUM (UG/L)	17	235.3	50	50	1500	3
9B	DISSOLVED ALUMINUM (UG/L)	1	50	50	50	50	0
9B	ANTIMONY (UG/L)	4	1	1	1	1	0
9B	ARSENIC (UG/L)	17	1.9	1	1	5	0
9B	DISSOLVED ARSENIC (UG/L)	1	2	2	2	2	0
9B	BARIUM (UG/L)	15	293.3	280	220	380	0
9B	DISSOLVED BARIUM (UG/L)	1	310	310	310	310	0
9B	BERYLLIUM (UG/L)	4	1	1	1	1	0
9B	BORON (UG/L)	17	558.8	500	500	1500	.
9B	DISSOLVED BORON (UG/L)	1	500	500	500	500	.
9B	CADMIUM (UG/L)	16	0.2	0.1	0.1	0.5	0
9B	DISSOLVED CADMIUM (UG/L)	1	1.4	1.4	1.4	1.4	0
9B	CHROMIUM (UG/L)	14	1.8	1	1	6	0
9B	DISSOLVED CHROMIUM (UG/L)	1	1	1	1	1	0
9B	COPPER (UG/L)	17	18.2	10	10	110	0
9B	DISSOLVED COPPER (UG/L)	1	10	10	10	10	0

Continued

9B	IRON - TOTAL (UG/L)	17	319.4	190	70	2000	3
9B	DISSOLVED IRON (UG/L)	1	100	100	100	100	0
9B	LEAD (UG/L)	15	1.1	1	1	3	0
9B	DISSOLVED LEAD (UG/L)	1	1	1	1	1	0
9B	LITHIUM (UG/L)	10	38.5	40	25	50	.
9B	DISSOLVED LITHIUM (UG/L)	1	40	40	40	40	.
9B	MANGANESE (UG/L)	17	75.3	90	5	130	11
9B	DISSOLVED MANGANESE (UG/L)	1	69	69	69	69	1
9B	MOLYBDENUM (UG/L)	5	22	20	20	30	.
9B	NICKEL (UG/L)	4	2	1.5	1	4	0
9B	SELENIUM (UG/L)	12	1	1	1	1	0
9B	DISSOLVED SELENIUM (UG/L)	1	1	1	1	1	0
9B	SILICON (UG/L)	13	7292.3	8000	3800	8800	.
9B	DISSOLVED SILICON (UG/L)	1	8500	8500	8500	8500	.
9B	STRONTIUM (UG/L)	15	506.7	520	320	670	.
9B	DISSOLVED STRONTIUM (UG/L)	1	480	480	480	480	.
9B	VANADIUM (UG/L)	15	11.3	10	10	30	.
9B	DISSOLVED VANADIUM (UG/L)	1	10	10	10	10	.
9B	ZINC (UG/L)	17	21.2	10	10	150	0
9B	DISSOLVED ZINC (UG/L)	1	10	10	10	10	0
9B	TOTAL DISSOLVED SOLIDS (MG/L)	17	273.5	290	80	360	0
9B	TOTAL SUSPENDED SOLIDS (MG/L)	14	2.1	1	1	6	.
9B	FECAL COLIFORM (#/100ML)	3	7	10	1	10	.
9B	WATER SURF. FR MP (M)	19	5.1	5.1	4.5	5.9	.
9B	WATER SURF. ELVN (M, MSL)	13	228.3	230	217.2	230.6	.
9B	WATER SURF. ELVN (FT, MSL)	13	749.2	754.6	712.6	756.6	.

Table 1. Kingston Groundwater Quality Summary. Data from 92/12/08 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
CYDB	ORP (MV)	5	450.6	385	346	636	.
CYDB	CONDUCTIVITY (ÜMHOS/CM)	5	1011.6	1088	289	1402	.
CYDB	DISSOLVED OXYGEN (MG/L)	5	7	7.2	4	9.3	.
CYDB	TEMPERATURE (DEG C)	5	16	12.3	4.2	29.1	.
CYDB	PH (STANDARD UNITS)	5	3.8	3.4	2.8	4.8	5
CYDB	ALKALINITY (MG/L)	5	0.6	0	0	2	.
CYDB	PHEN-PH ALKALINITY (MG/L)	3	0	0	0	0	.
CYDB	CO2 ACIDITY (MG/L)	5	152.2	149	22	300	.
CYDB	CA/MG HARDNESS (MG/L)	5	380.8	377.6	119.6	610	.
CYDB	TOTAL ORGANIC CARBON (MG/L)	4	1.3	1.2	0.9	1.8	.
CYDB	TOTAL INORGANIC CARBON (MG/L)	5	3.2	2	1	6	.
CYDB	CALCIUM (MG/L)	5	111.4	110	37	180	.
CYDB	DISSOLVED CALCIUM (MG/L)	2	108.5	108.5	37	180	.
CYDB	MAGNESIUM (MG/L)	5	24.9	25	6.6	39	.
CYDB	DISSOLVED MAGNESIUM (MG/L)	2	22.8	22.8	6.6	39	.
CYDB	SODIUM (MG/L)	5	19.6	13	3	45	.
CYDB	POTASSIUM (MG/L)	5	3.2	3.1	1.5	5.7	.
CYDB	CHLORIDE (MG/L)	5	4	2	2	9	0
CYDB	SULFATE (MG/L)	5	474	470	130	800	4
CYDB	ALUMINUM (UG/L)	5	11860	9900	2000	25000	5
CYDB	DISSOLVED ALUMINUM (UG/L)	2	5450	5450	2000	8900	2
CYDB	ANTIMONY (UG/L)	5	1.2	1	1	2	0
CYDB	DISSOLVED ANTIMONY (UG/L)	2	1	1	1	1	0
CYDB	ARSENIC (UG/L)	5	1.2	1	1	2	0
CYDB	DISSOLVED ARSENIC (UG/L)	2	1	1	1	1	0
CYDB	BARIUM (UG/L)	5	16	20	10	20	0
CYDB	DISSOLVED BARIUM (UG/L)	2	10	10	10	10	0
CYDB	BERYLLIUM (UG/L)	5	2.2	1	1	5	1
CYDB	DISSOLVED BERYLLIUM (UG/L)	2	1	1	1	1	0
CYDB	BORON (UG/L)	5	500	500	500	500	.
CYDB	DISSOLVED BORON (UG/L)	2	500	500	500	500	.
CYDB	CADMIUM (UG/L)	4	1.6	1.4	0.3	3.1	0
CYDB	DISSOLVED CADMIUM (UG/L)	2	0.9	0.9	0.3	1.5	0
CYDB	CHROMIUM (UG/L)	4	3.5	1	1	11	0
CYDB	DISSOLVED CHROMIUM (UG/L)	2	1	1	1	1	0
CYDB	COPPER (UG/L)	5	60	70	10	120	0
CYDB	DISSOLVED COPPER (UG/L)	2	15	15	10	20	0
CYDB	IRON - TOTAL (UG/L)	5	16500	13000	1000	40000	5
CYDB	DISSOLVED IRON (UG/L)	2	20440	20440	880	40000	2
CYDB	LEAD (UG/L)	5	1.4	1	1	3	0
CYDB	DISSOLVED LEAD (UG/L)	2	1	1	1	1	0
CYDB	LITHIUM (UG/L)	4	45	50	10	70	.
CYDB	DISSOLVED LITHIUM (UG/L)	2	35	35	10	60	.
CYDB	MANGANESE (UG/L)	5	3318	3200	590	5800	5
CYDB	DISSOLVED MANGANESE (UG/L)	2	3095	3095	590	5600	2
CYDB	MOLYBDENUM (UG/L)	4	20	20	20	20	.

Continued

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
CYDB	DISSOLVED MOLYBDENUM (UG/L)	2	20	20	20	20	.
CYDB	NICKEL (UG/L)	5	126.2	130	21	210	4
CYDB	DISSOLVED NICKEL (UG/L)	2	79.5	79.5	19	140	1
CYDB	STRONTIUM (UG/L)	5	434	400	130	740	.
CYDB	DISSOLVED STRONTIUM (UG/L)	2	435	435	140	730	.
CYDB	VANADIUM (UG/L)	5	10	10	10	10	.
CYDB	DISSOLVED VANADIUM (UG/L)	2	10	10	10	10	.
CYDB	ZINC (UG/L)	5	224	250	10	470	0
CYDB	DISSOLVED ZINC (UG/L)	2	155	155	60	250	0
CYDB	TOTAL DISSOLVED SOLIDS (MG/L)	5	638	600	190	1200	3
CYDB	TOTAL SUSPENDED SOLIDS (MG/L)	5	6	5	2	16	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/04.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
10	ORP (MV)	20	-45.7	-61.5	-102	128	.
10	CONDUCTIVITY (UMHOS/CM)	20	716.3	593	220	1190	.
10	DISSOLVED OXYGEN (MG/L)	20	0.2	0.2	0.1	0.5	.
10	TEMPERATURE (DEG C)	20	20.1	20.1	16.5	24	.
10	PH (STANDARD UNITS)	20	6.7	6.7	6.5	7	0
10	ALKALINITY (MG/L)	20	90.7	85.5	55	135	.
10	PHEN-PH ALKALINITY (MG/L)	4	0	0	0	0	.
10	ACIDITY (MG/L)	9	77.6	67	0	132	.
10	CO2 ACIDITY (MG/L)	8	35.5	32.5	23	56	.
10	CO2 (MG/L)	7	73.8	59	37.8	116	.
10	CA/MG HARDNESS (MG/L)	21	343.9	245	169.9	706	.
10	NITRATE+NITRITE NITROGEN (MG/L)	12	0.1	0	0	0.5	0
10	TOTAL ORGANIC CARBON (MG/L)	20	0.6	0.5	0.2	2	.
10	TOTAL INORGANIC CARBON (MG/L)	21	34.1	32	4	68	.
10	SULFIDE (MG/L)	8	0	0	0	0	.
10	CALCIUM (MG/L)	21	112.6	80	55	230	.
10	DISSOLVED CALCIUM (MG/L)	7	72.1	71	55	100	.
10	MAGNESIUM (MG/L)	21	15.2	11	7.9	32	.
10	DISSOLVED MAGNESIUM (MG/L)	7	9	9	7.9	9.9	.
10	SODIUM (MG/L)	21	9.6	10	6.2	13	.
10	POTASSIUM (MG/L)	21	7.6	7.3	6.4	9.4	.
10	CHLORIDE (MG/L)	21	4.1	4	2	7	0
10	SULFATE (MG/L)	21	306.2	230	90	730	9
10	FLUORIDE (MG/L)	12	0.5	0.5	0.1	1	0
10	ALUMINUM (UG/L)	21	1492.9	1800	50	3400	14
10	DISSOLVED ALUMINUM (UG/L)	7	50	50	50	50	0
10	ANTIMONY (UG/L)	5	1.2	1	1	2	0
10	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
10	ARSENIC (UG/L)	21	211.1	210	170	280	21
10	DISSOLVED ARSENIC (UG/L)	7	177.1	170	150	200	7
10	BARIUM (UG/L)	19	71.6	70	20	150	0
10	DISSOLVED BARIUM (UG/L)	7	35.7	30	20	60	0
10	BERYLLIUM (UG/L)	5	1	1	1	1	0
10	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
10	BORON (UG/L)	21	720.5	500	500	4800	.
10	DISSOLVED BORON (UG/L)	7	500	500	500	500	.
10	CADMIUM (UG/L)	20	0.2	0.1	0.1	1	0
10	DISSOLVED CADMIUM (UG/L)	7	0.4	0.3	0.1	1.4	0
10	CHROMIUM (UG/L)	18	2.6	1	1	7	0
10	DISSOLVED CHROMIUM (UG/L)	7	1	1	1	1	0
10	COPPER (UG/L)	21	16.2	10	10	130	0
10	DISSOLVED COPPER (UG/L)	7	10	10	10	10	0
10	IRON - TOTAL (UG/L)	21	41819	21000	6500	460000	21
10	DISSOLVED IRON (UG/L)	7	11442.9	10000	6400	23000	7
10	LEAD (UG/L)	19	2.3	1	0.8	8	0

Continued

10	DISSOLVED LEAD (UG/L)	7	1	1	1	1	0
10	LITHIUM (UG/L)	14	124.9	125	80	200	.
10	DISSOLVED LITHIUM (UG/L)	7	122.1	130	95	140	.
10	MANGANESE (UG/L)	21	731.4	660	250	1600	21
10	DISSOLVED MANGANESE (UG/L)	7	382.9	350	250	560	7
10	MOLYBDENUM (UG/L)	8	93.8	95	30	140	.
10	DISSOLVED MOLYBDENUM (UG/L)	5	58	60	20	120	.
10	NICKEL (UG/L)	5	1.6	1	1	4	0
10	DISSOLVED NICKEL (UG/L)	1	3	3	3	3	0
10	SELENIUM (UG/L)	12	1	1	1	1	0
10	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1	0
10	SILICON (UG/L)	16	9550	10100	4000	12000	.
10	DISSOLVED SILICON (UG/L)	6	7733.3	7750	7200	8300	.
10	STRONTIUM (UG/L)	19	1070.5	810	560	2100	.
10	DISSOLVED STRONTIUM (UG/L)	7	772.9	760	620	1000	.
10	VANADIUM (UG/L)	19	10	10	10	10	.
10	DISSOLVED VANADIUM (UG/L)	7	10	10	10	10	.
10	ZINC (UG/L)	21	21	10	10	80	0
10	DISSOLVED ZINC (UG/L)	7	61.4	10	10	350	0
10	TOTAL DISSOLVED SOLIDS (MG/L)	21	503.8	360	260	1000	8
10	TOTAL SUSPENDED SOLIDS (MG/L)	15	59.3	43	4	130	.
10	WATER SURF. FR MP (M)	23	0.9	0.3	0	1.8	.
10	WATER SURF. ELVN (M, MSL)	12	228.7	229	225.4	229.4	.
10	WATER SURF. ELVN (FT, MSL)	12	750.4	751.2	739.6	752.5	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
10A	ORP (MV)	22	256.1	245	31	455	.
10A	CONDUCTIVITY (ÜMHOS/CM)	22	753.5	797	419	1020	.
10A	DISSOLVED OXYGEN (MG/L)	22	0.6	0.3	0.1	3.3	.
10A	TEMPERATURE (DEG C)	22	20.6	20.8	17.9	22.9	.
10A	PH (STANDARD UNITS)	22	4.9	4.8	4.2	6.4	22
10A	ALKALINITY (MG/L)	21	16.1	6	0	106	.
10A	PHEN-PH ALKALINITY (MG/L)	5	0	0	0	0	.
10A	ACIDITY (MG/L)	12	187.7	223.5	0	294	.
10A	CO2 ACIDITY (MG/L)	9	121.6	117	34	180	.
10A	CO2 (MG/L)	8	171.3	196.1	0	259	.
10A	CA/MG HARDNESS (MG/L)	21	337.5	365	151.6	564	.
10A	NITRATE+NITRITE NITROGEN (MG/L)	11	0.1	0.1	0	0.6	0
10A	TOTAL ORGANIC CARBON (MG/L)	20	0.9	0.6	0.3	2.7	.
10A	TOTAL INORGANIC CARBON (MG/L)	20	27.7	27	3	110	.
10A	SULFIDE (MG/L)	8	0	0	0	0	.
10A	CALCIUM (MG/L)	21	101.4	110	48	160	.
10A	DISSOLVED CALCIUM (MG/L)	7	82.6	82	55	110	.
10A	MAGNESIUM (MG/L)	21	20.5	22	7.1	40	.
10A	DISSOLVED MAGNESIUM (MG/L)	7	13.9	15	9.5	16	.
10A	SODIUM (MG/L)	21	8	8	5.4	11	.
10A	POTASSIUM (MG/L)	21	7.2	7.2	4.9	12	.
10A	CHLORIDE (MG/L)	21	4.1	4	2	6	0
10A	SULFATE (MG/L)	21	360	370	40	640	14
10A	FLUORIDE (MG/L)	12	0.2	0.1	0.1	0.7	0
10A	ALUMINUM (UG/L)	21	21833.3	7900	2800	130000	21
10A	DISSOLVED ALUMINUM (UG/L)	7	740	590	50	1600	5
10A	ANTIMONY (UG/L)	5	1	1	1	1	0
10A	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
10A	ARSENIC (UG/L)	21	6	4	2	20	0
10A	DISSOLVED ARSENIC (UG/L)	7	5.9	3	1	25	0
10A	BARIUM (UG/L)	19	152.1	90	10	750	0
10A	DISSOLVED BARIUM (UG/L)	7	47.1	40	20	80	0
10A	BERYLLIUM (UG/L)	5	3.4	3	1	8	1
10A	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
10A	BORON (UG/L)	21	2445.7	1900	500	17000	.
10A	DISSOLVED BORON (UG/L)	7	1514.3	1400	1100	2000	.
10A	CADMIUM (UG/L)	20	0.3	0.2	0.1	1.4	0
10A	DISSOLVED CADMIUM (UG/L)	7	0.5	0.4	0.1	1.6	0
10A	CHROMIUM (UG/L)	18	14.2	4.5	1	80	0
10A	DISSOLVED CHROMIUM (UG/L)	7	1	1	1	1	0
10A	COPPER (UG/L)	21	47.1	20	10	210	0
10A	DISSOLVED COPPER (UG/L)	7	17.1	10	10	60	0
10A	IRON - TOTAL (UG/L)	21	102714	63000	18000	810000	21
10A	DISSOLVED IRON (UG/L)	7	27285.7	27000	18000	40000	7
10A	LEAD (UG/L)	19	18.1	7	2	86	3
10A	DISSOLVED LEAD (UG/L)	7	1	1	1	1	0

Continued

10A	LITHIUM (UG/L)	14	66.5	57.5	20	160	.	
10A	DISSOLVED LITHIUM (UG/L)	7	54.3	54	40	70	.	
10A	MANGANESE (UG/L)	21	8690.5	9300	2800	15000		21
10A	DISSOLVED MANGANESE (UG/L)	7	7900	7800	5600	13000		7
10A	MOLYBDENUM (UG/L)	8	20	20	20	20	.	
10A	DISSOLVED MOLYBDENUM (UG/L)	5	20	20	20	20	.	
10A	NICKEL (UG/L)	5	33.8	26	20	56		0
10A	DISSOLVED NICKEL (UG/L)	1	42	42	42	42		0
10A	SELENIUM (UG/L)	12	1	1	1	1		0
10A	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1		0
10A	SILICON (UG/L)	16	25975	20000	7600	53000	.	
10A	DISSOLVED SILICON (UG/L)	6	12500	12500	11000	15000	.	
10A	STRONTIUM (UG/L)	19	1594.2	1700	810	2400	.	
10A	DISSOLVED STRONTIUM (UG/L)	7	1377.1	1400	940	1700	.	
10A	VANADIUM (UG/L)	19	29.5	10	10	150	.	
10A	DISSOLVED VANADIUM (UG/L)	7	10	10	10	10	.	
10A	ZINC (UG/L)	21	169.5	170	50	350		0
10A	DISSOLVED ZINC (UG/L)	7	82	80	54	110		0
10A	TOTAL DISSOLVED SOLIDS (MG/L)	21	604.8	640	230	1000		14
10A	TOTAL SUSPENDED SOLIDS (MG/L)	15	441.2	180	26	2100	.	
10A	WATER SURF. FR MP (M)	23	2.1	2	1.2	4.3	.	
10A	WATER SURF. ELVN (M, MSL)	12	227.6	227.8	225.3	228.5	.	
10A	WATER SURF. ELVN (FT, MSL)	12	746.6	747.5	739.2	749.7	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
10B	ORP (MV)	14	9.9	0	-90	150	.
10B	CONDUCTIVITY (UMHOS/CM)	14	1124.4	1158	861	1300	.
10B	DISSOLVED OXYGEN (MG/L)	14	0.3	0.3	0.1	0.5	.
10B	TEMPERATURE (DEG C)	14	19.8	20	17.9	21	.
10B	PH (STANDARD UNITS)	14	6.1	6.1	5.9	6.3	14
10B	ALKALINITY (MG/L)	13	121.3	117	110	146	.
10B	PHEN-PH ALKALINITY (MG/L)	2	0	0	0	0	.
10B	ACIDITY (MG/L)	6	168.5	181	0	275	.
10B	CO2 ACIDITY (MG/L)	3	175	176	150	199	.
10B	CO2 (MG/L)	5	178	164.6	152.2	242	.
10B	CA/MG HARDNESS (MG/L)	14	566	593.5	394.3	677	.
10B	NITRATE+NITRITE NITROGEN (MG/L)	10	0.1	0	0	0.4	0
10B	TOTAL ORGANIC CARBON (MG/L)	13	1.4	1.1	0.3	4.1	.
10B	TOTAL INORGANIC CARBON (MG/L)	14	72.1	64.5	24	180	.
10B	SULFIDE (MG/L)	6	0	0	0	0	.
10B	CALCIUM (MG/L)	14	175	180	120	210	.
10B	DISSOLVED CALCIUM (MG/L)	1	120	120	120	120	.
10B	MAGNESIUM (MG/L)	14	31.4	32	22	40	.
10B	DISSOLVED MAGNESIUM (MG/L)	1	20	20	20	20	.
10B	SODIUM (MG/L)	14	36.1	35.5	31	42	.
10B	POTASSIUM (MG/L)	14	3.3	2.8	2.4	7.3	.
10B	CHLORIDE (MG/L)	14	13.6	14	10	17	0
10B	SULFATE (MG/L)	14	519.3	550	300	660	14
10B	FLUORIDE (MG/L)	10	0.1	0.1	0.1	0.5	0
10B	ALUMINUM (UG/L)	14	3888.6	335	50	25000	9
10B	DISSOLVED ALUMINUM (UG/L)	7	271.4	50	50	1600	1
10B	ANTIMONY (UG/L)	3	1	1	1	1	0
10B	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
10B	ARSENIC (UG/L)	14	2.4	2	1	5	0
10B	DISSOLVED ARSENIC (UG/L)	7	2.3	2	1	5	0
10B	BARIUM (UG/L)	12	99.2	55	30	320	0
10B	DISSOLVED BARIUM (UG/L)	7	28.6	30	10	40	0
10B	BERYLLIUM (UG/L)	3	1	1	1	1	0
10B	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
10B	BORON (UG/L)	14	910.7	520	500	5900	.
10B	DISSOLVED BORON (UG/L)	7	500	500	500	500	.
10B	CADMIUM (UG/L)	13	0.5	0.1	0.1	4	0
10B	DISSOLVED CADMIUM (UG/L)	7	0.7	0.2	0.1	3.5	0
10B	CHROMIUM (UG/L)	11	5.9	1	1	30	0
10B	DISSOLVED CHROMIUM (UG/L)	7	1.2	1	1	2	0
10B	COPPER (UG/L)	14	26.4	10	10	160	0
10B	DISSOLVED COPPER (UG/L)	1	10	10	10	10	0
10B	IRON - TOTAL (UG/L)	14	26571.4	24000	15000	49000	14
10B	DISSOLVED IRON (UG/L)	7	18287.1	22000	10	24000	6

Continued

10B	LEAD (UG/L)	12	3.8	1	1	20	0
10B	DISSOLVED LEAD (UG/L)	6	1.2	1	1	2	0
10B	LITHIUM (UG/L)	7	10	10	10	10 .	
10B	DISSOLVED LITHIUM (UG/L)	1	10	10	10	10 .	
10B	MANGANESE (UG/L)	14	9592.9	9950	7100	11000	14
10B	DISSOLVED MANGANESE (UG/L)	7	8900	9100	6900	10000	7
10B	MOLYBDENUM (UG/L)	3	20	20	20	20 .	
10B	DISSOLVED MOLYBDENUM (UG/L)	1	20	20	20	20 .	
10B	NICKEL (UG/L)	3	3.3	4	2	4	0
10B	DISSOLVED NICKEL (UG/L)	1	1	1	1	1	0
10B	SELENIUM (UG/L)	10	1	1	1	1	0
10B	DISSOLVED SELENIUM (UG/L)	6	1.3	1	1	2	0
10B	SILICON (UG/L)	11	13754.5	9700	4400	49000 .	
10B	DISSOLVED SILICON (UG/L)	6	6550	6900	4300	7800 .	
10B	STRONTIUM (UG/L)	12	769.2	745	520	1100 .	
10B	DISSOLVED STRONTIUM (UG/L)	7	684.3	700	550	750 .	
10B	VANADIUM (UG/L)	12	15.8	10	10	50 .	
10B	DISSOLVED VANADIUM (UG/L)	7	10	10	10	10 .	
10B	ZINC (UG/L)	14	31.4	20	10	100	0
10B	DISSOLVED ZINC (UG/L)	7	78.6	80	10	190	0
10B	TOTAL DISSOLVED SOLIDS (MG/L)	14	833.6	875	370	1100	13
10B	TOTAL SUSPENDED SOLIDS (MG/L)	8	21.6	18.5	6	47 .	
10B	WATER SURF. FR MP (M)	16	1.6	1.6	0.6	2.4 .	
10B	WATER SURF. ELVN (M, MSL)	10	228.5	228.6	226.2	229.2 .	
10B	WATER SURF. ELVN (FT, MSL)	10	749.6	750	742.2	751.9 .	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/06.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
11B	ORP (MV)	15	164.3	160	20	289	.
11B	CONDUCTIVITY (UMHOS/CM)	14	1800.2	1907.5	190	2180	.
11B	DISSOLVED OXYGEN (MG/L)	15	0.9	0.4	0.2	3.7	.
11B	TEMPERATURE (DEG C)	15	17	16.9	15.8	19	.
11B	PH (STANDARD UNITS)	15	6.7	6.6	6.2	7	1
11B	ALKALINITY (MG/L)	14	302.4	306	237	356	.
11B	PHEN-PH ALKALINITY (MG/L)	2	0	0	0	0	.
11B	ACIDITY (MG/L)	6	91.8	88.5	0	193	.
11B	CO2 ACIDITY (MG/L)	4	92	104	40	120	.
11B	CO2 (MG/L)	5	97.1	86.2	63.4	170	.
11B	CA/MG HARDNESS (MG/L)	15	1407.8	1374	1076	1719	.
11B	NITRATE+NITRITE NITROGEN (MG/L)	11	0.1	0	0	0.6	0
11B	TOTAL ORGANIC CARBON (MG/L)	14	1	0.9	0.7	1.5	.
11B	TOTAL INORGANIC CARBON (MG/L)	15	115.7	100	53	220	.
11B	SULFIDE (MG/L)	6	0	0	0	0	.
11B	CALCIUM (MG/L)	15	452	440	350	540	.
11B	MAGNESIUM (MG/L)	15	67.8	67	49	90	.
11B	SODIUM (MG/L)	15	9.9	9.7	8.7	12	.
11B	POTASSIUM (MG/L)	15	2.7	2.6	2.2	3.3	.
11B	CHLORIDE (MG/L)	15	6.3	7	4	8	0
11B	SULFATE (MG/L)	15	988.7	1000	650	1400	15
11B	FLUORIDE (MG/L)	11	0.1	0.1	0.1	0.2	0
11B	ALUMINUM (UG/L)	15	1612.7	650	50	9200	10
11B	ANTIMONY (UG/L)	3	1	1	1	1	0
11B	ARSENIC (UG/L)	15	1.5	1	1	6	0
11B	BARIUM (UG/L)	13	43.1	40	10	130	0
11B	BERYLLIUM (UG/L)	3	1	1	1	1	0
11B	BORON (UG/L)	15	501.3	500	500	520	.
11B	CADMIUM (UG/L)	14	0.1	0.1	0.1	0.3	0
11B	CHROMIUM (UG/L)	12	2.8	1	1	12	0
11B	COPPER (UG/L)	15	20.7	10	10	80	0
11B	IRON - TOTAL (UG/L)	15	1934.7	980	210	12000	13
11B	LEAD (UG/L)	13	1.9	1	1	6	0
11B	LITHIUM (UG/L)	7	28.6	30	10	40	.
11B	MANGANESE (UG/L)	15	662	660	160	1200	15
11B	MOLYBDENUM (UG/L)	4	25	20	20	40	.
11B	NICKEL (UG/L)	3	2.7	1	1	6	0
11B	SELENIUM (UG/L)	11	1	1	1	1	0
11B	SILICON (UG/L)	12	11666.7	9900	5600	23000	.
11B	STRONTIUM (UG/L)	13	510.8	520	390	680	.
11B	TITANIUM (UG/L)	1	170	170	170	170	.
11B	VANADIUM (UG/L)	13	11.5	10	10	20	.
11B	ZINC (UG/L)	15	17.3	10	10	50	0
11B	TOTAL DISSOLVED SOLIDS (MG/L)	15	1773.3	1800	1300	2000	15
11B	TOTAL SUSPENDED SOLIDS (MG/L)	8	108.3	78	2	320	.
11B	WATER SURF. FR MP (M)	17	2.8	2.5	2	4.2	.
11B	WATER SURF. ELVN (M, MSL)	11	231.2	231.6	227.7	232.4	.
11B	WATER SURF. ELVN (FT, MSL)	11	758.4	759.8	747.2	762.5	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/06.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
12A	ORP (MV)	15	26.4	5	-41	180	.
12A	CONDUCTIVITY (UMHOS/CM)	15	775.9	780	621	920	.
12A	DISSOLVED OXYGEN (MG/L)	15	0.3	0.2	0.1	0.7	.
12A	TEMPERATURE (DEG C)	15	16.8	16.6	14.2	20.8	.
12A	PH (STANDARD UNITS)	15	6.6	6.6	6.2	6.8	2
12A	ALKALINITY (MG/L)	14	213	212.5	175	253	.
12A	PHEN-PH ALKALINITY (MG/L)	3	0	0	0	0	.
12A	ACIDITY (MG/L)	6	68	77.5	0	107	.
12A	CO2 ACIDITY (MG/L)	5	79.6	71	63	108	.
12A	CO2 (MG/L)	5	71.7	68.6	57	94	.
12A	CA/MG HARDNESS (MG/L)	14	405.2	404.5	221	523	.
12A	NITRATE+NITRITE NITROGEN (MG/L)	10	0.1	0	0	0.1	0
12A	TOTAL ORGANIC CARBON (MG/L)	14	1.8	1.7	1.3	3.3	.
12A	TOTAL INORGANIC CARBON (MG/L)	15	92.5	74	48	190	.
12A	SULFIDE (MG/L)	5	0	0	0	0	.
12A	CALCIUM (MG/L)	15	106.1	110	0.1	150	.
12A	MAGNESIUM (MG/L)	15	27.5	28	0	38	.
12A	SODIUM (MG/L)	15	6.9	6.7	5.7	8	.
12A	POTASSIUM (MG/L)	15	2.9	2.9	2.4	3.3	.
12A	CHLORIDE (MG/L)	15	3.3	3	2	4	0
12A	SULFATE (MG/L)	15	215.3	230	140	400	1
12A	FLUORIDE (MG/L)	10	0.3	0.2	0.1	0.4	0
12A	ALUMINUM (UG/L)	15	1116.7	210	50	5500	8
12A	ANTIMONY (UG/L)	3	1	1	1	1	0
12A	ARSENIC (UG/L)	15	1.6	1	1	4	0
12A	BARIUM (UG/L)	14	40.7	30	10	110	0
12A	BERYLLIUM (UG/L)	3	2.7	1	1	6	1
12A	BORON (UG/L)	15	500	500	500	500	.
12A	CADMIUM (UG/L)	14	0.2	0.1	0.1	1	0
12A	CHROMIUM (UG/L)	13	2	1	1	6	0
12A	COPPER (UG/L)	15	20.7	10	10	110	0
12A	IRON - TOTAL (UG/L)	15	4132	2200	10	15000	14
12A	LEAD (UG/L)	14	2.7	1.5	1	9	0
12A	LITHIUM (UG/L)	8	10	10	10	10	.
12A	MANGANESE (UG/L)	15	4547	4100	5	10000	14
12A	MOLYBDENUM (UG/L)	4	20	20	20	20	.
12A	NICKEL (UG/L)	3	1	1	1	1	0
12A	SELENIUM (UG/L)	10	1	1	1	1	0
12A	SILICON (UG/L)	12	4285	4300	20	11000	.
12A	STRONTIUM (UG/L)	14	237.1	230	50	390	.
12A	VANADIUM (UG/L)	14	19.3	10	10	50	.
12A	ZINC (UG/L)	15	16	10	10	70	0
12A	TOTAL DISSOLVED SOLIDS (MG/L)	15	548	540	300	940	10
12A	TOTAL SUSPENDED SOLIDS (MG/L)	9	8.3	7	2	23	.
12A	WATER SURF. FR MP (M)	18	1.8	1.7	1.3	2.6	.
12A	WATER SURF. ELVN (M, MSL)	16	232.1	232.1	231.7	232.3	.
12A	WATER SURF. ELVN (FT, MSL)	12	761.4	761.5	760.1	762.2	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/06.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
12B	ORP (MV)	15	-5	-40	-100	161	.
12B	CONDUCTIVITY (UMHOS/CM)	15	1317.8	1345	1200	1390	.
12B	DISSOLVED OXYGEN (MG/L)	15	0.3	0.3	0.1	0.5	.
12B	TEMPERATURE (DEG C)	15	16.3	16.5	14.3	18.7	.
12B	PH (STANDARD UNITS)	15	7	7	6.8	7.1	0
12B	ALKALINITY (MG/L)	15	298.8	320	46	330	.
12B	PHEN-PH ALKALINITY (MG/L)	3	0	0	0	0	.
12B	ACIDITY (MG/L)	7	51.6	57	0	75	.
12B	CO2 ACIDITY (MG/L)	5	50	53	32	61	.
12B	CO2 (MG/L)	6	52.9	54	34.3	66	.
12B	CA/MG HARDNESS (MG/L)	16	714.7	745	203	837	.
12B	NITRATE+NITRITE NITROGEN (MG/L)	10	0.1	0	0	0.7	0
12B	TOTAL ORGANIC CARBON (MG/L)	15	0.7	0.5	0.2	2.2	.
12B	TOTAL INORGANIC CARBON (MG/L)	16	108.2	94.5	58	200	.
12B	SULFIDE (MG/L)	6	0	0	0	0	.
12B	CALCIUM (MG/L)	16	210	220	60	240	.
12B	MAGNESIUM (MG/L)	16	46.3	47	13	70	.
12B	SODIUM (MG/L)	16	35.5	36	31	38	.
12B	POTASSIUM (MG/L)	16	8.9	8.7	8.2	11	.
12B	CHLORIDE (MG/L)	16	3.3	3.5	1	4	0
12B	SULFATE (MG/L)	16	491.3	490	380	580	16
12B	FLUORIDE (MG/L)	10	0.1	0.1	0.1	0.1	0
12B	ALUMINUM (UG/L)	16	825.6	50	50	7100	4
12B	ANTIMONY (UG/L)	3	1	1	1	1	0
12B	ARSENIC (UG/L)	16	1.3	1	1	3	0
12B	BARIUM (UG/L)	14	16.4	10	10	50	0
12B	BERYLLIUM (UG/L)	3	2.7	1	1	6	1
12B	BORON (UG/L)	16	500	500	500	500	.
12B	CADMIUM (UG/L)	15	0.2	0.1	0.1	1	0
12B	CHROMIUM (UG/L)	14	1.6	1	1	5	0
12B	COPPER (UG/L)	16	18.1	10	10	100	0
12B	IRON - TOTAL (UG/L)	16	2100	1700	1400	7300	16
12B	LEAD (UG/L)	15	1.2	1	1	2	0
12B	LITHIUM (UG/L)	9	60.7	60	50	70	.
12B	MANGANESE (UG/L)	16	462.5	445	360	820	16
12B	MOLYBDENUM (UG/L)	5	20	20	20	20	.
12B	NICKEL (UG/L)	4	1.3	1	1	2	0
12B	SELENIUM (UG/L)	10	1	1	1	1	0
12B	SILICON (UG/L)	13	11184.6	12000	6000	19000	.
12B	STRONTIUM (UG/L)	14	5011.4	5350	360	6100	.
12B	VANADIUM (UG/L)	14	10.7	10	10	20	.
12B	ZINC (UG/L)	16	20	10	10	70	0
12B	TOTAL DISSOLVED SOLIDS (MG/L)	16	1036.9	1000	590	1400	16
12B	TOTAL SUSPENDED SOLIDS (MG/L)	10	3.7	4	1	6	.
12B	WATER SURF. FR MP (M)	18	2	1.9	1.6	3.6	.
12B	WATER SURF. ELVN (M, MSL)	17	231.8	231.9	230.2	232.2	.
12B	WATER SURF. ELVN (FT, MSL)	12	760.3	760.8	755.1	761.8	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/11 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
13A	ORP (MV)	20	-71.1	-109.5	-138	151	.
13A	CONDUCTIVITY (UMHOS/CM)	20	621.3	551	427	1470	.
13A	DISSOLVED OXYGEN (MG/L)	20	0.2	0.2	0	0.7	.
13A	TEMPERATURE (DEG C)	20	17.9	17.8	14.8	22.3	.
13A	PH (STANDARD UNITS)	20	6.6	6.6	6.4	6.7	2
13A	ALKALINITY (MG/L)	19	208.9	211	179	258	.
13A	PHEN-PH ALKALINITY (MG/L)	5	0	0	0	0	.
13A	ACIDITY (MG/L)	9	170.1	133	0	500	.
13A	CO2 ACIDITY (MG/L)	8	165.1	167.5	122	216	.
13A	CO2 (MG/L)	8	168.5	129.5	97	440	.
13A	CA/MG HARDNESS (MG/L)	21	194.5	151	113.3	498	.
13A	NITRATE+NITRITE NITROGEN (MG/L)	12	0.1	0	0	1.2	0
13A	AMMONIA NITROGEN (MG/L)	2	0.7	0.7	0.7	0.8	.
13A	TOTAL KJELDAHL NITROGEN (MG/L)	2	1.1	1.1	1.1	1.2	.
13A	TOTAL ORGANIC CARBON (MG/L)	20	2.8	2.6	1	6.1	.
13A	TOTAL INORGANIC CARBON (MG/L)	21	95.7	77	31	480	.
13A	SULFIDE (MG/L)	9	0	0	0	0.1	.
13A	CALCIUM (MG/L)	21	58.3	47	35	150	.
13A	DISSOLVED CALCIUM (MG/L)	7	40.4	44	28	49	.
13A	MAGNESIUM (MG/L)	21	11.9	8.8	6.3	30	.
13A	DISSOLVED MAGNESIUM (MG/L)	7	6.6	6.6	4.5	8.9	.
13A	SODIUM (MG/L)	21	28.2	25	21	67	.
13A	POTASSIUM (MG/L)	21	7.3	5.4	3.6	25	.
13A	CHLORIDE (MG/L)	21	1.8	2	1	3	0
13A	SULFATE (MG/L)	21	180	88	20	950	3
13A	FLUORIDE (MG/L)	12	0.2	0.2	0.1	0.3	0
13A	ALUMINUM (UG/L)	21	9343.8	1300	80	110000	20
13A	DISSOLVED ALUMINUM (UG/L)	11	82.7	50	50	410	1
13A	ANTIMONY (UG/L)	5	1	1	1	1	0
13A	ARSENIC (UG/L)	21	91.8	85	51	180	21
13A	DISSOLVED ARSENIC (UG/L)	11	89.3	82	28	150	10
13A	BARIUM (UG/L)	19	277.4	220	110	1200	0
13A	DISSOLVED BARIUM (UG/L)	11	171.8	170	100	270	0
13A	BERYLLIUM (UG/L)	5	1	1	1	1	0
13A	BORON (UG/L)	21	639.5	500	500	1700	.
13A	DISSOLVED BORON (UG/L)	11	603.6	500	500	1500	.
13A	CADMIUM (UG/L)	20	0.4	0.2	0.1	1.7	0
13A	DISSOLVED CADMIUM (UG/L)	11	0.7	0.4	0.1	3.1	0
13A	CHROMIUM (UG/L)	18	12.7	2	1	86	0
13A	DISSOLVED CHROMIUM (UG/L)	11	1.1	1	1	2	0
13A	COPPER (UG/L)	21	17.6	10	10	90	0
13A	DISSOLVED COPPER (UG/L)	7	10	10	10	10	0
13A	IRON - TOTAL (UG/L)	21	64952.4	48000	30000	220000	21
13A	DISSOLVED IRON (UG/L)	11	58090.9	43000	26000	210000	11

Continued

13A	LEAD (UG/L)	19	7	2	1	60	1
13A	DISSOLVED LEAD (UG/L)	11	1	1	1	1	0
13A	LITHIUM (UG/L)	15	50.5	40	10	200	.
13A	DISSOLVED LITHIUM (UG/L)	7	35.7	30	23	60	.
13A	MANGANESE (UG/L)	21	1496.2	1200	840	4000	21
13A	DISSOLVED MANGANESE (UG/L)	11	1271.8	1000	840	3600	11
13A	MOLYBDENUM (UG/L)	8	20	20	20	20	.
13A	DISSOLVED MOLYBDENUM (UG/L)	4	20	20	20	20	.
13A	NICKEL (UG/L)	5	1.6	1	1	4	0
13A	SELENIUM (UG/L)	13	1.2	1	1	3	0
13A	DISSOLVED SELENIUM (UG/L)	7	1.1	1	1	2	0
13A	SILICON (UG/L)	16	17681.3	14500	2300	56000	.
13A	DISSOLVED SILICON (UG/L)	11	11345.5	12000	8100	14000	.
13A	STRONTIUM (UG/L)	19	709.5	630	400	1300	.
13A	DISSOLVED STRONTIUM (UG/L)	11	628.2	550	400	1200	.
13A	TITANIUM (UG/L)	1	84	84	84	84	.
13A	VANADIUM (UG/L)	19	32.1	10	10	240	.
13A	DISSOLVED VANADIUM (UG/L)	11	12.7	10	10	40	.
13A	ZINC (UG/L)	21	50.5	20	10	250	0
13A	DISSOLVED ZINC (UG/L)	11	44.5	20	10	170	0
13A	TOTAL DISSOLVED SOLIDS (MG/L)	21	344.3	290	160	990	2
13A	TOTAL SUSPENDED SOLIDS (MG/L)	16	197.7	130	22	1200	.
13A	WATER SURF. FR MP (M)	22	3.2	3.1	2	4.9	.
13A	WATER SURF. ELVN (M, MSL)	11	230.8	231.1	229.1	232.5	.
13A	WATER SURF. ELVN (FT, MSL)	11	757.1	758.1	751.8	762.7	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/05 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
13B	ORP (MV)	17	-34.1	-80	-170	573	.
13B	CONDUCTIVITY (UMHOS/CM)	17	311.3	319	277	322	.
13B	DISSOLVED OXYGEN (MG/L)	17	0.3	0.3	0.1	1.5	.
13B	TEMPERATURE (DEG C)	17	16.5	16.6	15.1	18.6	.
13B	PH (STANDARD UNITS)	17	8.3	8.3	8	8.4	0
13B	ALKALINITY (MG/L)	16	171.4	167.5	159	249	.
13B	PHEN-PH ALKALINITY (MG/L)	4	0	0	0	0	.
13B	ACIDITY (MG/L)	7	21.9	4	0	120	.
13B	CO2 ACIDITY (MG/L)	6	0.8	0	0	4	.
13B	CO2 (MG/L)	5	27	3.5	0	106	.
13B	CA/MG HARDNESS (MG/L)	17	27.3	26	22	40	.
13B	NITRATE+NITRITE NITROGEN (MG/L)	10	0	0	0	0.1	0
13B	TOTAL ORGANIC CARBON (MG/L)	16	0.6	0.5	0.2	2.5	.
13B	TOTAL INORGANIC CARBON (MG/L)	17	71.1	52	39	160	.
13B	SULFIDE (MG/L)	6	0	0	0	0	.
13B	CALCIUM (MG/L)	17	8.4	8.4	7.1	9.6	.
13B	DISSOLVED CALCIUM (MG/L)	4	8.7	8.8	7.3	10	.
13B	MAGNESIUM (MG/L)	17	1.5	1.2	0.9	4.3	.
13B	DISSOLVED MAGNESIUM (MG/L)	4	1.2	1.1	1	1.5	.
13B	SODIUM (MG/L)	17	62.7	66	6.3	77	.
13B	POTASSIUM (MG/L)	17	2.1	2.1	1.7	2.6	.
13B	CHLORIDE (MG/L)	17	1.2	1	1	2	0
13B	SULFATE (MG/L)	17	6.7	2	1	77	0
13B	FLUORIDE (MG/L)	10	0.3	0.2	0.1	0.5	0
13B	ALUMINUM (UG/L)	17	242.9	50	50	1500	4
13B	DISSOLVED ALUMINUM (UG/L)	5	50	50	50	50	0
13B	ANTIMONY (UG/L)	3	1	1	1	1	0
13B	ARSENIC (UG/L)	17	1.5	1	1	9	0
13B	DISSOLVED ARSENIC (UG/L)	5	1.2	1	1	2	0
13B	BARIUM (UG/L)	15	214.7	210	180	260	0
13B	DISSOLVED BARIUM (UG/L)	5	190	190	150	240	0
13B	BERYLLIUM (UG/L)	3	1	1	1	1	0
13B	BORON (UG/L)	17	529.4	500	500	1000	.
13B	DISSOLVED BORON (UG/L)	5	500	500	500	500	.
13B	CADMIUM (UG/L)	16	0.3	0.1	0.1	1	0
13B	DISSOLVED CADMIUM (UG/L)	5	0.3	0.2	0.1	0.5	0
13B	CHROMIUM (UG/L)	15	5	1	1	56	0
13B	DISSOLVED CHROMIUM (UG/L)	5	1	1	1	1	0
13B	COPPER (UG/L)	17	12.4	10	10	40	0
13B	DISSOLVED COPPER (UG/L)	4	10	10	10	10	0
13B	IRON - TOTAL (UG/L)	17	217.6	120	10	1900	1
13B	DISSOLVED IRON (UG/L)	5	26	20	10	60	0
13B	LEAD (UG/L)	16	1.3	1	1	3	0
13B	DISSOLVED LEAD (UG/L)	5	1.2	1	1	2	0
13B	LITHIUM (UG/L)	10	27.2	30	20	30	.

Continued

13B	DISSOLVED LITHIUM (UG/L)	4	27.5	25	20	40	.	
13B	MANGANESE (UG/L)	17	22.8	19	5	55		1
13B	DISSOLVED MANGANESE (UG/L)	5	25.6	27	20	30		0
13B	MOLYBDENUM (UG/L)	6	20	20	20	20	.	
13B	DISSOLVED MOLYBDENUM (UG/L)	4	17.5	20	10	20	.	
13B	NICKEL (UG/L)	4	1.3	1	1	2		0
13B	SELENIUM (UG/L)	10	1.1	1	1	2		0
13B	DISSOLVED SELENIUM (UG/L)	1	1	1	1	1		0
13B	SILICON (UG/L)	14	6421.4	6350	3500	8600	.	
13B	DISSOLVED SILICON (UG/L)	5	6660	6400	5900	7400	.	
13B	STRONTIUM (UG/L)	15	174	170	150	220	.	
13B	DISSOLVED STRONTIUM (UG/L)	5	140	160	50	180	.	
13B	VANADIUM (UG/L)	15	10.7	10	10	20	.	
13B	DISSOLVED VANADIUM (UG/L)	5	10	10	10	10	.	
13B	ZINC (UG/L)	17	18.8	10	10	100		0
13B	DISSOLVED ZINC (UG/L)	5	12	10	10	20		0
13B	TOTAL DISSOLVED SOLIDS (MG/L)	17	188.8	200	90	230		0
13B	TOTAL SUSPENDED SOLIDS (MG/L)	12	1.9	1	1	7	.	
13B	WATER SURF. FR MP (M)	19	3.9	3.7	2.8	6.7	.	
13B	WATER SURF. ELVN (M, MSL)	10	230.6	230.9	227.6	231.2	.	
13B	WATER SURF. ELVN (FT, MSL)	10	756.5	757.6	746.6	758.6	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/05 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
14A	ORP (MV)	21	43.4	3	-50	270	.
14A	CONDUCTIVITY (UMHOS/CM)	21	3208	3240	2913	3380	.
14A	DISSOLVED OXYGEN (MG/L)	21	0.7	0.3	0.1	6.2	.
14A	TEMPERATURE (DEG C)	21	18.1	17.7	15.7	23.3	.
14A	PH (STANDARD UNITS)	21	6.1	6.1	5.9	6.4	21
14A	ALKALINITY (MG/L)	20	420.1	426	353	466	.
14A	PHEN-PH ALKALINITY (MG/L)	6	0	0	0	0	.
14A	ACIDITY (MG/L)	8	633.8	713	0	994	.
14A	CO2 ACIDITY (MG/L)	9	501.2	530	380	602	.
14A	CO2 (MG/L)	7	637.4	651.2	466	875	.
14A	CA/MG HARDNESS (MG/L)	21	2023.9	2191	210	2446	.
14A	NITRATE+NITRITE NITROGEN (MG/L)	12	0.2	0	0	0.9	0
14A	TOTAL ORGANIC CARBON (MG/L)	20	4.6	4.5	0.5	9.1	.
14A	TOTAL INORGANIC CARBON (MG/L)	21	146.1	160	42	270	.
14A	SULFIDE (MG/L)	7	0	0	0	0	.
14A	CALCIUM (MG/L)	21	578.9	630	66	710	.
14A	DISSOLVED CALCIUM (MG/L)	7	508.6	590	110	630	.
14A	MAGNESIUM (MG/L)	21	140.5	150	11	200	.
14A	DISSOLVED MAGNESIUM (MG/L)	7	133.3	140	53	170	.
14A	SODIUM (MG/L)	21	23.2	24	9.3	32	.
14A	POTASSIUM (MG/L)	21	51	54	2.9	74	.
14A	CHLORIDE (MG/L)	21	11.2	12	3	15	0
14A	SULFATE (MG/L)	21	1651.7	1800	65	2300	20
14A	FLUORIDE (MG/L)	12	0.1	0.1	0.1	0.2	0
14A	ALUMINUM (UG/L)	21	2201.4	510	50	10000	12
14A	DISSOLVED ALUMINUM (UG/L)	7	50	50	50	50	0
14A	ANTIMONY (UG/L)	5	1.2	1	1	2	0
14A	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
14A	ARSENIC (UG/L)	21	39	41	1	71	2
14A	DISSOLVED ARSENIC (UG/L)	7	38.9	38	30	46	0
14A	BARIUM (UG/L)	19	76.3	70	10	200	0
14A	DISSOLVED BARIUM (UG/L)	7	58.6	20	10	160	0
14A	BERYLLIUM (UG/L)	5	1	1	1	1	0
14A	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
14A	BORON (UG/L)	21	596.2	560	500	870	.
14A	DISSOLVED BORON (UG/L)	7	535.7	500	500	650	.
14A	CADMIUM (UG/L)	20	0.2	0.1	0.1	1.1	0
14A	DISSOLVED CADMIUM (UG/L)	7	0.4	0.3	0.1	1.4	0
14A	CHROMIUM (UG/L)	18	4	2.5	1	17	0
14A	DISSOLVED CHROMIUM (UG/L)	7	2.6	1	1	12	0
14A	COPPER (UG/L)	21	19	10	10	70	0
14A	DISSOLVED COPPER (UG/L)	7	12.9	10	10	20	0
14A	IRON - TOTAL (UG/L)	21	124184	120000	870	220000	21
14A	DISSOLVED IRON (UG/L)	7	102857	100000	93000	110000	7

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14A	LEAD (UG/L)	20	2.7	1.5	0.9	9	0
14A	DISSOLVED LEAD (UG/L)	7	1.1	1	1	2	0
14A	LITHIUM (UG/L)	13	35.2	30	28	50 .	
14A	DISSOLVED LITHIUM (UG/L)	7	34.7	40	25	40 .	
14A	MANGANESE (UG/L)	21	9590.3	8300	97	25000	21
14A	DISSOLVED MANGANESE (UG/L)	7	7814.3	6700	5000	13000	7
14A	MOLYBDENUM (UG/L)	8	20	20	20	20 .	
14A	DISSOLVED MOLYBDENUM (UG/L)	5	42	20	20	130 .	
14A	NICKEL (UG/L)	5	1.4	1	1	3	0
14A	DISSOLVED NICKEL (UG/L)	1	3	3	3	3	0
14A	SELENIUM (UG/L)	13	1.8	1	1	3	0
14A	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1	0
14A	SILICON (UG/L)	16	23500	26000	10000	38000 .	
14A	DISSOLVED SILICON (UG/L)	6	25166.7	23000	18000	38000 .	
14A	STRONTIUM (UG/L)	19	2116.8	2200	220	2700 .	
14A	DISSOLVED STRONTIUM (UG/L)	7	2271.4	2300	1800	2900 .	
14A	VANADIUM (UG/L)	19	27.4	10	10	70 .	
14A	DISSOLVED VANADIUM (UG/L)	7	20	10	10	50 .	
14A	ZINC (UG/L)	21	46.7	30	10	170	0
14A	DISSOLVED ZINC (UG/L)	7	30	10	10	80	0
14A	TOTAL DISSOLVED SOLIDS (MG/L)	21	2963.8	3100	240	6600	20
14A	TOTAL SUSPENDED SOLIDS (MG/L)	14	142.1	52	4	690 .	
14A	WATER SURF. FR MP (M)	23	4.6	4.4	3	9.4 .	
14A	WATER SURF. ELVN (M, MSL)	12	227.6	227.6	227.2	227.9 .	
14A	WATER SURF. ELVN (FT, MSL)	12	746.7	746.7	745.3	747.7 .	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/05 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
14B	ORP (MV)	19	102.9	47	-20	603	.
14B	CONDUCTIVITY (UMHOS/CM)	19	1131.1	1075	783	1572	.
14B	DISSOLVED OXYGEN (MG/L)	19	0.5	0.4	0.2	1.6	.
14B	TEMPERATURE (DEG C)	19	17.3	17	14.9	21.8	.
14B	PH (STANDARD UNITS)	19	6.8	6.9	6.2	7.2	2
14B	ALKALINITY (MG/L)	19	284.1	276	226	376	.
14B	PHEN-PH ALKALINITY (MG/L)	5	0	0	0	0	.
14B	ACIDITY (MG/L)	7	48.7	32	0	135	.
14B	CO2 ACIDITY (MG/L)	9	90.2	80	40	182	.
14B	CO2 (MG/L)	6	50	29	18	119	.
14B	CA/MG HARDNESS (MG/L)	20	707.8	654.5	307	1142.6	.
14B	NITRATE+NITRITE NITROGEN (MG/L)	11	0.6	0	0	6.5	0
14B	TOTAL ORGANIC CARBON (MG/L)	19	0.9	1	0.2	1.9	.
14B	TOTAL INORGANIC CARBON (MG/L)	20	102.5	94	50	230	.
14B	SULFIDE (MG/L)	6	0	0	0	0	.
14B	CALCIUM (MG/L)	20	232.5	215	90	390	.
14B	DISSOLVED CALCIUM (MG/L)	5	226	220	200	270	.
14B	MAGNESIUM (MG/L)	20	30.9	30.5	20	44	.
14B	DISSOLVED MAGNESIUM (MG/L)	5	30.6	31	26	36	.
14B	SODIUM (MG/L)	20	7.1	6.6	2.6	14.6	.
14B	POTASSIUM (MG/L)	20	3.7	3.2	2.4	11	.
14B	CHLORIDE (MG/L)	20	5.6	5.5	3	8	0
14B	SULFATE (MG/L)	20	382.9	375	68	610	19
14B	FLUORIDE (MG/L)	11	0.1	0.1	0.1	0.5	0
14B	ALUMINUM (UG/L)	20	643.5	360	50	2200	11
14B	DISSOLVED ALUMINUM (UG/L)	5	50	50	50	50	0
14B	ANTIMONY (UG/L)	5	1.2	1	1	2	0
14B	DISSOLVED ANTIMONY (UG/L)	1	1	1	1	1	0
14B	ARSENIC (UG/L)	20	1.6	1	1	8	0
14B	DISSOLVED ARSENIC (UG/L)	5	1.8	1	1	4	0
14B	BARIUM (UG/L)	18	46.7	40	10	100	0
14B	DISSOLVED BARIUM (UG/L)	5	40	30	20	70	0
14B	BERYLLIUM (UG/L)	5	1	1	1	1	0
14B	DISSOLVED BERYLLIUM (UG/L)	1	1	1	1	1	0
14B	BORON (UG/L)	20	500	500	500	500	.
14B	DISSOLVED BORON (UG/L)	5	500	500	500	500	.
14B	CADMIUM (UG/L)	19	0.5	0.1	0.1	5.2	1
14B	DISSOLVED CADMIUM (UG/L)	5	0.2	0.2	0.1	0.3	0
14B	CHROMIUM (UG/L)	18	1.8	1	1	7	0
14B	DISSOLVED CHROMIUM (UG/L)	5	1	1	1	1	0
14B	COPPER (UG/L)	20	18	10	10	120	0
14B	DISSOLVED COPPER (UG/L)	5	10	10	10	10	0
14B	IRON - TOTAL (UG/L)	20	1417	1300	150	3000	19
14B	DISSOLVED IRON (UG/L)	5	814	770	720	1000	5

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14B	LEAD (UG/L)	19	1.8	1	1	8	0
14B	DISSOLVED LEAD (UG/L)	5	1	1	1	1	0
14B	LITHIUM (UG/L)	12	23	20	10	60	.
14B	DISSOLVED LITHIUM (UG/L)	5	21	20	10	40	.
14B	MANGANESE (UG/L)	20	602.5	545	140	1200	20
14B	DISSOLVED MANGANESE (UG/L)	5	576	550	490	720	5
14B	MOLYBDENUM (UG/L)	8	20	20	20	20	.
14B	DISSOLVED MOLYBDENUM (UG/L)	5	20	20	20	20	.
14B	NICKEL (UG/L)	7	1.7	2	1	3	0
14B	DISSOLVED NICKEL (UG/L)	1	1	1	1	1	0
14B	SELENIUM (UG/L)	12	1.4	1	1	6	0
14B	SILICON (UG/L)	15	10126.7	10000	4300	14000	.
14B	DISSOLVED SILICON (UG/L)	4	10400	10500	9600	11000	.
14B	STRONTIUM (UG/L)	17	457.1	420	350	680	.
14B	DISSOLVED STRONTIUM (UG/L)	5	374	370	240	490	.
14B	VANADIUM (UG/L)	17	10	10	10	10	.
14B	DISSOLVED VANADIUM (UG/L)	5	10	10	10	10	.
14B	ZINC (UG/L)	20	16	10	10	90	0
14B	DISSOLVED ZINC (UG/L)	5	10	10	10	10	0
14B	TOTAL DISSOLVED SOLIDS (MG/L)	20	839	790	370	1300	19
14B	TOTAL SUSPENDED SOLIDS (MG/L)	13	22.1	14	3	81	.
14B	WATER SURF. FR MP (M)	23	5.3	5	4.8	8.5	.
14B	WATER SURF. ELVN (M, MSL)	11	226.7	227	223.9	227.3	.
14B	WATER SURF. ELVN (FT, MSL)	11	743.7	744.8	734.7	745.7	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/03 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
15A	ORP (MV)	18	131	111.5	-70	308	.
15A	CONDUCTIVITY (UMHOS/CM)	19	403.3	408	340	427	.
15A	DISSOLVED OXYGEN (MG/L)	19	0.7	0.7	0.2	2	.
15A	TEMPERATURE (DEG C)	19	29.2	17.3	15	243	.
15A	PH (STANDARD UNITS)	19	7.4	7.4	7.1	7.7	0
15A	ALKALINITY (MG/L)	19	195.6	193	180	221	.
15A	PHEN-PH ALKALINITY (MG/L)	5	0	0	0	0	.
15A	ACIDITY (MG/L)	10	14.1	13.5	0	27	.
15A	CO2 ACIDITY (MG/L)	6	16.8	16.5	12	21	.
15A	CO2 (MG/L)	9	13.7	12	6.2	24	.
15A	CA/MG HARDNESS (MG/L)	18	371.8	213.6	182.7	2439	.
15A	NITRATE+NITRITE NITROGEN (MG/L)	12	0.1	0	0	1	0
15A	TOTAL ORGANIC CARBON (MG/L)	17	0.9	0.5	0.2	4.1	.
15A	TOTAL INORGANIC CARBON (MG/L)	18	77.8	69.5	46	130	.
15A	SULFIDE (MG/L)	8	0	0	0	0	.
15A	CALCIUM (MG/L)	18	113.3	68	58	680	.
15A	DISSOLVED CALCIUM (MG/L)	2	74	74	66	82	.
15A	MAGNESIUM (MG/L)	18	21.6	11	9	180	.
15A	DISSOLVED MAGNESIUM (MG/L)	2	9.2	9.2	9.2	9.3	.
15A	SODIUM (MG/L)	18	11.1	10	7.9	27	.
15A	POTASSIUM (MG/L)	18	5.8	2.2	1.8	62	.
15A	CHLORIDE (MG/L)	18	3.6	3	1	14	0
15A	SULFATE (MG/L)	18	127.3	22	12	1900	1
15A	FLUORIDE (MG/L)	12	0.1	0.1	0.1	0.2	0
15A	ALUMINUM (UG/L)	18	1428.9	705	50	11000	10
15A	DISSOLVED ALUMINUM (UG/L)	2	50	50	50	50	0
15A	ANTIMONY (UG/L)	5	1	1	1	1	0
15A	ARSENIC (UG/L)	18	3.8	1	1	34	0
15A	DISSOLVED ARSENIC (UG/L)	2	1	1	1	1	0
15A	BARIUM (UG/L)	16	148.8	140	40	330	0
15A	DISSOLVED BARIUM (UG/L)	2	175	175	170	180	0
15A	BERYLLIUM (UG/L)	5	1	1	1	1	0
15A	BORON (UG/L)	18	525	500	500	950	.
15A	DISSOLVED BORON (UG/L)	2	500	500	500	500	.
15A	CADMIUM (UG/L)	17	0.9	0.1	0.1	9.5	1
15A	DISSOLVED CADMIUM (UG/L)	2	0.7	0.7	0.1	1.4	0
15A	CHROMIUM (UG/L)	15	2.6	1	1	14	0
15A	DISSOLVED CHROMIUM (UG/L)	2	1	1	1	1	0
15A	COPPER (UG/L)	18	14.4	10	10	40	0
15A	DISSOLVED COPPER (UG/L)	2	10	10	10	10	0
15A	IRON - TOTAL (UG/L)	18	12620	245	20	210000	8
15A	DISSOLVED IRON (UG/L)	2	90	90	10	170	0
15A	LEAD (UG/L)	16	2.9	1.2	1	14	0

Continued

15A	DISSOLVED LEAD (UG/L)	2	1	1	1	1	0
15A	LITHIUM (UG/L)	10	14	10	10	20 .	
15A	DISSOLVED LITHIUM (UG/L)	2	10	10	10	10 .	
15A	MANGANESE (UG/L)	18	1611	110	9	25000	15
15A	DISSOLVED MANGANESE (UG/L)	2	40	40	28	52	1
15A	MOLYBDENUM (UG/L)	5	22	20	20	30 .	
15A	NICKEL (UG/L)	5	1.2	1	1	2	0
15A	SELENIUM (UG/L)	14	1.1	1	1	2	0
15A	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1	0
15A	SILICON (UG/L)	13	10392.3	8500	4600	33000 .	
15A	DISSOLVED SILICON (UG/L)	2	8650	8650	8100	9200 .	
15A	STRONTIUM (UG/L)	16	353.8	215	90	2000 .	
15A	DISSOLVED STRONTIUM (UG/L)	2	340	340	230	450 .	
15A	TITANIUM (UG/L)	1	5	5	5	5 .	
15A	VANADIUM (UG/L)	16	12.5	10	10	40 .	
15A	DISSOLVED VANADIUM (UG/L)	2	10	10	10	10 .	
15A	ZINC (UG/L)	18	17.8	10	10	50	0
15A	DISSOLVED ZINC (UG/L)	2	15	15	10	20	0
15A	TOTAL DISSOLVED SOLIDS (MG/L)	18	436.7	250	200	3500	2
15A	TOTAL SUSPENDED SOLIDS (MG/L)	12	68.6	25	1	390 .	
15A	WATER SURF. FR MP (M)	21	2.7	2.7	2.3	3.6 .	
15A	WATER SURF. ELVN (M, MSL)	13	239.5	239.9	237.2	240.4 .	
15A	WATER SURF. ELVN (FT, MSL)	13	785.7	787.2	778.1	788.7 .	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/03 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
15B	ORP (MV)	16	8.7	-27.5	-70	184	.
15B	CONDUCTIVITY (UMHOS/CM)	17	577.1	584	530	620	.
15B	DISSOLVED OXYGEN (MG/L)	17	0.3	0.3	0.1	0.6	.
15B	TEMPERATURE (DEG C)	17	16.7	16.4	15	19.9	.
15B	PH (STANDARD UNITS)	17	7.1	7.1	6.8	7.3	0
15B	ALKALINITY (MG/L)	17	257.6	252	241	340	.
15B	PHEN-PH ALKALINITY (MG/L)	5	0	0	0	0	.
15B	ACIDITY (MG/L)	7	25.4	23	0	45	.
15B	CO2 ACIDITY (MG/L)	6	26.8	27.5	10	40	.
15B	CO2 (MG/L)	6	26.2	21.6	14.1	40	.
15B	CA/MG HARDNESS (MG/L)	17	317.4	303	186.5	586	.
15B	NITRATE+NITRITE NITROGEN (MG/L)	11	0	0	0	0	0
15B	TOTAL ORGANIC CARBON (MG/L)	16	0.5	0.5	0.2	0.8	.
15B	TOTAL INORGANIC CARBON (MG/L)	17	85.3	77	48	140	.
15B	SULFIDE (MG/L)	6	0	0	0	0	.
15B	CALCIUM (MG/L)	17	95.2	90	61	190	.
15B	MAGNESIUM (MG/L)	17	19.4	19	8.3	27	.
15B	SODIUM (MG/L)	17	11.5	12	5.9	14	.
15B	POTASSIUM (MG/L)	17	3.5	3.5	3.3	3.8	.
15B	CHLORIDE (MG/L)	17	6.2	6	3	8	0
15B	SULFATE (MG/L)	17	74.4	58	50	310	1
15B	FLUORIDE (MG/L)	11	0.1	0.1	0.1	0.1	0
15B	ALUMINUM (UG/L)	17	381.8	70	50	1400	7
15B	ANTIMONY (UG/L)	5	1	1	1	1	0
15B	ARSENIC (UG/L)	17	1.1	1	1	2	0
15B	BARIUM (UG/L)	15	50	50	10	130	0
15B	BERYLLIUM (UG/L)	5	1	1	1	1	0
15B	BORON (UG/L)	17	500	500	500	500	.
15B	CADMIUM (UG/L)	16	0.2	0.1	0.1	0.6	0
15B	CHROMIUM (UG/L)	15	1.5	1	1	5	0
15B	COPPER (UG/L)	17	22.4	10	10	150	0
15B	IRON - TOTAL (UG/L)	17	1021.8	660	320	4800	17
15B	LEAD (UG/L)	16	2.2	1	1	10	0
15B	LITHIUM (UG/L)	9	22.2	20	10	30	.
15B	MANGANESE (UG/L)	17	162.7	140	86	330	17
15B	MOLYBDENUM (UG/L)	5	20	20	20	20	.
15B	NICKEL (UG/L)	6	1	1	1	1	0
15B	SELENIUM (UG/L)	13	1	1	1	1	0
15B	SILICON (UG/L)	12	10341.7	11000	5500	12000	.
15B	STRONTIUM (UG/L)	15	630	670	200	790	.
15B	VANADIUM (UG/L)	15	10	10	10	10	.
15B	ZINC (UG/L)	17	50.6	10	10	320	0
15B	TOTAL DISSOLVED SOLIDS (MG/L)	17	401.2	360	270	700	3
15B	TOTAL SUSPENDED SOLIDS (MG/L)	10	21.1	3	1	150	.
15B	WATER SURF. FR MP (M)	19	1.9	1.9	1.4	2.4	.
15B	WATER SURF. ELVN (M, MSL)	11	240.1	240.7	233.8	241.2	.
15B	WATER SURF. ELVN (FT, MSL)	11	787.7	789.6	767.2	791.3	.

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
16A	ORP (MV)	21	-11.6	-35	-110	165	.
16A	CONDUCTIVITY (UMHOS/CM)	21	392.8	396	368	415	.
16A	DISSOLVED OXYGEN (MG/L)	21	0.4	0.3	0.1	0.9	.
16A	TEMPERATURE (DEG C)	21	16.8	17	14.9	20.8	.
16A	PH (STANDARD UNITS)	21	7.3	7.3	7	7.4	0
16A	ALKALINITY (MG/L)	21	135.8	135	117	148	.
16A	PHEN-PH ALKALINITY (MG/L)	6	0	0	0	0	.
16A	ACIDITY (MG/L)	9	29.9	10	0	180	.
16A	CO2 ACIDITY (MG/L)	9	18.1	12	7	70	.
16A	CO2 (MG/L)	8	29.6	9.7	6.2	158	.
16A	CA/MG HARDNESS (MG/L)	23	172.5	170	149	278.1	.
16A	NITRATE+NITRITE NITROGEN (MG/L)	14	0	0	0	0.3	0
16A	TOTAL ORGANIC CARBON (MG/L)	22	0.6	0.5	0	1.2	.
16A	TOTAL INORGANIC CARBON (MG/L)	23	56.3	55	28	100	.
16A	SULFIDE (MG/L)	10	0	0	0	0	.
16A	CALCIUM (MG/L)	23	50.4	49	45	85	.
16A	DISSOLVED CALCIUM (MG/L)	6	51.8	51	47	59	.
16A	MAGNESIUM (MG/L)	23	11.3	11	9	16	.
16A	DISSOLVED MAGNESIUM (MG/L)	6	10.4	9.9	9.3	13	.
16A	SODIUM (MG/L)	23	18.1	18	15	23.2	.
16A	POTASSIUM (MG/L)	23	2.3	2.3	2.1	2.6	.
16A	CHLORIDE (MG/L)	23	1.4	1	1	4	0
16A	SULFATE (MG/L)	23	78.5	70	48	300	1
16A	FLUORIDE (MG/L)	14	0.4	0.4	0.1	0.6	0
16A	ALUMINUM (UG/L)	23	1174.8	550	50	4700	16
16A	DISSOLVED ALUMINUM (UG/L)	6	50	50	50	50	0
16A	ANTIMONY (UG/L)	5	1	1	1	1	0
16A	ARSENIC (UG/L)	23	1.3	1	1	3	0
16A	DISSOLVED ARSENIC (UG/L)	6	1	1	1	1	0
16A	BARIUM (UG/L)	20	50	50	30	80	0
16A	DISSOLVED BARIUM (UG/L)	6	60	60	30	100	0
16A	BERYLLIUM (UG/L)	5	1	1	1	1	0
16A	BORON (UG/L)	23	500	500	500	500	.
16A	DISSOLVED BORON (UG/L)	6	500	500	500	500	.
16A	CADMIUM (UG/L)	22	0.2	0.1	0.1	1	0
16A	DISSOLVED CADMIUM (UG/L)	6	0.5	0.4	0.1	1.2	0
16A	CHROMIUM (UG/L)	20	2.5	1	1	15	0
16A	DISSOLVED CHROMIUM (UG/L)	6	1	1	1	1	0
16A	COPPER (UG/L)	23	12.6	10	10	30	0
16A	DISSOLVED COPPER (UG/L)	6	10	10	10	10	0
16A	IRON - TOTAL (UG/L)	23	1889.6	1100	410	5900	23
16A	DISSOLVED IRON (UG/L)	6	603.3	695	210	900	4
16A	LEAD (UG/L)	21	2.5	1	1	8	0
16A	DISSOLVED LEAD (UG/L)	6	1	1	1	1	0

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16A	LITHIUM (UG/L)	15	25.8	30	10	40	.	
16A	DISSOLVED LITHIUM (UG/L)	6	24.2	30	10	30	.	
16A	MANGANESE (UG/L)	23	1271.7	1300	150	1700		23
16A	DISSOLVED MANGANESE (UG/L)	6	1233.3	1250	1100	1300		6
16A	MOLYBDENUM (UG/L)	8	20	20	20	20	.	
16A	DISSOLVED MOLYBDENUM (UG/L)	4	20	20	20	20	.	
16A	NICKEL (UG/L)	6	4.2	2.5	1	13		0
16A	SELENIUM (UG/L)	16	1	1	1	1		0
16A	DISSOLVED SELENIUM (UG/L)	2	1	1	1	1		0
16A	SILICON (UG/L)	18	8722.2	8350	4200	12000	.	
16A	DISSOLVED SILICON (UG/L)	6	8333.3	8300	7700	9200	.	
16A	STRONTIUM (UG/L)	20	365.5	350	300	650	.	
16A	DISSOLVED STRONTIUM (UG/L)	6	330	340	190	450	.	
16A	VANADIUM (UG/L)	20	11	10	10	20	.	
16A	DISSOLVED VANADIUM (UG/L)	6	10	10	10	10	.	
16A	ZINC (UG/L)	23	22.2	10	10	150		0
16A	DISSOLVED ZINC (UG/L)	6	10	10	10	10		0
16A	TOTAL DISSOLVED SOLIDS (MG/L)	23	248.7	250	210	280		0
16A	TOTAL SUSPENDED SOLIDS (MG/L)	16	58.8	10	1	330	.	
16A	WATER SURF. FR MP (M)	25	2.7	2.9	1.1	4.6	.	
16A	WATER SURF. ELVN (M, MSL)	14	230.7	231	227.8	232.6	.	
16A	WATER SURF. ELVN (FT, MSL)	14	756.9	758	747.4	763	.	

Table 1. Kingston Groundwater Quality Summary. Data from 89/01/04 to 94/12/08.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
16B	ORP (MV)	19	138.6	90	-10	443	.
16B	CONDUCTIVITY (UMHOS/CM)	19	403	410	375	420	.
16B	DISSOLVED OXYGEN (MG/L)	19	0.3	0.3	0.1	0.6	.
16B	TEMPERATURE (DEG C)	19	16.6	16.7	14.8	19.8	.
16B	PH (STANDARD UNITS)	19	7.3	7.3	6.9	7.4	0
16B	ALKALINITY (MG/L)	19	136.6	137	117	145	.
16B	PHEN-PH ALKALINITY (MG/L)	6	0	0	0	0	.
16B	ACIDITY (MG/L)	7	30.4	9	0	160	.
16B	CO2 ACIDITY (MG/L)	9	13.3	10	7	26	.
16B	CO2 (MG/L)	6	31.3	8.8	6.2	141	.
16B	CA/MG HARDNESS (MG/L)	20	174.4	171.5	154	207	.
16B	NITRATE+NITRITE NITROGEN (MG/L)	10	0	0	0	0.3	0
16B	TOTAL ORGANIC CARBON (MG/L)	19	0.5	0.4	0.2	1.3	.
16B	TOTAL INORGANIC CARBON (MG/L)	20	54.1	39.5	14	150	.
16B	SULFIDE (MG/L)	5	0	0	0	0	.
16B	CALCIUM (MG/L)	20	51.7	50.5	48	60	.
16B	DISSOLVED CALCIUM (MG/L)	5	52.8	49	46	65	.
16B	MAGNESIUM (MG/L)	20	11	11	8.2	14	.
16B	DISSOLVED MAGNESIUM (MG/L)	5	10	9.3	8.2	13	.
16B	SODIUM (MG/L)	19	18.6	18	0.1	35	.
16B	POTASSIUM (MG/L)	19	2.4	2.3	1.7	3.6	.
16B	CHLORIDE (MG/L)	20	1.5	1	1	4	0
16B	SULFATE (MG/L)	20	73.9	72.5	56	110	0
16B	FLUORIDE (MG/L)	10	0.4	0.5	0.1	0.8	0
16B	ALUMINUM (UG/L)	20	2297.5	270	50	12000	14
16B	DISSOLVED ALUMINUM (UG/L)	5	50	50	50	50	0
16B	ANTIMONY (UG/L)	5	1	1	1	1	0
16B	ARSENIC (UG/L)	20	1.2	1	1	3	0
16B	DISSOLVED ARSENIC (UG/L)	5	1	1	1	1	0
16B	BARIUM (UG/L)	18	64.4	50	30	200	0
16B	DISSOLVED BARIUM (UG/L)	5	50	40	20	80	0
16B	BERYLLIUM (UG/L)	5	1	1	1	1	0
16B	BORON (UG/L)	20	500	500	500	500	.
16B	DISSOLVED BORON (UG/L)	5	500	500	500	500	.
16B	CADMIUM (UG/L)	19	0.2	0.1	0.1	1	0
16B	DISSOLVED CADMIUM (UG/L)	5	0.3	0.3	0.1	0.6	0
16B	CHROMIUM (UG/L)	18	2.4	1	1	11	0
16B	DISSOLVED CHROMIUM (UG/L)	5	1	1	1	1	0
16B	COPPER (UG/L)	20	16	10	10	60	0
16B	DISSOLVED COPPER (UG/L)	5	10	10	10	10	0
16B	IRON - TOTAL (UG/L)	20	2516	325	10	12000	11
16B	DISSOLVED IRON (UG/L)	5	14	10	10	30	0
16B	LEAD (UG/L)	19	3	1	1	12	0
16B	DISSOLVED LEAD (UG/L)	5	1	1	1	1	0

Continued

16B	LITHIUM (UG/L)	13	22.5	20	10	70	.
16B	DISSOLVED LITHIUM (UG/L)	5	16.4	20	10	20	.
16B	MANGANESE (UG/L)	20	858	815	620	2000	20
16B	DISSOLVED MANGANESE (UG/L)	5	708	690	620	820	5
16B	MOLYBDENUM (UG/L)	10	20	20	20	20	.
16B	DISSOLVED MOLYBDENUM (UG/L)	5	20	20	20	20	.
16B	NICKEL (UG/L)	6	1	1	1	1	0
16B	SELENIUM (UG/L)	10	1	1	1	1	0
16B	SILICON (UG/L)	14	11271.4	9650	6500	28000	.
16B	DISSOLVED SILICON (UG/L)	5	8040	7700	7500	8800	.
16B	STRONTIUM (UG/L)	18	368.3	360	320	440	.
16B	DISSOLVED STRONTIUM (UG/L)	5	324	320	280	360	.
16B	VANADIUM (UG/L)	18	11.1	10	10	30	.
16B	DISSOLVED VANADIUM (UG/L)	5	10	10	10	10	.
16B	ZINC (UG/L)	20	13	10	10	40	0
16B	DISSOLVED ZINC (UG/L)	5	12	10	10	20	0
16B	TOTAL DISSOLVED SOLIDS (MG/L)	19	257.9	260	220	290	0
16B	TOTAL SUSPENDED SOLIDS (MG/L)	14	24	10.5	1	96	.
16B	WATER SURF. FR MP (M)	21	2.2	1.9	1.2	7	.
16B	WATER SURF. ELVN (M, MSL)	10	231	231.7	223.2	232.4	.
16B	WATER SURF. ELVN (FT, MSL)	10	757.9	760.2	732.3	762.6	.

Table 1. Kingston Groundwater Quality Summary. Data from 92/12/07 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
17	ORP (MV)	3	122	177	-13	202	.
17	CONDUCTIVITY (UMHOS/CM)	3	2029.7	1500	1429	3160	.
17	DISSOLVED OXYGEN (MG/L)	3	0.4	0.3	0.1	0.8	.
17	TEMPERATURE (DEG C)	3	17.9	17.8	16.5	19.3	.
17	PH (STANDARD UNITS)	3	6	6.1	5.6	6.3	3
17	ALKALINITY (MG/L)	3	84	88	71	93	.
17	PHEN-PH ALKALINITY (MG/L)	2	0	0	0	0	.
17	CO2 ACIDITY (MG/L)	2	168	168	166	170	.
17	CO2 (MG/L)	1	204	204	204	204	.
17	CA/MG HARDNESS (MG/L)	3	1011.6	935.4	910.4	1189	.
17	TOTAL ORGANIC CARBON (MG/L)	2	0.9	0.9	0.4	1.5	.
17	TOTAL INORGANIC CARBON (MG/L)	3	40.3	42	36	43	.
17	CALCIUM (MG/L)	3	366.7	340	330	430	.
17	DISSOLVED CALCIUM (MG/L)	2	360	360	340	380	.
17	MAGNESIUM (MG/L)	3	23.3	21	21	28	.
17	DISSOLVED MAGNESIUM (MG/L)	2	23	23	20	26	.
17	SODIUM (MG/L)	3	8.3	8.1	7.5	9.2	.
17	POTASSIUM (MG/L)	3	21.7	17	14	34	.
17	CHLORIDE (MG/L)	3	4	4	4	4	0
17	SULFATE (MG/L)	3	923.3	830	740	1200	3
17	ALUMINUM (UG/L)	3	17633.3	13000	1900	38000	3
17	DISSOLVED ALUMINUM (UG/L)	2	50	50	50	50	0
17	ANTIMONY (UG/L)	3	2.3	1	1	5	0
17	DISSOLVED ANTIMONY (UG/L)	2	3.5	3.5	2	5	0
17	ARSENIC (UG/L)	3	255	100	85	580	3
17	DISSOLVED ARSENIC (UG/L)	2	292.5	292.5	85	500	2
17	BARIUM (UG/L)	3	160	140	30	310	0
17	DISSOLVED BARIUM (UG/L)	2	15	15	10	20	0
17	BERYLLIUM (UG/L)	3	1	1	1	1	0
17	DISSOLVED BERYLLIUM (UG/L)	2	1	1	1	1	0
17	BORON (UG/L)	3	693.3	580	500	1000	.
17	DISSOLVED BORON (UG/L)	2	755	755	580	930	.
17	CADMIUM (UG/L)	2	0.9	0.9	0.4	1.4	0
17	DISSOLVED CADMIUM (UG/L)	2	0.2	0.2	0.1	0.3	0
17	CHROMIUM (UG/L)	2	40.5	40.5	25	56	0
17	DISSOLVED CHROMIUM (UG/L)	2	1	1	1	1	0
17	COPPER (UG/L)	3	33.3	20	10	70	0
17	DISSOLVED COPPER (UG/L)	2	10	10	10	10	0
17	IRON - TOTAL (UG/L)	3	65000	53000	42000	100000	3
17	DISSOLVED IRON (UG/L)	2	58000	58000	47000	69000	2
17	LEAD (UG/L)	3	24.7	27	1	46	0
17	DISSOLVED LEAD (UG/L)	2	1	1	1	1	0
17	LITHIUM (UG/L)	2	170	170	110	230	.
17	DISSOLVED LITHIUM (UG/L)	2	130	130	100	160	.
17	MANGANESE (UG/L)	3	2600	2100	2000	3700	3
17	DISSOLVED MANGANESE (UG/L)	2	2600	2600	2000	3200	2

Continued

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
17	MOLYBDENUM (UG/L)	2	20	20	20	20	.
17	DISSOLVED MOLYBDENUM (UG/L)	2	20	20	20	20	.
17	NICKEL (UG/L)	3	28.7	28	9	49	0
17	DISSOLVED NICKEL (UG/L)	2	5	5	1	9	0
17	SELENIUM (UG/L)	1	1	1	1	1	0
17	STRONTIUM (UG/L)	3	1733.3	1600	1400	2200	.
17	DISSOLVED STRONTIUM (UG/L)	2	1750	1750	1500	2000	.
17	VANADIUM (UG/L)	3	60	40	10	130	.
17	DISSOLVED VANADIUM (UG/L)	2	10	10	10	10	.
17	ZINC (UG/L)	3	77.7	73	30	130	0
17	DISSOLVED ZINC (UG/L)	2	40	40	40	40	0
17	TOTAL DISSOLVED SOLIDS (MG/L)	3	1400	1300	1000	1900	3
17	TOTAL SUSPENDED SOLIDS (MG/L)	3	980	940	200	1800	.
17	WATER SURF. FR MP (M)	4	2.5	2.6	2.3	2.6	.

Table 1. Kingston Groundwater Quality Summary. Data from 92/12/07 to 94/12/07.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX	NUMBER OF EXCEEDANCES
19	ORP (MV)	3	124	169	-16	219	.
19	CONDUCTIVITY (UMHOS/CM)	3	2301.3	2391	2040	2473	.
19	DISSOLVED OXYGEN (MG/L)	3	0.5	0.3	0.1	1.2	.
19	TEMPERATURE (DEG C)	3	17.9	17.8	17.7	18.1	.
19	PH (STANDARD UNITS)	3	6	5.9	5.9	6.2	3
19	ALKALINITY (MG/L)	3	95.3	102	70	114	.
19	PHEN-PH ALKALINITY (MG/L)	2	0	0	0	0	.
19	CO2 ACIDITY (MG/L)	2	440	440	414	466	.
19	CO2 (MG/L)	1	666	666	666	666	.
19	CA/MG HARDNESS (MG/L)	4	1601.3	1593.8	1525.6	1691.9	.
19	TOTAL ORGANIC CARBON (MG/L)	3	0.5	0.6	0.4	0.6	.
19	TOTAL INORGANIC CARBON (MG/L)	4	54.3	53.5	44	66	.
19	CALCIUM (MG/L)	4	570	560	550	610	.
19	DISSOLVED CALCIUM (MG/L)	3	470	460	400	550	.
19	MAGNESIUM (MG/L)	4	43.3	43.5	37	49	.
19	DISSOLVED MAGNESIUM (MG/L)	3	39.3	42	32	44	.
19	SODIUM (MG/L)	4	9.9	9.9	8.8	11	.
19	POTASSIUM (MG/L)	4	36.5	37	30	42	.
19	CHLORIDE (MG/L)	4	4	4	4	4	0
19	SULFATE (MG/L)	4	1850	1900	1400	2200	4
19	ALUMINUM (UG/L)	4	1467.5	1300	870	2400	4
19	DISSOLVED ALUMINUM (UG/L)	3	56.7	60	50	60	0
19	ANTIMONY (UG/L)	4	1.3	1	1	2	0
19	DISSOLVED ANTIMONY (UG/L)	3	1.7	2	1	2	0
19	ARSENIC (UG/L)	4	59.3	55.5	47	79	2
19	DISSOLVED ARSENIC (UG/L)	3	48.3	44	43	58	1
19	BARIUM (UG/L)	4	37.5	40	30	40	0
19	DISSOLVED BARIUM (UG/L)	3	23.3	20	20	30	0
19	BERYLLIUM (UG/L)	4	1	1	1	1	0
19	DISSOLVED BERYLLIUM (UG/L)	3	1	1	1	1	0
19	BORON (UG/L)	4	2275	2400	1200	3100	.
19	DISSOLVED BORON (UG/L)	3	1833.3	2000	1200	2300	.
19	CADMIUM (UG/L)	3	0.1	0.1	0.1	0.1	0
19	DISSOLVED CADMIUM (UG/L)	3	0.1	0.1	0.1	0.1	0
19	CHROMIUM (UG/L)	3	1	1	1	1	0
19	DISSOLVED CHROMIUM (UG/L)	3	1	1	1	1	0
19	COPPER (UG/L)	4	10	10	10	10	0
19	DISSOLVED COPPER (UG/L)	3	10	10	10	10	0
19	IRON - TOTAL (UG/L)	4	312500	325000	180000	420000	4
19	DISSOLVED IRON (UG/L)	3	286667	300000	230000	330000	3
19	LEAD (UG/L)	4	1.3	1	1	2	0
19	DISSOLVED LEAD (UG/L)	3	1	1	1	1	0
19	LITHIUM (UG/L)	3	273.3	310	200	310	.
19	DISSOLVED LITHIUM (UG/L)	3	266.7	300	200	300	.
19	MANGANESE (UG/L)	4	9625	9700	7100	12000	4
19	DISSOLVED MANGANESE (UG/L)	3	8033.3	8100	6800	9200	3

Continued

19	MOLYBDENUM (UG/L)	3	20	20	20	20 .	
19	DISSOLVED MOLYBDENUM (UG/L)	3	20	20	20	20 .	
19	NICKEL (UG/L)	4	1.3	1	1	2	0
19	DISSOLVED NICKEL (UG/L)	3	1	1	1	1	0
19	SELENIUM (UG/L)	1	1	1	1	1	0
19	STRONTIUM (UG/L)	4	3050	3000	2800	3400 .	
19	DISSOLVED STRONTIUM (UG/L)	3	2533.3	2600	2300	2700 .	
19	VANADIUM (UG/L)	4	10	10	10	10 .	
19	DISSOLVED VANADIUM (UG/L)	3	10	10	10	10 .	
19	ZINC (UG/L)	4	112.5	115	70	150	0
19	DISSOLVED ZINC (UG/L)	3	96.7	100	70	120	0
19	TOTAL DISSOLVED SOLIDS (MG/L)	4	2750	3000	1500	3500	4
19	TOTAL SUSPENDED SOLIDS (MG/L)	4	98	101	60	130 .	
19	WATER SURF. FR MP (M)	4	3.3	3.4	3.1	3.4 .	

Emory River Water Quality. Summary of 8 Stations near Kingston Fossil Plant.
Data from 60/05/12 to 85/01/01.

WELL I.D.	PARAMETER	N	MEAN	MEDIAN	MIN	MAX
Emory R.	DISSOLVED OXYGEN (MG/L)	231	8.6	8.5	0.2	13.7
Emory R.	COD (MG/L)	45	5.6	5	1	25
Emory R.	PH (STANDARD UNITS)	259	7.2	7.3	5.5	8.5
Emory R.	ALKALINITY (MG/L)	340	28	17	1	189
Emory R.	PHEN-PH ALKALINITY (MG/L)	339	0.2	0	0	87
Emory R.	ACIDITY (MG/L)	206	2	2	0	10
Emory R.	CA/MG HARDNESS (MG/L)	125	51	32	6	170
Emory R.	CALCIUM as CaCO3 (MG/L)	207	21	17	6	63
Emory R.	CALCIUM (MG/L)	77	12	8	1	33
Emory R.	MAGNESIUM as CaCO3 (MG/L)	113	16	14	2.9	52
Emory R.	MAGNESIUM (MG/L)	171	3.4	2.2	0.5	24
Emory R.	SODIUM (MG/L)	270	2.9	2.15	0	63
Emory R.	POTASSIUM (MG/L)	271	1.3	1.1	0	50
Emory R.	CHLORIDE (MG/L)	312	4.2	4	0.93	21
Emory R.	SULFATE (MG/L)	270	16.7	14	3	80
Emory R.	ALUMINUM (UG/L)	123	995	380	20	50000
Emory R.	ANTIMONY (UG/L)	61	2.5	1	1	30
Emory R.	ARSENIC (UG/L)	75	3.2	1	1	110
Emory R.	BARIUM (UG/L)	129	43	30	5	400
Emory R.	BERYLLIUM (UG/L)	15	10	10	10	10
Emory R.	BORON (UG/L)	13	103	100	10	250
ry R.	CADMIUM (UG/L)	132	1.2	1	0	30
R.	CHROMIUM (UG/L)	125	4	1	1	113
ory R.	COBALT (UG/L)	109	8.9	10	1	40
nory R.	COPPER (UG/L)	220	272	212	10	1850
Emory R.	IRON - TOTAL (UG/L)	286	628	430	7	4600
Emory R.	LEAD (UG/L)	132	8.9	10	5	31
Emory R.	LITHIUM (UG/L)	15	11.3	10	10	30
Emory R.	MANGANESE (UG/L)	272	124	100	2	1350
Emory R.	NICKEL (UG/L)	200	24.5	10	0	290
Emory R.	SELENIUM (UG/L)	69	1.2	1	1	8
Emory R.	SILVER (UG/L)	124	2.3	1	1	10
Emory R.	STRONTIUM (UG/L)	1	40	40	40	40
Emory R.	ZINC (UG/L)	212	35.2	20.5	1	200
Emory R.	WATER TEMP. (Deg. C)	289	18	19.3	1	29.6
Emory R.	TURBIDITY (JTU)	322	13	7	0	330
Emory R.	BOD.5 Day (MG/L)	92	1.4	1.1	1	4.3
Emory R.	TOTAL DISSOLVED SOLIDS (MG/L)	36	77.5	50	20	210
Emory R.	TOTAL SUSPENDED SOLIDS (MG/L)	240	19.4	10	0	195

emory.xls

A60 040130 500
Env. Document Type: Solid Waste Correspondence

cc: L. F. Campbell, KFP 1A-KST
EDM, WT CA-K

ENVIRONMENTAL ASSISTANCE CENTER
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
PHONE (865) 594-6035 STATEWIDE 1-888-891-8332 FAX (865) 594-6105

January 20, 2004

Ms. Janet Watts
Manager of Environmental Affairs
Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402-2801

RE: Proposed Minor Modification- Kingston Fossil Plant Landfill IDL 73-0094

Dear Ms. Watts:

The Division of Solid Waste Management has reviewed the proposed modification to the landfill's operation to allow an alternative waste placement mechanism. This modification has been reviewed in accordance with Rule Chapter 1200-1-7 Solid Waste Processing and Disposal. The request entails the addition of a dry hauling option for waste disposal into the cell at times when movement by wet slurry pumping poses some operational difficulty or is not desired. We find the revised waste movement mechanism meets the regulatory requirements, and we agree that this revision should be considered a minor modification. The Division hereby approves the request. Please retain this correspondence along with the initialed copy of your request as part of the facility's operation manual.

If you have any question concerning this correspondence, please call me at (865) 594-5474.

Yours truly,

Paula Plont
Environmental Protection Specialist
Division of Solid Waste Management

RECEIVED
JAN 27 2004
ENVIRON...
FOSS...

cc: Nashville Central Office—DSWM

JAN 0 8 2004

LFC 1-13
PJP 1-13

FILE COPY

MOD approved 1/15/04 PJP.

TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

January 6, 2004

Ms. Paula Plont
Division of Solid Waste
Knoxville EAC
2700 Middlebrook Pike, Suite 220
Knoxville, Tennessee 37921

TENNESSEE VALLEY AUTHORITY (TVA) – REQUEST FOR MINOR MODIFICATION – KINGSTON FOSSIL PLANT (KIF) IDL 73-0094

Dear Ms. Plont:

As you discussed with members of my staff, TVA seeks a minor modification of its Solid Waste Permit at KIF to facilitate the movement of ash into the permitted dredge when dredging is not possible. This modification would entail an additional sentence to be added to item (5) on page 6 of the closure plan originally submitted in September 1995. A revised page 6 is enclosed.

If you have questions concerning this correspondence, please call Larry C. Bowers at (423) 751-4947 in Chattanooga.

Sincerely,

Janet Watts

Janet K. Watts
Manager of Environmental Affairs
5D Lookout Place

Enclosure

cc: Mr. Glen Pugh
Solid Waste Section
Division of Solid Waste Management
5th Floor, L&C Tower
401 Church Street
Nashville, Tennessee 37243-1535

(3) The sluicing water continues on through the stilling pool before it is discharged into the river. Within the stilling pool the water is treated with lime as needed to control the pH.

(4) The dredge cell dikes are constructed out of bottom ash material collected from the the bottom ash sluice channel. This ash is collected and transported by pans to the dredge cell area. Pans, dozers, backhoe/loaders, front-end loaders and dump trucks are then used to shape and construct the dikes in accordance with the drawings included with this plan.

(5) During normal operation, material is then periodically dredged from the active ash pond and is hydraulically deposited to the interior of the dredge cell dikes. However, hydraulic dredging may not be possible or desired at all times and TVA will on occasion transport material to the dredge cell by other means including dipping and hauling.

(6) The disposal process is an essentially continuous incremental procedure. No daily earth cover will be required. Intermediate cover may be placed in areas of the dredge cell dike that do not achieve final contours and vegetated during inactive phases of operation. The ash is physically stable, nonputrescible, and is not an attractant for disease or animal vectors.

(7) The dredge cell side-slopes will continue at 3:1 with intermediate benches for erosion control and surface water drainage.

(8) Dust is controlled by utilizing a water tank truck as required on the haul roads and dikes.

(9) The ash disposal area dikes are formally inspected each spring.

2. <u>Drainage System</u>

The surface water drainage system will be operated with the same concepts as have proven to be historically successful during the operation of other TVA ash facilities.

The potential run-on from surrounding areas will continue to be intercepted in the existing diversion ditching network. The handling of this extraneous water assists in stormwater management and erosion control within the ash pond area.

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

DWC
KEN BURNETT

August 13, 1996

Mr. Randy M. Cole, Plant Manager
Tennessee Valley Authority
Kingston Fossil Plant
P.O. Box 2000
Kingston, Tennesee 37763

RE: Closure/Post-Closure Plan for ash pond disposal area

Dear Mr. Cole:

The closure-post closure plan for the ash pond disposal area at Kingston Fossil Plant, as prepared by Tennessee valley Authority, Site and Environmental Engineering Section, and submitted to our office on July 19, 1996, has been reviewed in accordance with Rule Chapter 1200-1-7, Solid Waste Processing and Disposal. This unit is presently a series of impoundments in which sluiced and dredged ash is ponded, with dikes raised in the dredge ponds as previously deposited ash settles. However, the site will be closed as a landfill when the area is filled to maximum capacity. Therefore the standards for closure of a coal ash monofill are being applied to the closure of this site. We find that the following additional information or revisions are necessary if the plan is to be approved:

(1) We cannot tell from the plans how the surface drainage channels across the former ash pond area are to be stabilized against erosion. This needs to be clarified.

(2) The second alternative for the final cap has only a bentonite-impregnated fabric product over the final ash surface, with no soil component in the cap. This is unacceptable; if the cap consists of only a membrane, there will be no cap at all at any point where there is a puncture, tear, or defect. Bentonite-impregnated fabrics are only approved in combination with soil liners, although a higher permeability (i.e., 1×10^{-6} cm/sec.) would be allowed for the soil component if a GCL material is also used.

(3) Only grasses which can develop their root system within the 1-foot loose soil/topsoil zone should be planted. Deep rooted species such as sericea lespedeza should not be used.

Please prepare and submit revisions to the closure/post closure plan to address these items. If you should have any questions concerning this review, do not hesitate to contact me.

594-5975

Yours truly,

Rick Brown

Rick Brown
Environmental Engineeer
Division of Solid Waste Management

RSB a:\tvakncl.doc

cc: DSWM- Nashville Central Office

CAPITAL PROJECT JUSTIFICATION FORM

1 **PROJECT NAME**
A Project
ASH POND 1 & 2 CLOSURE PLAN

2 **PROJECT ID**

I. PROJECT DESCRIPTION

3 **PROJECT LOCATION**

UNIT (if applicable): 00

4 **ORGANIZATION**

CAO	CFO	CNO	COO
			X

5 **IDENTIFY RELATED OUTAGE (If any)**

6 **TECHNICAL CONTACT**
NAME: E. JERRY REED
PHONE: 751-3516
LOCATION: CHATTANOOGA
LP 2G-C

7 **SPONSORED BY**
NAME: G.H. PIGG / JOE BENEDICT
PHONE: 423-945-7269
LOCATION: BULL RUN

8 **PROJECT CATEGORY**

ECONOMIC	REGULATORY	CUSTOMER	BOARD/STRATEGIC
	X		

9 **REASON FOR IMPROVEMENT (Consequences of not doing)**
INDUSTRIAL IMPOUNDMENTS WHICH HAVE BEEN DRAINED OR ARE NO LONGER IN SERVICE ARE SUBJECT TO POST-CLOSURE CARE AND CLOSURE REQUIREMENTS AS SOLID WASTE DISPOSAL FACILITIES.

10 **PROBLEM DEFINITION**
THE INACTIVE ASH DISPOSAL POND KNOWN AS POND 1 & 2 HAVE BEEN ABANDONED. ABANDONED INDUSTRIAL IMPOUNDMENTS WHICH WERE PREVIOUSLY REGULATED UNDER NPDES ARE REQUIRED TO CLOSE AS CLASS II SOLID WASTE DISPOSAL FACILITIES. THE TARGET IS TO SECURE A CLOSURE PLAN FOR THIS POND WHICH CONSIDERS ITS CURRENT USE AND POTENTIAL FUTURE USES.

11 **PROJECT SCOPE**

Reshape the inactive pond to promote positive surface drainage. Cover the ash deposits with soil and seed, fertilize and mulch.

Reshaping, covering, and seeding of the inactive pond will reduce risk associated with groundwater contamination and reclaim the area for future site use.

12 **IMPACT OF DELAY TO NEXT AVAILABLE IMPLEMENTATION WINDOW**

Moderate risk is assumed by not securing a state-approved closure plan for this inactive pond. Compliance orders with more stringent closure requirements could result in closure costs of 200 % of current costs.

13 **HOW WILL THE ACHIEVEMENT OF CLAIMED BENEFITS BE MEASURED FOR THIS PROJECT?**

The root cause for this action is a change in the Tennessee Division of Solid Waste Management's disposal rules governing soild waste disposal facilities. Since post closure care and financial assurance are required of all facilities, industrial impoundments which are no longer in service (no longer have an NPDES-permitted discharge) must be closed according to solid waste facility requirements.

CAPITAL PROJECT ECONOMIC ANALYSIS INPUT

BULL RUN FOSSIL PLANT

UNIT 1

PROJECT NAME: A Project UNIT: 00 PROJECT ID:

ASH POND 1 & 2 CLOSURE PLAN

Prior Years Cost $ 000's): 0

BENEFIT INPUT SECTION

YEAR	HEAT RATE IMPRVMNT BTU/KWH	EFOR FORCED OUTAGE HOURS	EFOR FORCED DERATING MWH	EFOR FORCED DERATING HRS	EFOR MWHL	O&M SAVINGS IN ($ 000'S)	STATION SERVICE SAVINGS IN KWH	OTHER BENEFITS SAVINGS IN ($ 000'S)	OUTAGE REDCTNS OUTAGE HRS REDUCED	PROJECT COST ($000'S)
1997	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0

Contingency included in Project Estimate : 0

CALCULATION AND BENEFIT VALUE SECTION

FISCAL YEAR	HEAT RATE BENEFIT IN ($ 000'S)	EFOR MWH IMPROVE	EFOR UNIT EFOR	EFOR SYSTEM EFOR	O&M SAVINGS IN ($ 000'S)	STATION SERVICE SAVINGS IN ($ 000'S)	OTHER BENEFITS SAVINGS IN ($ 000'S)	OUTAGE REDCTNS SAVINGS IN ($ 000'S)	BENEFIT VALUE* IN ($ 000'S)
1997	0	0	0.00%	0.000%	0	0	0	0	0
1998	0	0	0.00%	0.000%	0	0	0	0	0
1999	0	0	0.00%	0.000%	0	0	0	0	0
2000	0	0	0.00%	0.000%	0	0	0	0	0
2001	0	0	0.00%	0.000%	0	0	0	0	0
2002	0	0	0.00%	0.000%	0	0	0	0	0
2003	0	0	0.00%	0.000%	0	0	0	0	0
2004	0	0	0.00%	0.000%	0	0	0	0	0
2005	0	0	0.00%	0.000%	0	0	0	0	0
2006	0	0	0.00%	0.000%	0	0	0	0	0
2007	0	0	0.00%	0.000%	0	0	0	0	0
2008	0	0	0.00%	0.000%	0	0	0	0	0
2009	0	0	0.00%	0.000%	0	0	0	0	0
2010	0	0	0.00%	0.000%	0	0	0	0	0
2011	0	0	0.00%	0.000%	0	0	0	0	0
2012	0	0	0.00%	0.000%	0	0	0	0	0
2013	0	0	0.00%	0.000%	0	0	0	0	0
2014	0	0	0.00%	0.000%	0	0	0	0	0
2015	0	0	0.00%	0.000%	0	0	0	0	0
2016	0	0	0.00%	0.000%	0	0	0	0	0
2017	0	0	0.00%	0.000%	0	0	0	0	0

* ... to FY97 dollars is done next page of CJ

CAPITAL PROJECT JUSTIFICATION FORM

1 **PROJECT NAME**
A Project
ASH POND 1 & 2 CLOSURE PLAN

2 **PROJECT ID**

II. PROJECT ECONOMIC EVALUATION

14 **PROJECT COST**

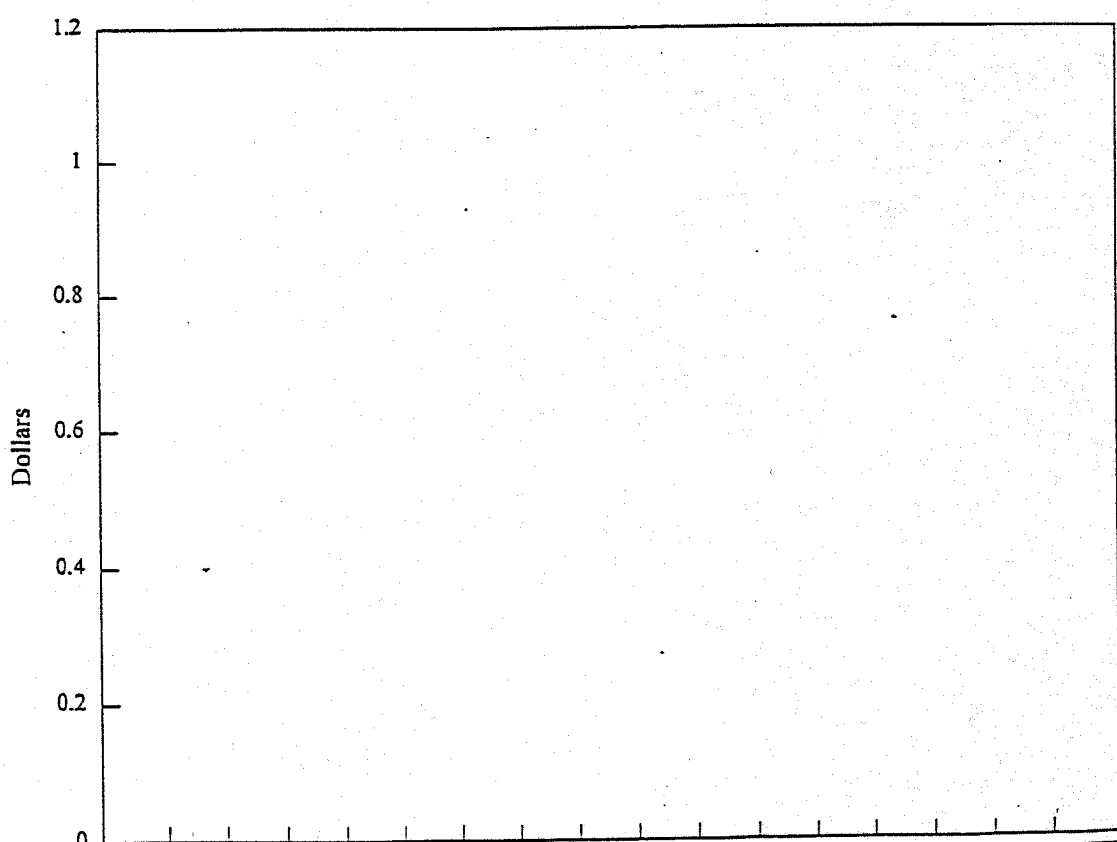
	Thousands of Dollars
SUNK COSTS:	~~0~~
REMAINING COST:	~~0~~
TOTAL COST:	~~0~~
CONTINGENCY:	~~0~~

15 **PROJECT ECONOMIC INDICATORS**

NPV @ 15% :	0	IRR:	ERR %
PI @ 15% :	ERR	PAYBACK:	3 yrs

16

PROJECT CASH FLOW



X-Axis	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		Outyrs
I COSTS *	~~0~~	0	0	0	0	0	0	0	0	0	0	0	0	0		0
I BENEFITS *	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
- NPV **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Non-discounted Cash flow
** Cumulative value of Present worth @ 15% Discount Rate

TVA-00014628

CAPITAL PROJECT JUSTIFICATION FORM

1 PROJECT NAME
A Project
ASH POND 1 & 2 CLOSURE PLAN

2 PROJECT ID

II. PROJECT ECONOMIC EVALUATION (continued)

17 COST ASSUMPTIONS

Cost Assumptions	CL L/M/H	Basis for Confidence Level (CL)	Sensitivity/Range Low	Most Probable	High
INSTALLATION COSTS = #	L	SIMILIAR JOB ON SITE INDICATES COSTS ARE COMPAREABLE	L		
ENGINEERING COST = #	L	PREVIOUS FIELD SUPPORT	L		

18 BENEFIT ASSUMPTIONS

Benefit Assumptions	CL L/M/H	Basis for Confidence Level (CL)	Sensitivity/Range Low	Most Probable	High
THE PLANT WILL BE FINED UPTO #25K PER DAY FOR EACH VIOCATION OF THE SOLIDS WASTE REGULATION NOT MET.	L	CLOSURE PLAN WILL BE DEVELOP TO MEET THE STATE OF TN. SPECIFICATIONS AND CLOSURE WILL BE APPROVED BY STATE OF TN.	L		

CAPITAL PROJECT JUSTIFICATION FORM

1 PROJECT NAME
A Project
ASH POND 1 & 2 CLOSURE PLAN

PROJECT ID

III. PROGRAM PLAN

19 IS THIS PROJECT PART OF A PROGRAM PLAN?

NO [X] 'If NO, go to section IV. YES [ ] ______ PROGRAM NAME

20 IDENTIFY THE PRINCIPAL OBJECTIVES OF THE PROGRAM

21 HOW DOES THIS PROJECT MEET THESE OBJECTIVES?

IV. PROJECT COORDINATION (For Non Program Plan)

22 SHOULD THE PROJECT BE LINKED TO ONE OR MORE OTHER PROJECTS?

PROJECT NAME	ID	APPROVED YES/NO	ORG	RELATIONSHIP

CAPITAL PROJECT JUSTIFICATION FORM

1 PROJECT NAME	2 PROJECT ID
A Project ASH POND 1 & 2 CLOSURE PLAN	

V. REGULATORY

(If this Project is not a Requirement, Commitment, or Nuclear Safety, skip this page.)

23 IS THIS PROJECT A REQUIREMENT? [X]

IS THIS PROJECT A COMMITMENT? [ ]

IS THIS PROJECT NUCLEAR SAFETY? [ ]

24 SOURCE OF REQUIREMENT, COMMITMENT, NUCLEAR SAFETY (Provide specific reference)

25 WHAT IS THE PENALITY FOR NON-COMPLIANCE (Financial, legal, political)?

LEGAL ACTION MAYBE TAKEN BY STATE OF TN., MAYBE A MONETARY FINE.

26 DOES THIS PROJECT TOTALLY RESOLVE THIS ISSUE?

YES [X] NO [ ] If NO, list the other projects required

PROJECT NAME	ID	APPROVED YES/NO	ORG	RELATIONSHIP

27 DOES THIS RESOLVE OTHER ISSUES?

YES [X] NO [ ]

28 THIS PROJECT MUST BE FUNDED THIS YEAR?

YES [ ] If YES, Why? NO [X]

This project must be completed by: [ ] (Date)

CAPITAL PROJECT JUSTIFICATION FORM

1 PROJECT NAME	2 PROJECT ID
A Project ASH POND 1 & 2 CLOSURE PLAN	

VI. BOARD/STRATEGIC

29 WHO DIRECTED?

30 WHEN?

31 WHY (Tie to Strategic Directive)?

32 THIS PROJECT MUST BE FUNDED THIS YEAR?

YES [ ] If YES, Why? NO [ ]

This project must be completed by: [ ] (Date)