CLOSURE/POST-CLOSURE PLAN
ASH POND AREA

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

JULY 1995

PRELIMINARY

TVA

Prepared By:

Tennessee Valley Authority
Site and Environmental Engineering Section

TVA 489H (EN DES-2-78) TENNESSEE VALLEY AUTHORITY SHEET OF

SUBJECT KIF Dredge Cells - Survey to tie in new dike w/ existing PROJECT

BKE 12/21/95

COMPUTED BY DATE CHECKED BY DATE

Weather: Clear, 35°F

SETUP 1

Pt	+	H.I.	−	Elev.	Descr.
DREDGE2				793.56	Angle iron, NW corner cell 3
ASH26	5.18	798.74			Concr. Mon.
℄ Begin Sta			16.10	782.64	

SETUP 2

Pt	+	HI	−	Elev	Descr
ASH26				794.13	Concr. Monument
Dredge 2	5.42	799.55			Angle iron
			14.30	785.25	

16.50
15.68
.82

179°41'00"

TVA

FAX COVER

Send To:

Name: Keith Elder Date: 12/18/95

Company: TVA Fossil & Hydro

Address:

Phone: 751-6370

Fax Number: 751-7094

Verification Number:

Number of pages including cover: 2

Subject: Kingston FP Ash Pond Control

From: Tennessee Valley Authority

Name: Rudy Vincent

Organization: G.I.E.

Address:

Tennessee Valley Authority
Geographic Information
And Engineering

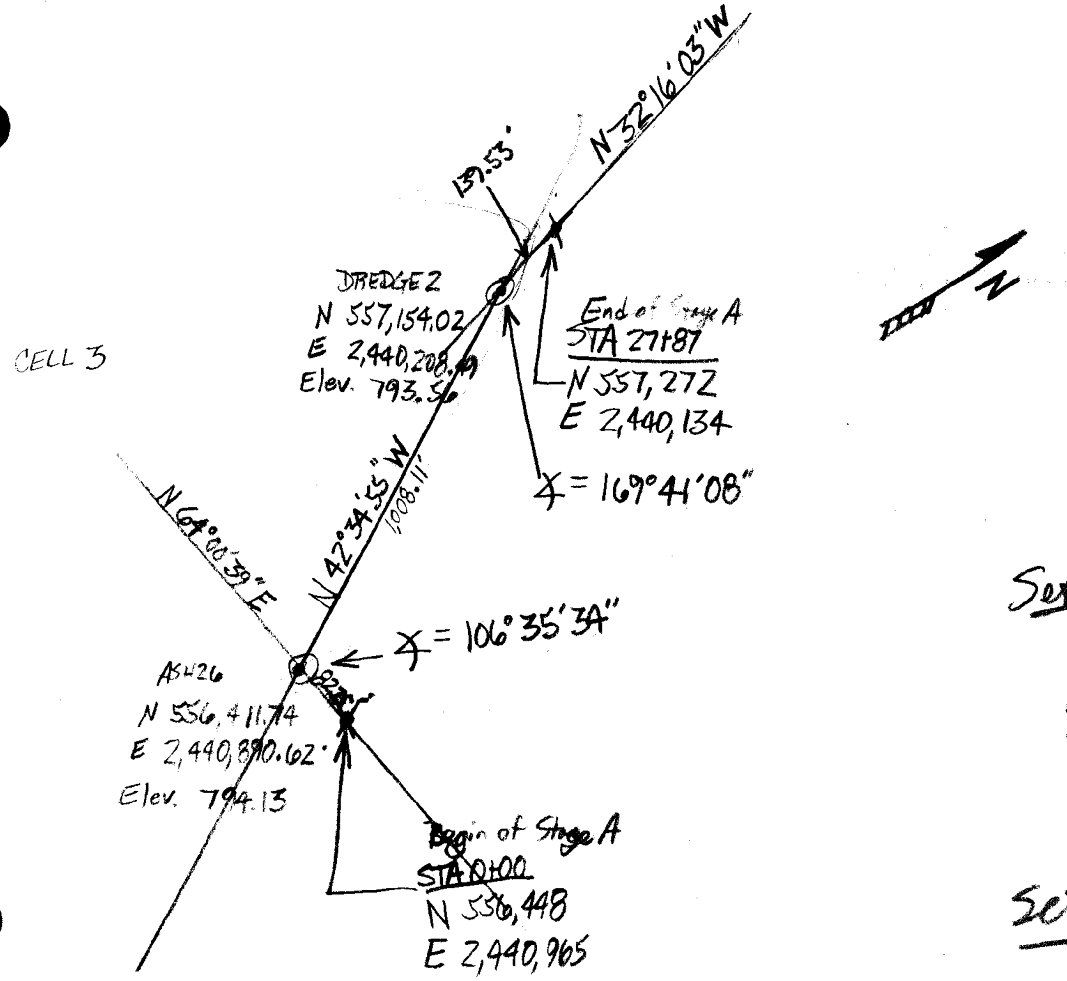
Project: KINGSTON FOSSIL PLANT
ASH POND CONTROL

Projection: TENNESSEE LAMBERT
Horizontal Datum: NAD 27 Order: 4TH Units: US Survey Feet
Vertical Datum: NGVD 29 Order: 4TH Units: US Survey Feet

Printing Date: 12-18-1995

Name	Northing	Easting	Elev	Remarks
ASH-26	556411.74	2440890.62	794.13	CONCRETE MONUMENT
DREDGE-2	557154.02	2440208.49	793.56	ANGLE IRON

[illegible]: Coordinat[illegible]
and [illegible]
plant [illegible]



Setup 1

247° 00' 45"
106 35 34
353 35 79
353 36 19

Setup 2

~~[illegible]~~
180°19'00"
169°41'08"
349°60'08"
350°00'08

64 00 39
+ 42 34 55
106 34 94
106° 35' 34"

42 34 55
− 32 16 03
10° 18' 52"

179 59 60
− 10 18 52
169° 41' 08"

① Set on ASH26, sight on DREDGE2, turn 106°35'34" to the right, measure distance of 82.75'
should be near elev. 783.0

② Set on DREDGE2, sight on ASH26, turn 169°41'08" to the left, measure distance of 139.53'
Should be near elev. 783.0

14.98
13.58
1.40

TVA

FAX COVER

Send To:

Name: Kieth Elder/LYNN PETTY Date: 7/26/95

Company:

Address:

Phone:

Fax Number:

Verification Number:

Number of pages including cover:

Subject:

From: Tennessee Valley Authority

Name: Ed Phillips

Organization: Maps & Surveys - TVA

Address:

X-8416

KIF GW Well Locations

29 March 1990

TENNESSEE VALLEY AUTHORITY
MAPS & SURVEYS DEPARTMENT
ENGINEERING

KINGSTON STEAM PLANT
BORING MONITORING WELLS

DATES OF SURVEY: 4-8 MAY 1989
7 MARCH 1990

BOOKS: ESS-3102 PAGES 18-28
ES-3604 PAGES 2-6,16-17

Designation	NAD 27 4th Order Tenn. Lambert Coordinates	Geodetic Coordinates (Deg-Min-Sec)	Plant Grid Coordinates *
KSW-2	X= 2,439,476.6 Y= 554,606.1	35-54-23.274 N 84-30-57.569 W	W 14+06 N 26+07
KSW-4A	X= 2,440,561.0 Y= 558,112.4	35-54-57.785 N 84-30-43.742 W	W 24+06 N 61+38
KSW-4B	X= 2,440,564.1 Y= 558,118.0	35-54-57.839 N 84-30-43.702 W	W 24+07 N 61+44
KSW-5	X= 2,442,354.5 Y= 556,714.7	35-54-43.692 N 84-30-22.199 W	W 1+41 N 59+4[illegible]
[illegible]	[illegible] 2,442,367.0 [illegible],719.8	35-54-4[illegible] [illegible]	

Designation	NAD 27 4th Order Tenn. Lambert Coordinates	Geodetic Coordinates (Deg-Min-Sec)	Plant Grid Coordinates *
KSW-9A	X= 2,439,482.8 Y= 553,767.2	35-54-14.978 N 84-30-57.649 W	W 9+44 N 19+07
KSW-9B	X= 2,439,492.5 Y= 553,779.1	35-54-15.093 N 84-30-57.529 W	W 9+42 N 19+22
KSW-10	X= 2,439,725.1 Y= 553,287.0	35-54-10.193 N 84-30-54.792 W	W 4+79 N 16+36
KSW-10A	X= 2,439,750.4 Y= 553,305.4	35-54-10.371 N 84-30-54.481 W	W 4+68 N 16+65
KSW-10B	X= 2,439,738.1 Y= 553,296.2	35-54-10.282 N 84-30-54.633 W	W 4+73 N 16+51
KSW-11B	X= 2,439,013.2 Y= 552,749.6	35-54-04.985 N 84-31-03.544 W	W 7+84 N 7+97
KSW-12A	X= 2,438,625.3 Y= 553,907.7	35-54-16.496 N 84-31-08.045 W	W 17+40 N 15+57
KSW-12B	X= 2,438,629.2 Y= 553,938.5	35-54-16.799 N 84-31-07.993 W	W 17+53 N 15+85
KSW-13A	X= 2,440,338.8 Y= 554,661.4	35-54-23.692 N 84-30-47.080 W	W 7+13 N 31+23
KSW-13B	X= 2,440,311.1 Y= [illegible],656.7	35-54-23.650 N 84-30-47.417 [illegible]	[illegible]

TVA-00012573

Designation	NAD 27 4th Order Tenn. Lambert Coordinates	Geodetic Coordinates (Deg-Min-Sec)	Plant Grid Coordinates *
KSW-16A	X= 2,439,081.6 Y= 556,533.3	35-54-42.391 N 84-31-02.015 W	W 27+87 N 40+08
KSW-16B	X= 2,439,101.4 Y= 556,551.3	35-54-42.566 N 84-31-01.772 W	W 27+80 N 40+34

(*) Note: Expected accuracy of plant grid coordinates is approximately two feet.

Descriptions

None Given

Designation	4th Order Elevation (Feet)	Remarks
KSW-2	767.8	
KSW-4A	755.2	
KSW-4B	753.9	
KSW-5	756.0	
KSW-5A	753.1	
KSW-5B	753.7	
KSW-6A	752.2	Top of pipe
KSW-6B	751.8	
KSW-8	770.9	
KSW-9A	772.5	
KSW-9B	772.4	
KSW-10	756.8	
KSW-10A	756.3	
KSW-10B	756.4	

Designation	4th Order Elevation (Feet)	Remarks
KSW-15A	796.1	Top of pipe inside of casing - High side of pipe.
KSW-15B	795.9	Top of pipe inside of casing - High side of pipe.
KSW-16A	768.6	
KSW-16B	768.1	

CLOSURE/POST-CLOSURE PLAN
ASH POND AREA

TENNESSEE VALLEY AUTHORITY

KINGSTON FOSSIL PLANT

JULY 1995

Prepared By:

Tennessee Valley Authority
Site and Environmental Design Section

TITLE				REPORT NO.
CLOSURE/POST-CLOSURE PLAN ASH POND AREA				PLANT/UNIT KINGSTON FOSSIL PLANT
VENDOR	CONTRACT No.	KEY NOUNS ASH POND, CLOSURE		
APPLICABLE DESIGN DOCUMENTS	REV		MEDS ACCESSION NUMBER	
	R0			
REFERENCES	R1			
	R2			

TENNESSEE VALLEY AUTHORITY
FOSSIL & HYDRO POWER
FOSSIL ENGINEERING

JOHN
THIS SHEET WILL BE REPLACED WITH A TYPED PAGE.

	Revision 0	R1	R2
Date			
Prepared			
Checked			
Submitted			
Reviewed			
Recommended			
Approved			

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

Table of Contents

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.

(I BELIEVE THIS STATEMENT IS WRONG, LARGE STILLING POOL SHOULD PROVIDE FREE WATER VOLUME. OK as is

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 760,000 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 projected date of closure for the Ash Disposal facility will be affected by TVA's schedule for completing dredging to the new dredged ash disposal area, filling the active ash pond with ash, and by generation rates. 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 names, addresses, 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
(615) 376-6135

As of date of this report, the plant manager is Mr. Randy M. Cole.

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 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, 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 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 using 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. TN0005444 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 final cover material and establishment of vegetative cover will be accomplished as soon as possible. This helps control erosion and maintains an effective drainage system. Past operations have maintained good attention to detail in this regard. This attention to detail will continue in order to keep erodible ash under erosion control.

In areas where final contours are not achieved but will be reserved for later use, an intermediate cover of soil suitable for support of vegetative growth will be placed and seeded to establish vegetation. This material may be removed at a later date when stacking resumes. As with the areas receiving final cover this material will be placed as soon as possible to aid in erosion and dust control.

3. Leachate Collection

This facility currently does not have a leachate collection system. Monitoring and investigations conducted by TVA at other sites and previously furnished to DSWM conclude that during active ash stacking little or no leachate will be produced and site groundwater monitoring does not indicate evidence of leachate contamination.

Therefore, in accordance with the March 18, 1990 regulation (1200-1-7-.04)(1)(b)3. (page .04-1) leachate collection is not required for this facility since the facility currently does not have a leachate collection system and there is no indication of leachate contamination.

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 only 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 produced gases.

5. **Final Cover**

The final cap to be utilized on top of the ash will be as follows (from top layer downward):

- Soil suitable for the support of vegetation (12")
- Drainage layer with permeability 1×10^{-1} cm/sec
- Impervious liner

The footprint for the ash disposal area to receive final cover is shown on drawing 10W426-1. 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 proved 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 abandon 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. ~~(Commencement of construction for closure or completion of closure construction project????????)~~

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 ~~(is this sufficient?)~~.

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

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.

NEW SECTION!

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 1×10^{-7} cm/sec 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.

- 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.

<u>Clay Construction Certification</u>: 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-24887. Material should contain less than 30% by weight of the fragment retained on a 3/4-inch sieve per ASTM D422. 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
Sericea Lespedeza (Lespedeza cuneata), scarified	95	85
Interstate Sericea Lespedeza (Lespedeza cuneata, variety Interstate), scarified	95	85
White Clover (Trifolium repens)	95	85
Alsike Clover (Trifolium repens hybridum)	95	85

1

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	
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

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

(4) Interstate Sericea Lespedeza
(scarified) . . . . 30 pounds per acre 1
Kentucky 31 Fescue . . . 30 pounds per acre
Total mixture . . . 60 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

(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 1
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 1

(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

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.

APPENDIX B

TCLP and VOC Testing of KIF Ash

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		

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

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

PROJECT ID ____

REFERENCE: ☐ WORKPLAN ☐ OTHER

ACC'T 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 ____

LABORATORY COMMENTS ____

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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 (1×10^{-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.

TABLE OF CONTENTS

TABLE OF CONTENTS

(continued)

LIST OF FIGURES

Page

LIST OF TABLES

TABLE OF CONTENTS

(continued)

Page

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.

[illegible]

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.

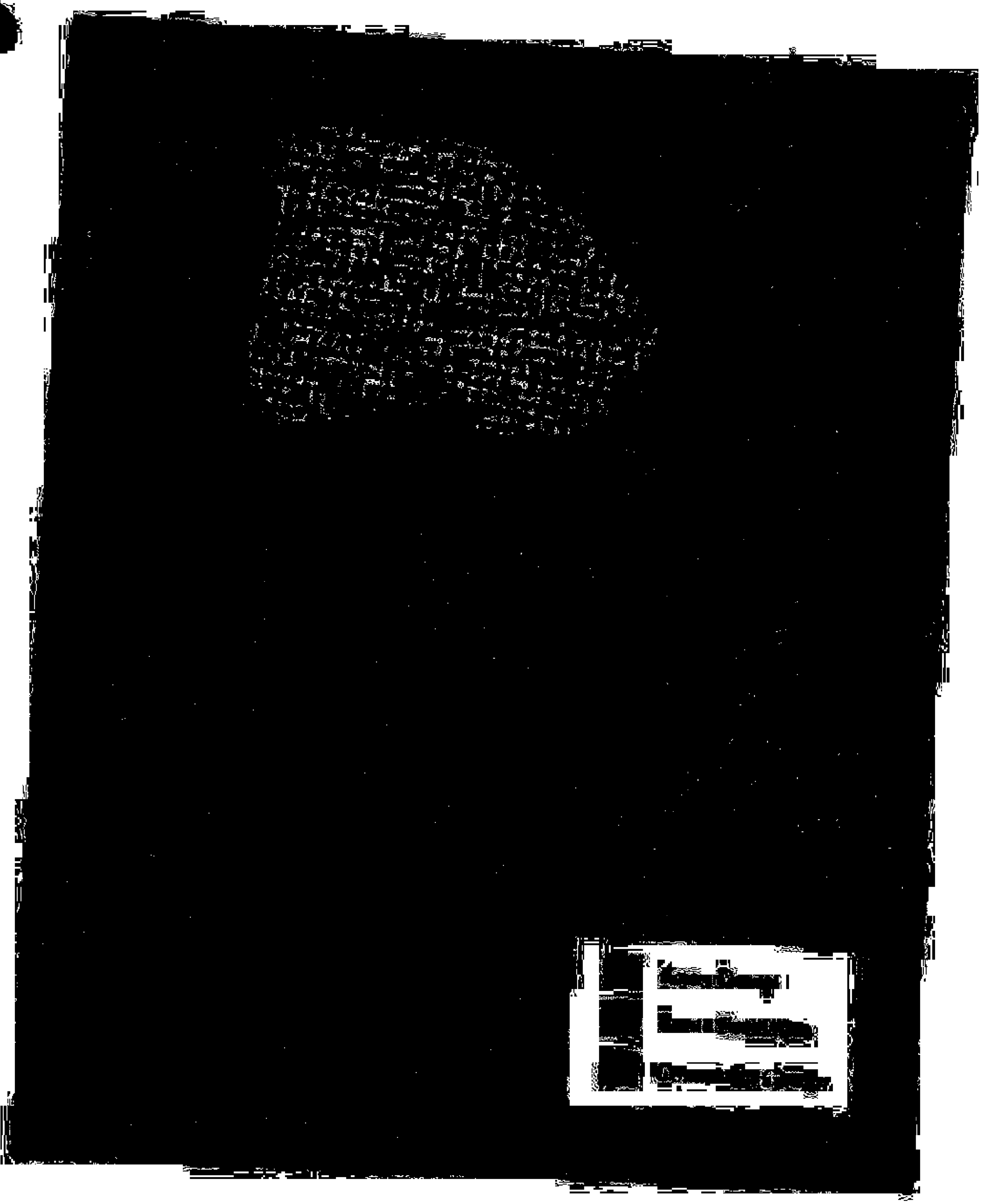
A third investigation was conducted by Singleton Laboratories [1994] in the dredge cell area which provided additional useful subsurface information. Two-inch split-spoon and three-inch Shelby tube samples were collected at ten sites for laboratory geotechnical testing. Top-of-rock and groundwater level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



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

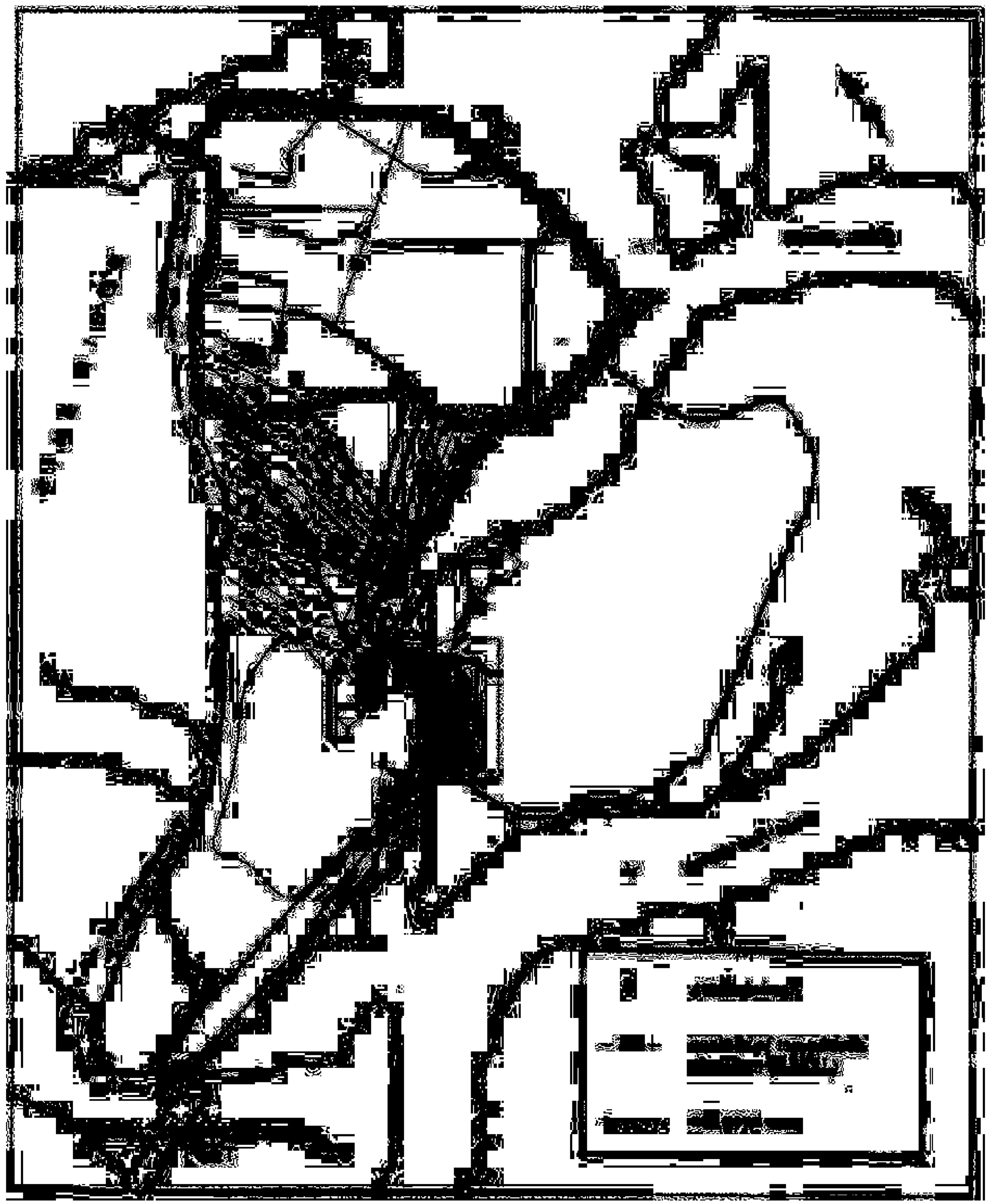
A mantle of predominantly alluvial soils generally lies above bedrock in the ash pond area as indicated in the two hydrogeologic profiles presented on Figure 2-3 and the soil isopachous map of Figure 2-4. Soil thickness is highly variable, ranging from about 5 ft along a portion of the northern perimeter 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.



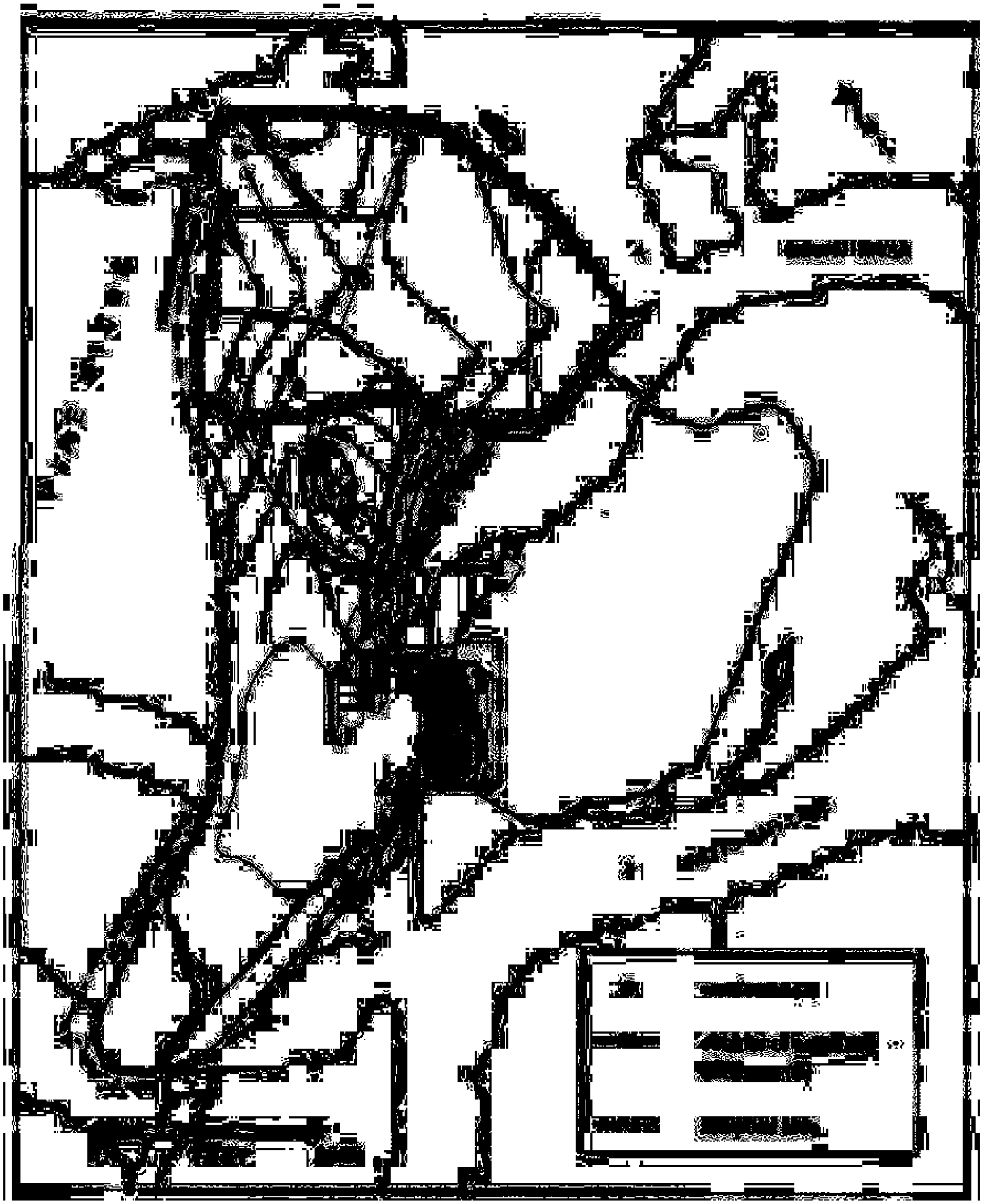


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TABLE 2-1

Summary of Hydraulic Conductivity Data

Well No.	Laboratory Permeameter Tests				Field Tests			
	Sample Elevation (ft-MSL)	Kh (cm/s)	Kv (cm/s)	Material Type	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

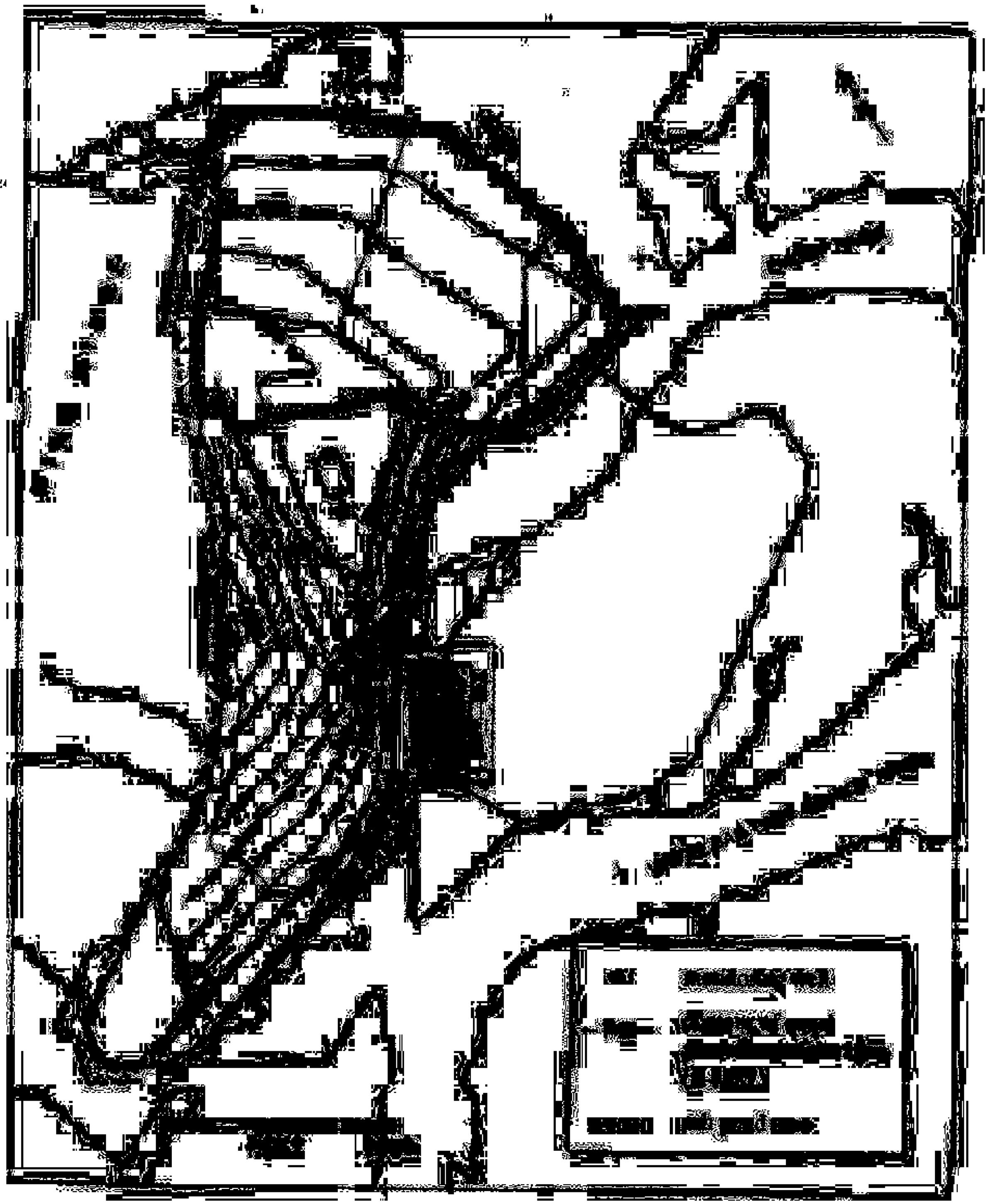
Based on historical meteorological data for Oak Ridge (approximately 20 miles northwest of the site), the annual precipitation at the site is estimated to range from 39 to 70 inches and average approximately 52 inches. Average net groundwater recharge at the site, according to the Kingston groundwater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

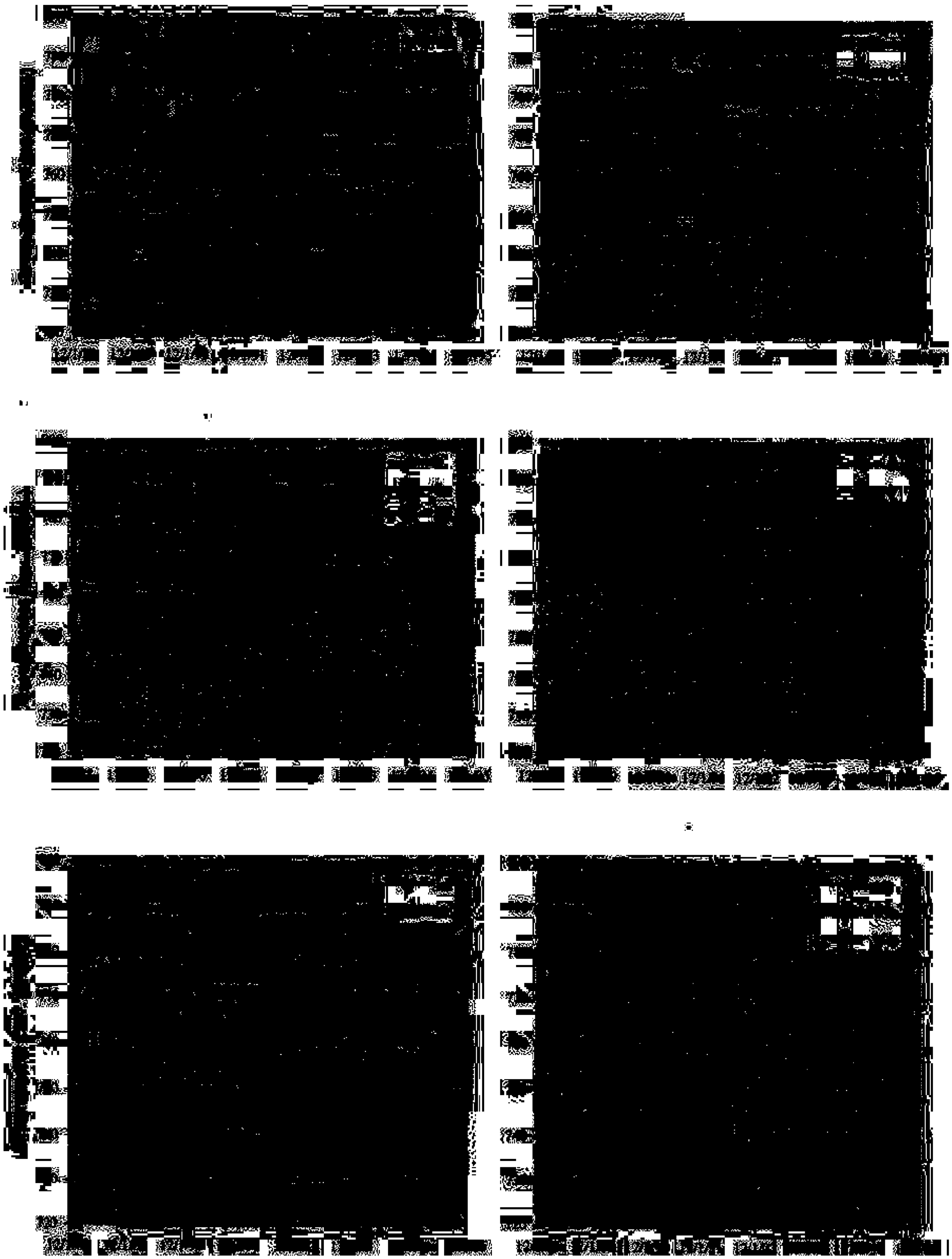
3. GROUNDWATER QUALITY

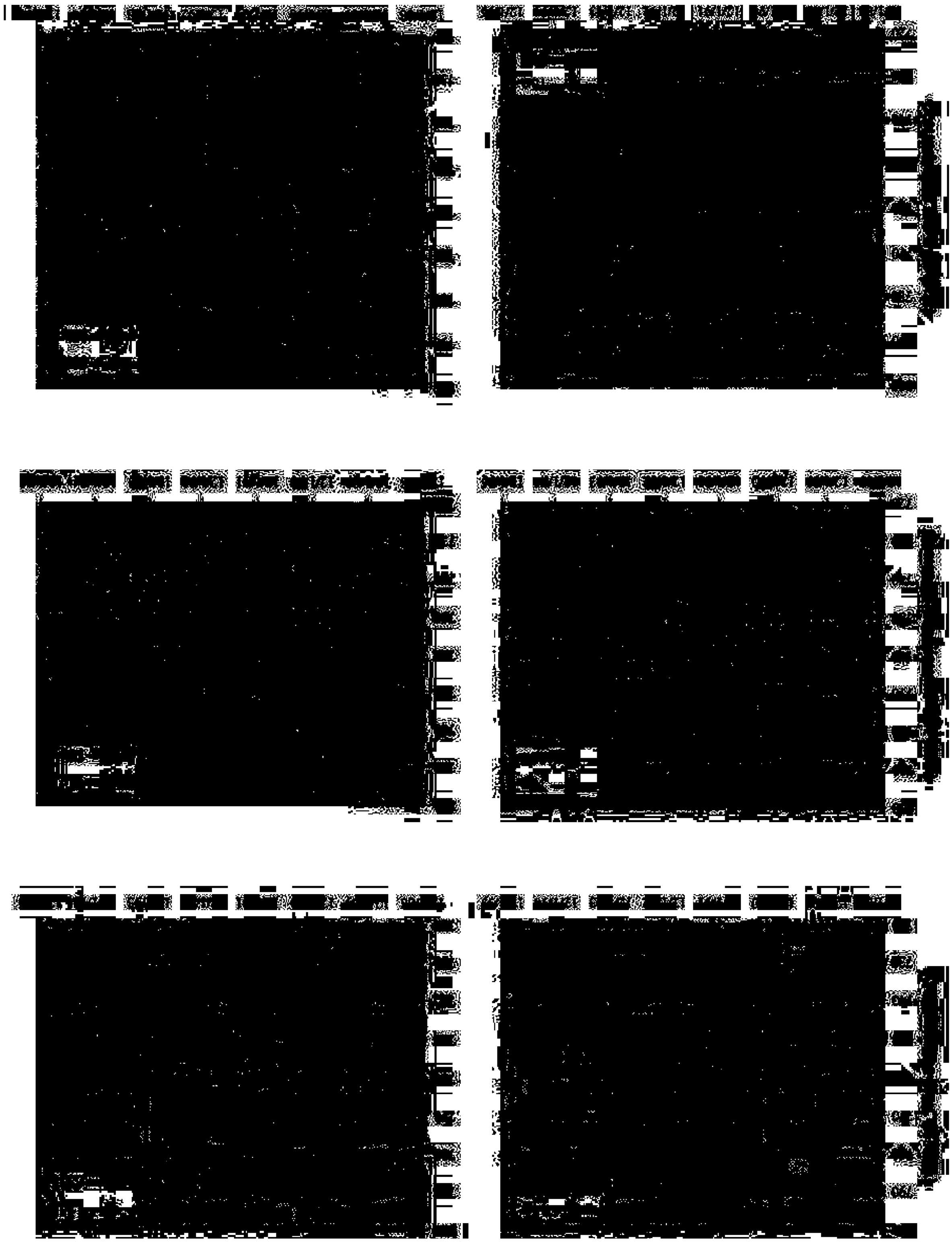
Methods and Approach

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







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

		Well I.D.											
		CYDB		4A		4B		6A		9A		10	
Parameter	Units	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	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	

		10A		10B		14A		14B		17		19	
		Tot	Diss	Tot	Diss	Tot	Diss	Tot	Diss	Tot	Diss	Tot	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	

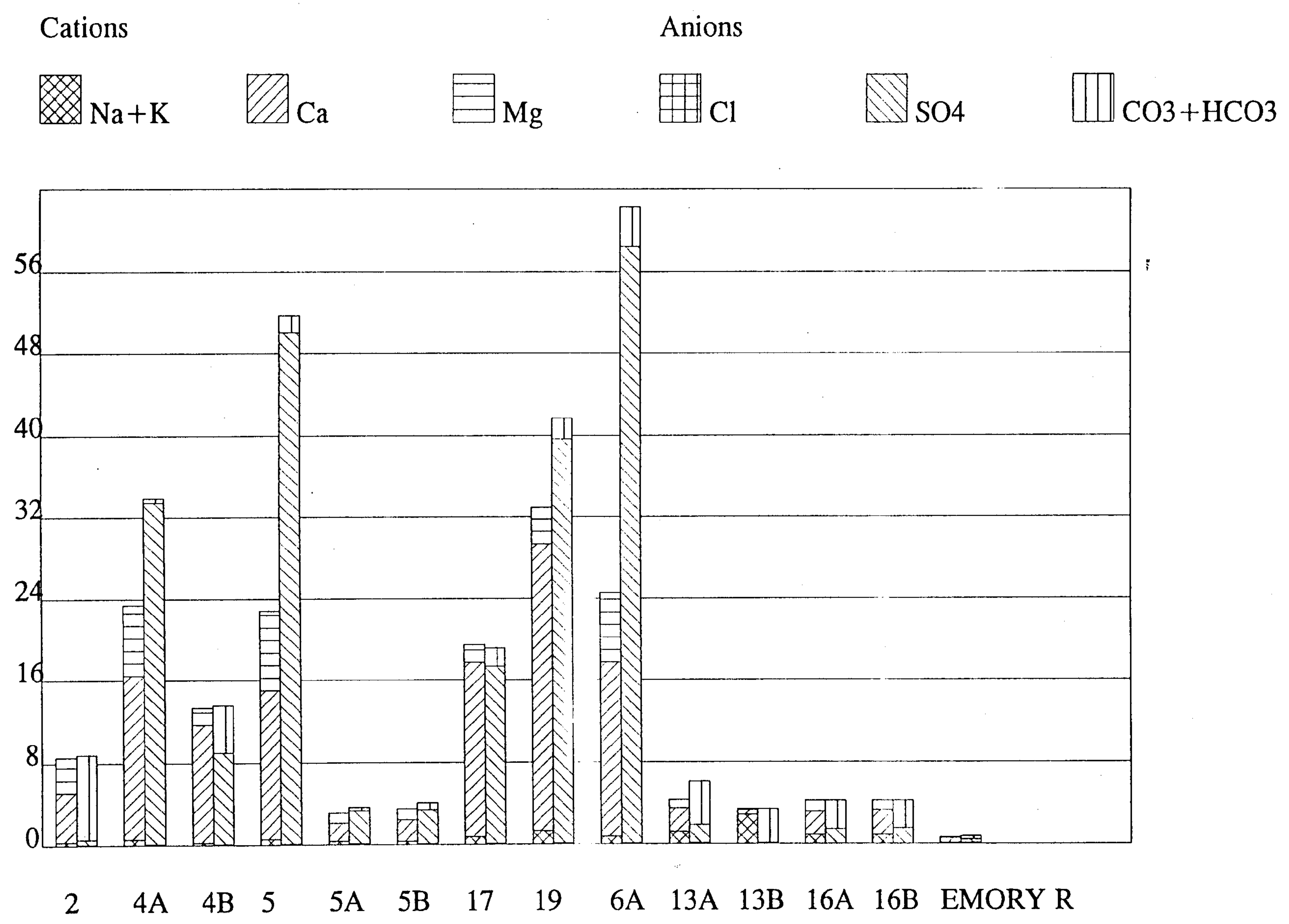


Figure 3-1. Ionic Distributions for Ash Pond Area

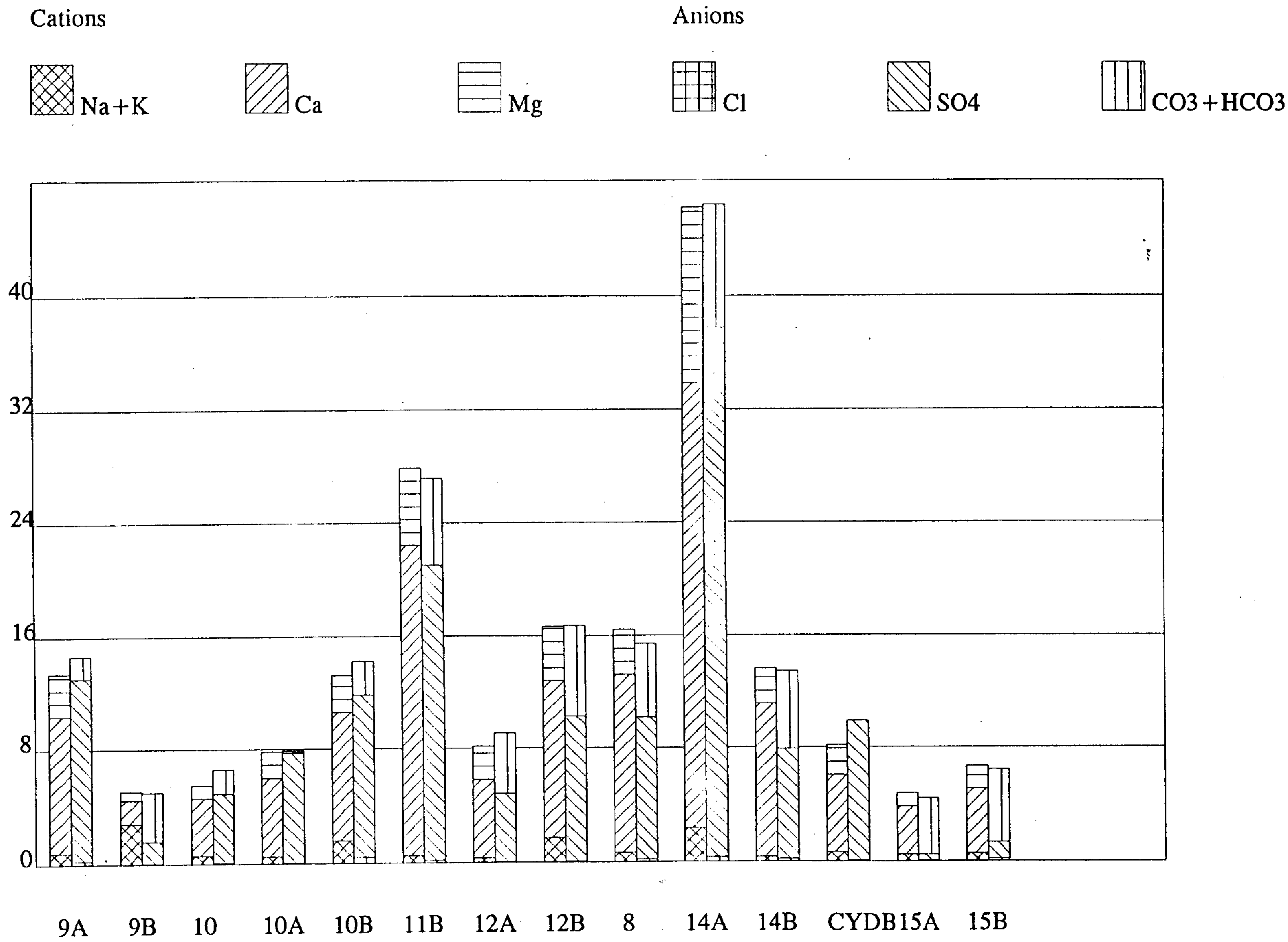


Figure 3-2. Ionic Distributions for Metal Cleaning Pond and Coal Yard Areas

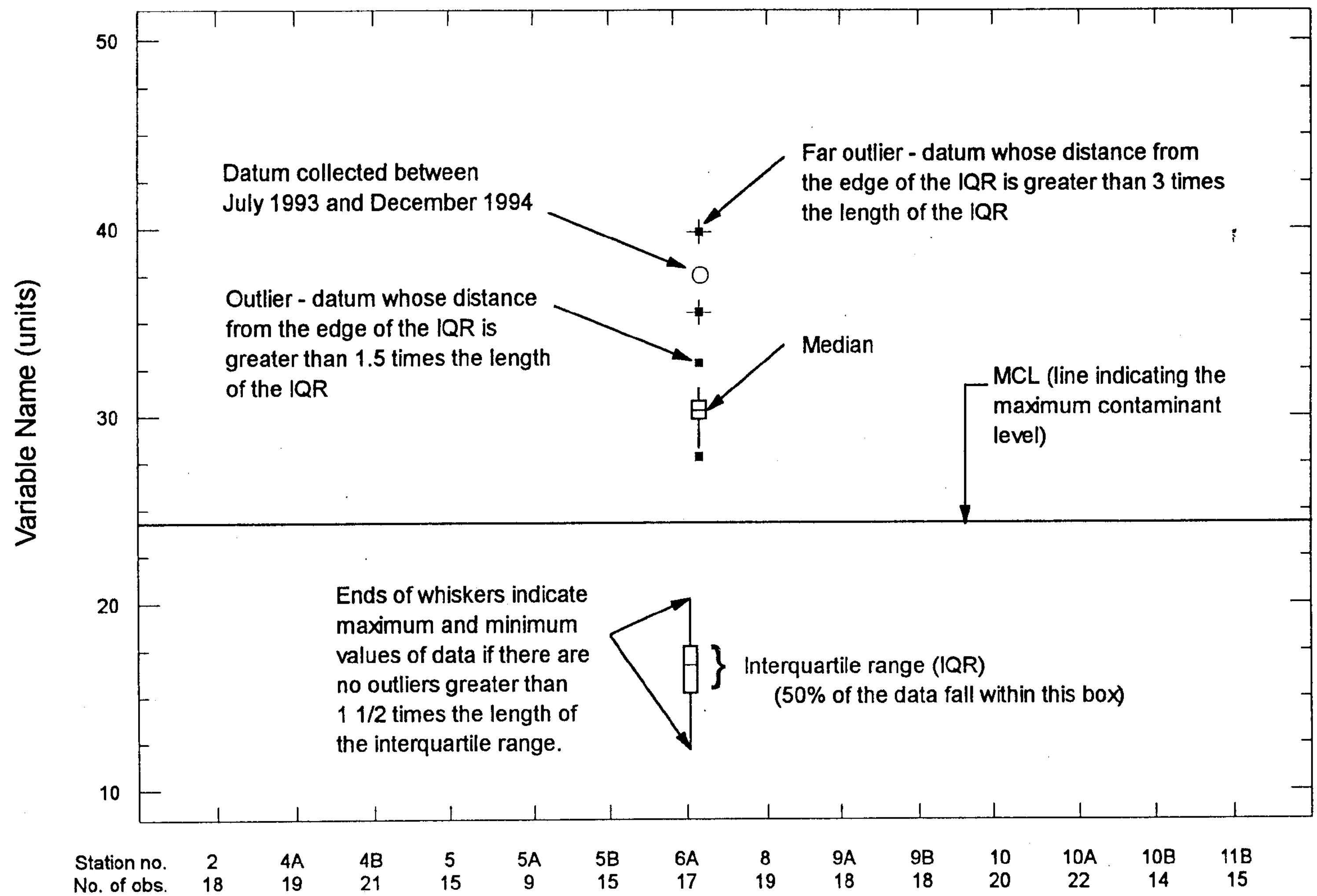


Figure 3-3. Key to Box and Whiskers Plots

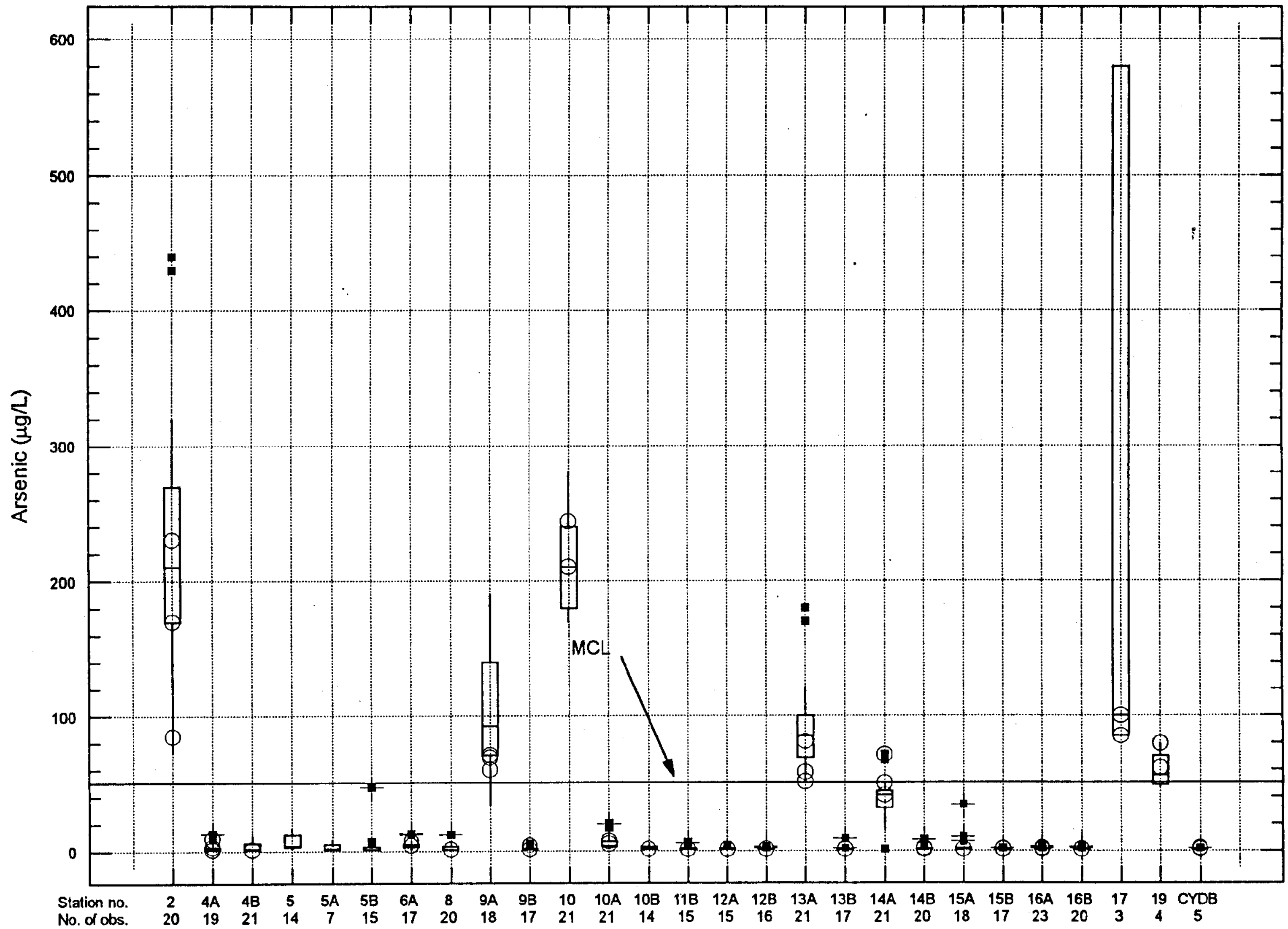


Figure 3-4. Arsenic Groundwater Data Through April 1995

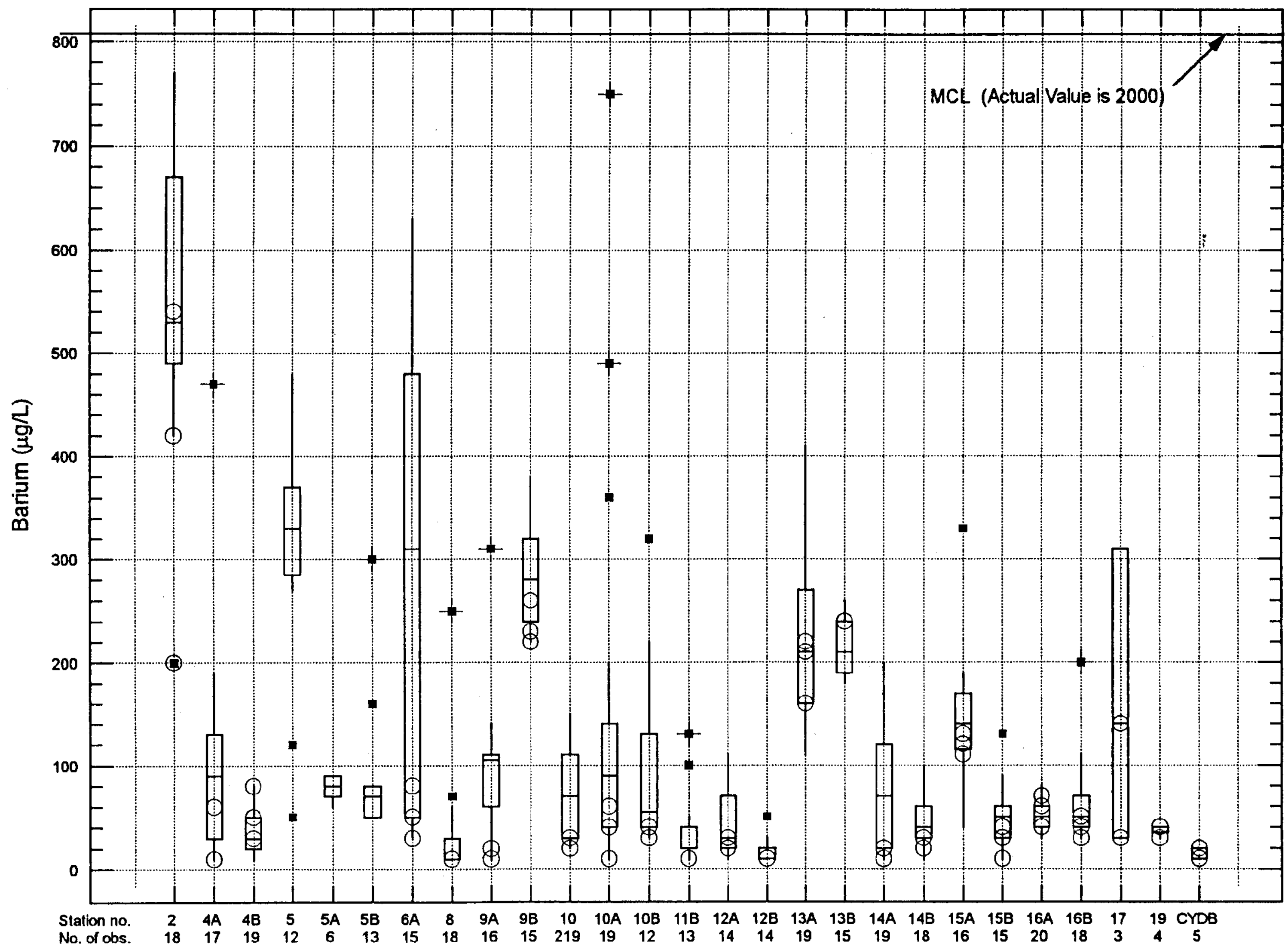


Figure 3-5. Barium Groundwater Data Through April 1995

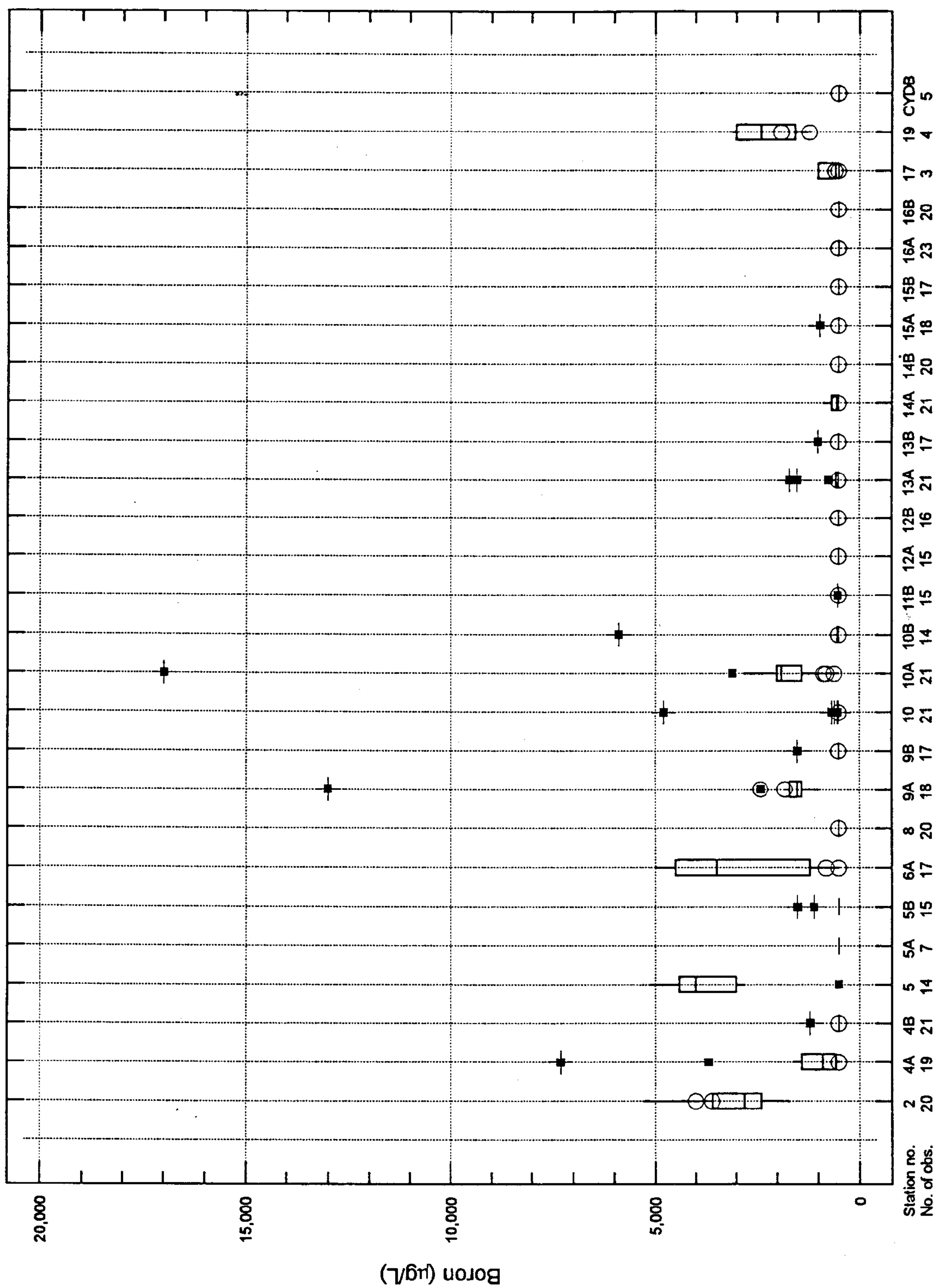


Figure 3-6. Boron Groundwater Data Through April 1995

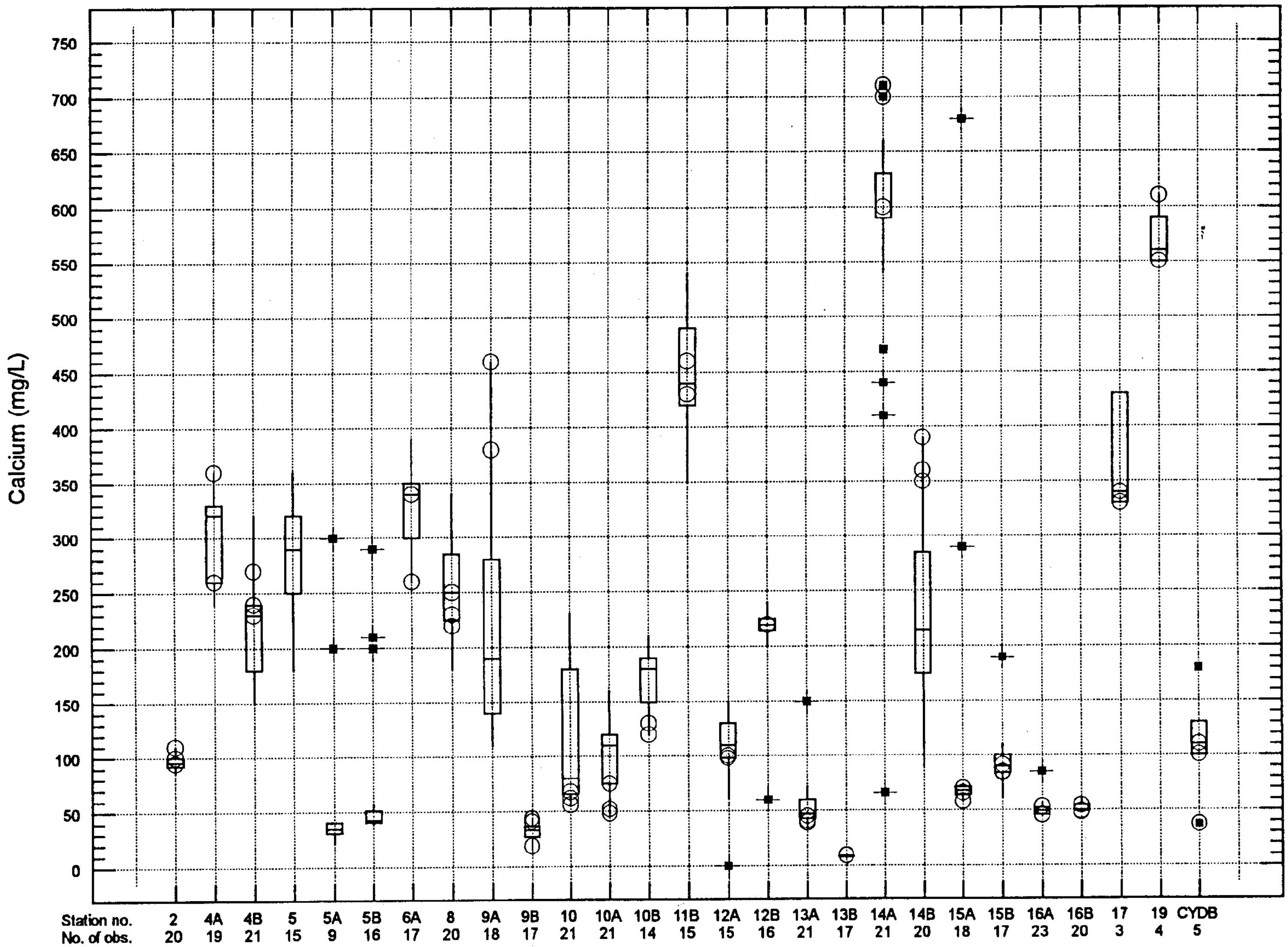


Figure 3-7. Calcium Groundwater Data Through April 1995

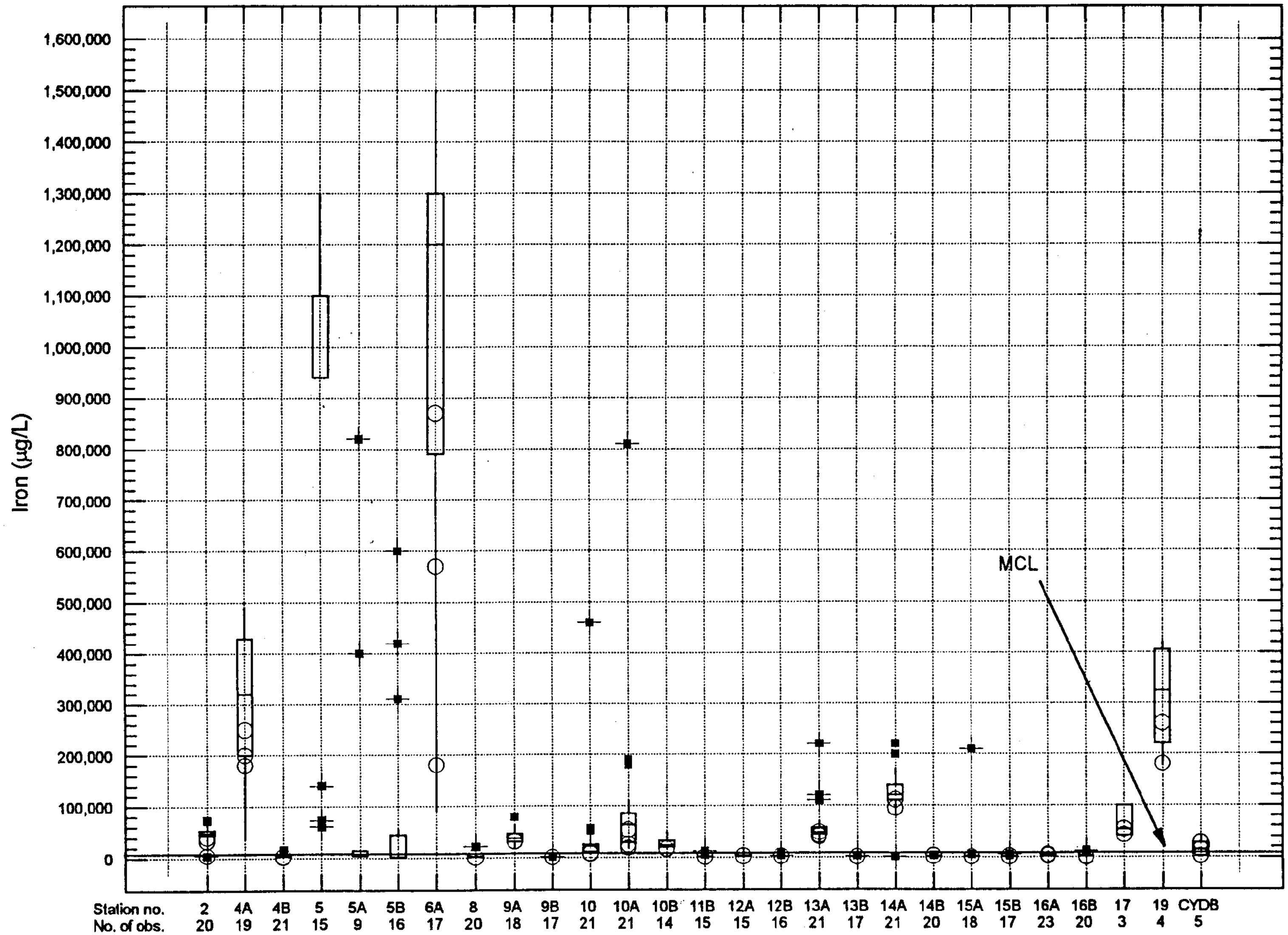


Figure 3-8. Iron Groundwater Data Through April 1995

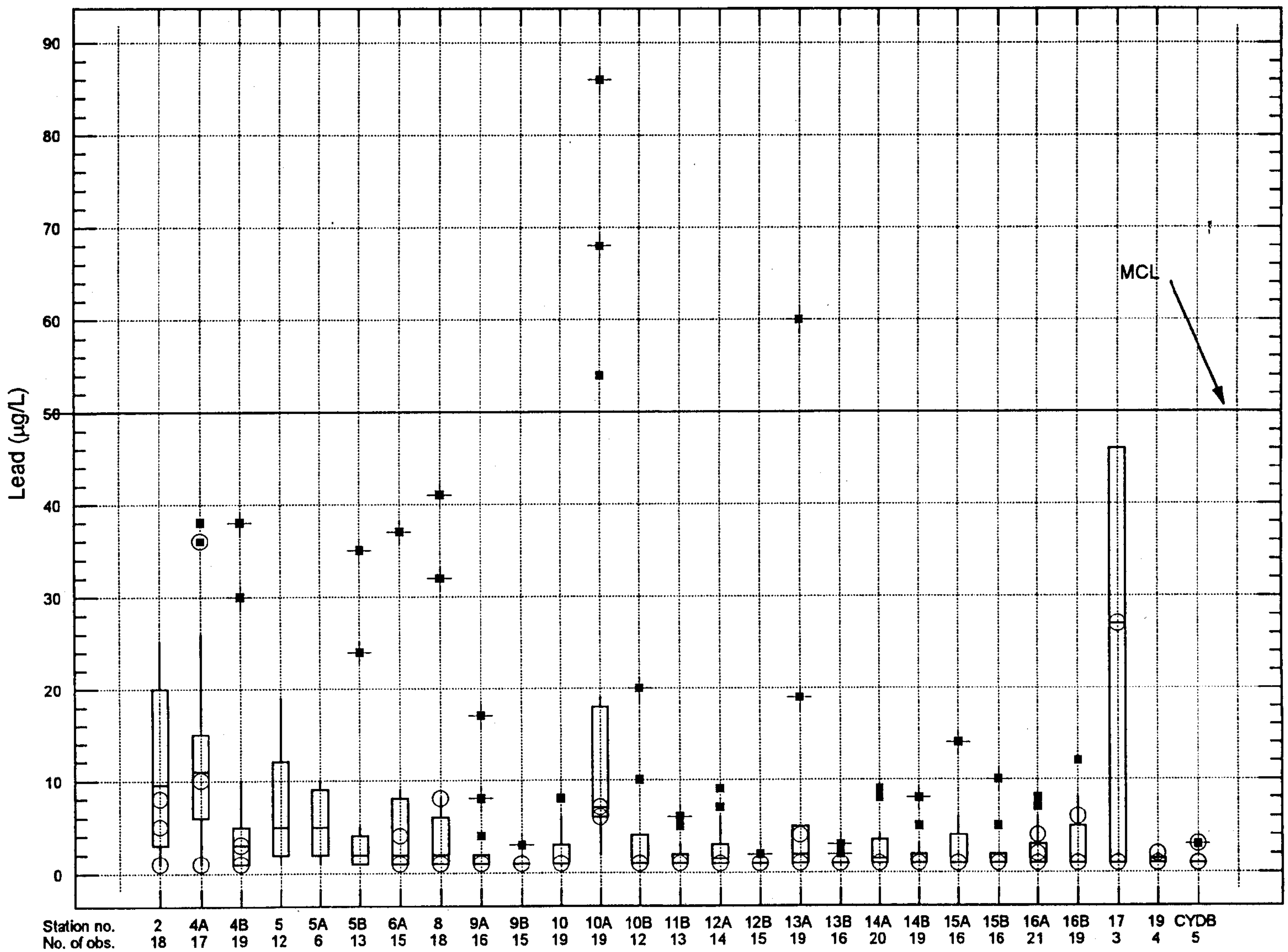


Figure 3-9. Lead Groundwater Data Through April 1995

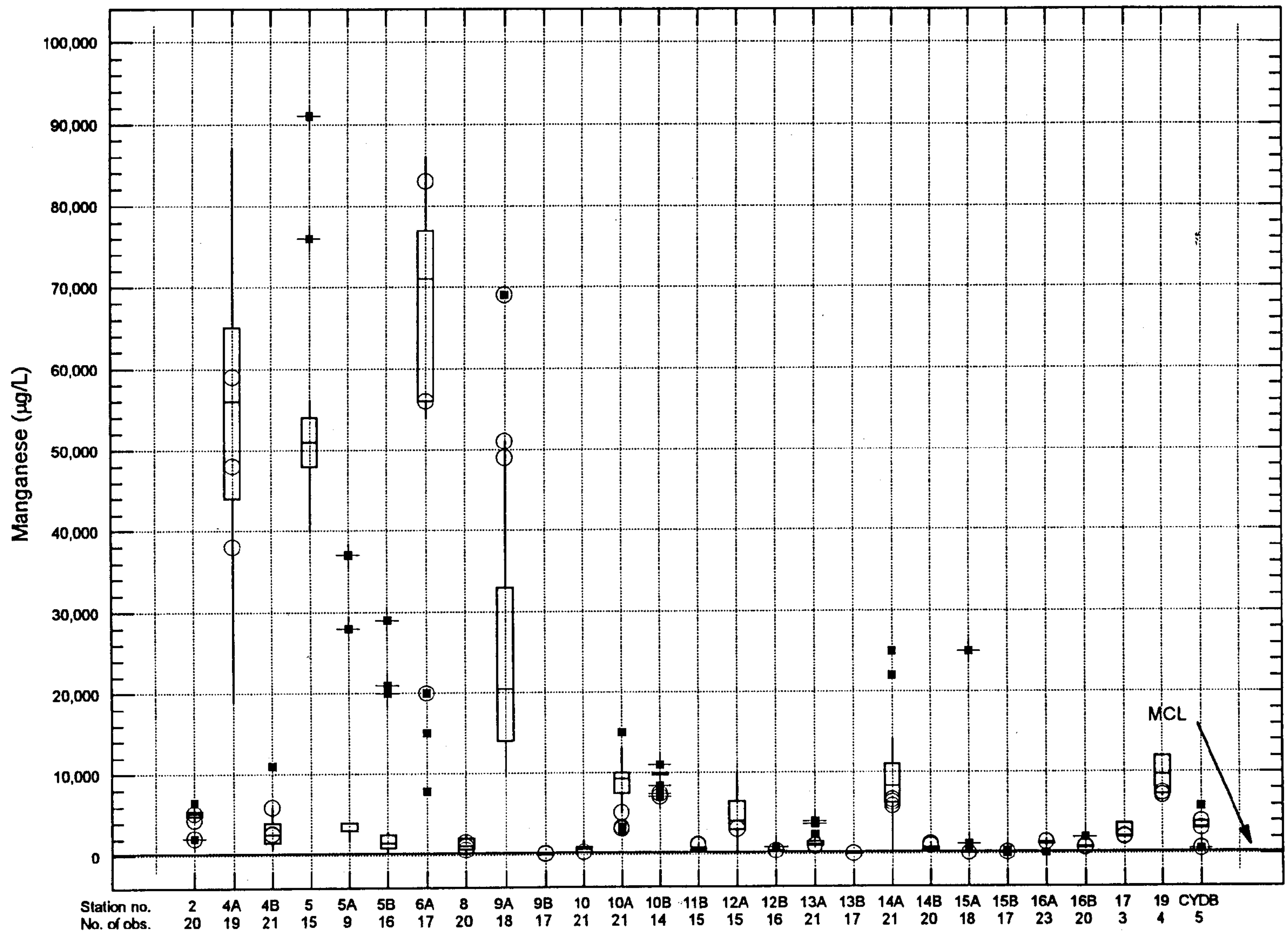


Figure 3-10. Manganese Groundwater Data Through April 1995

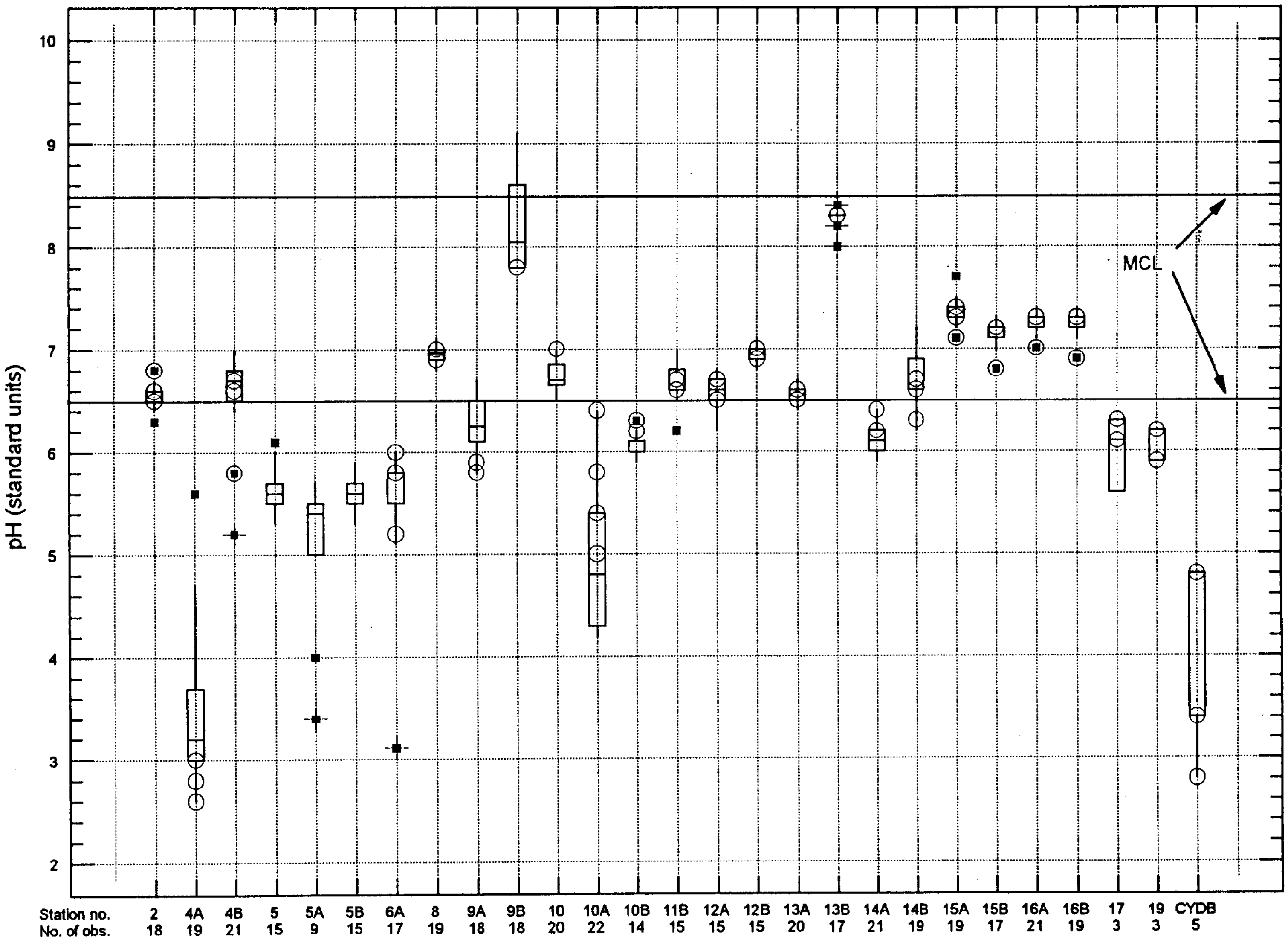


Figure 3-11. pH Groundwater Data Through April 1995

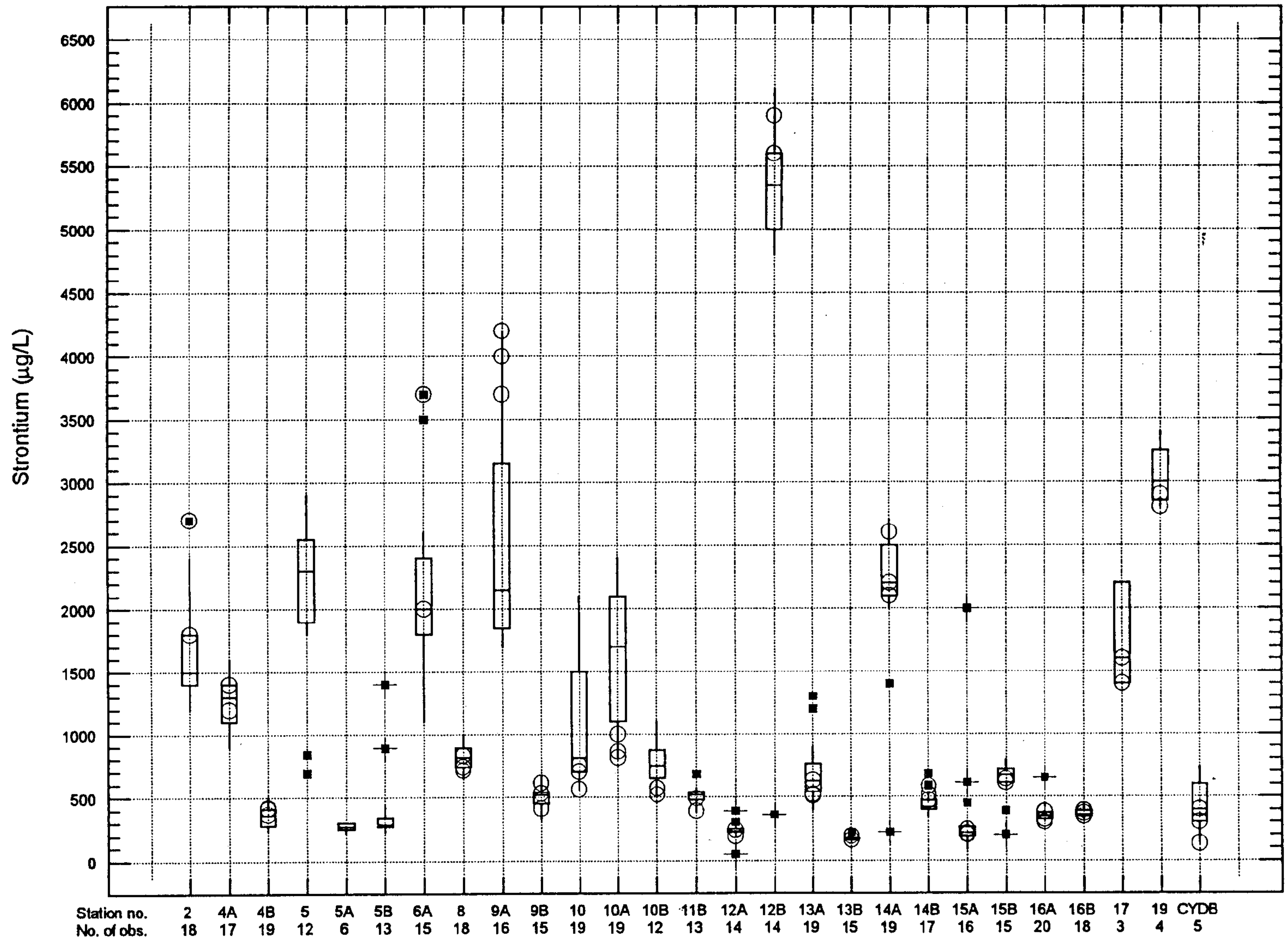


Figure 3-12. Strontium Groundwater Data Through April 1995

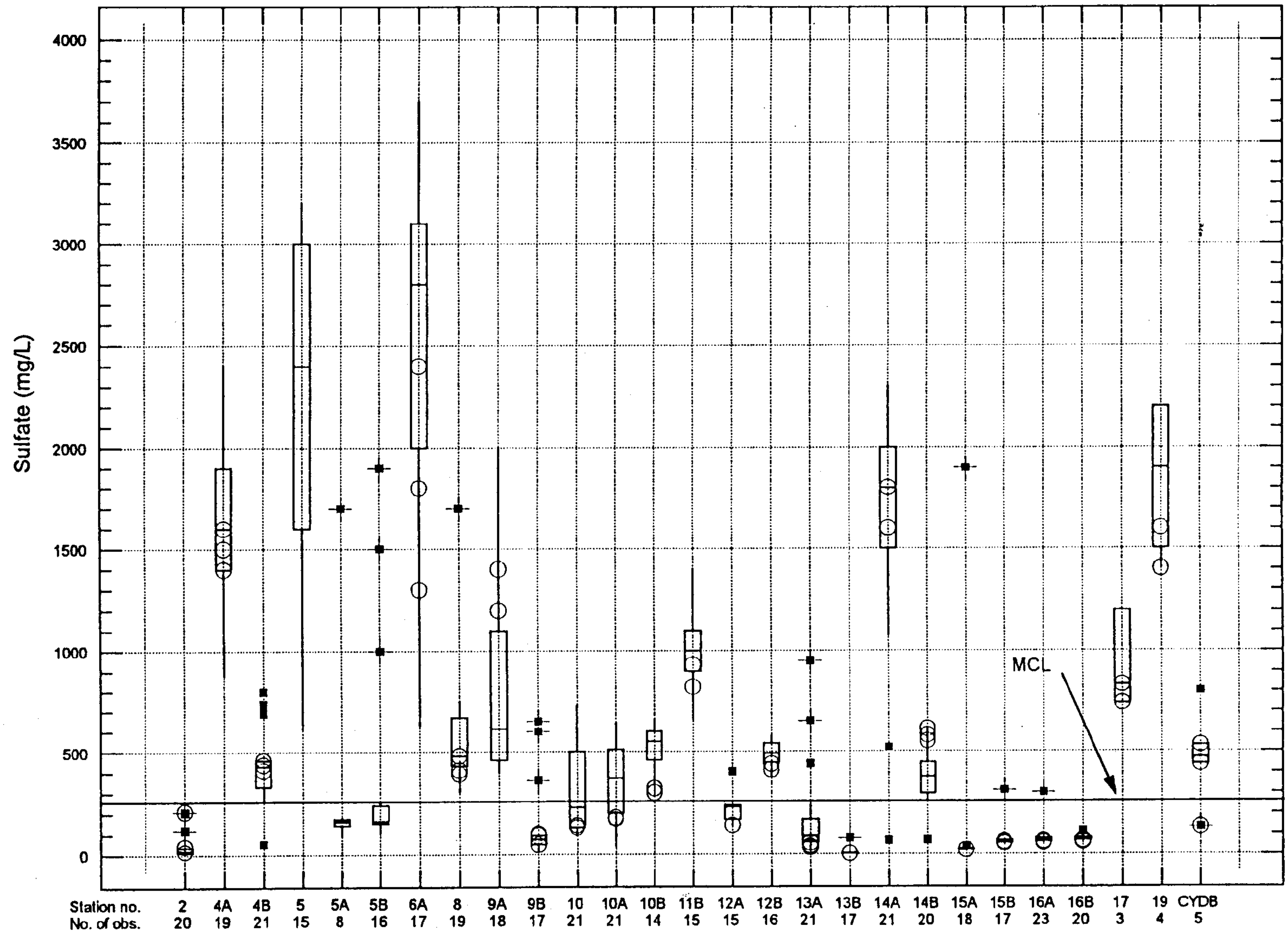


Figure 3-13. Sulfate Groundwater Data Through April 1995

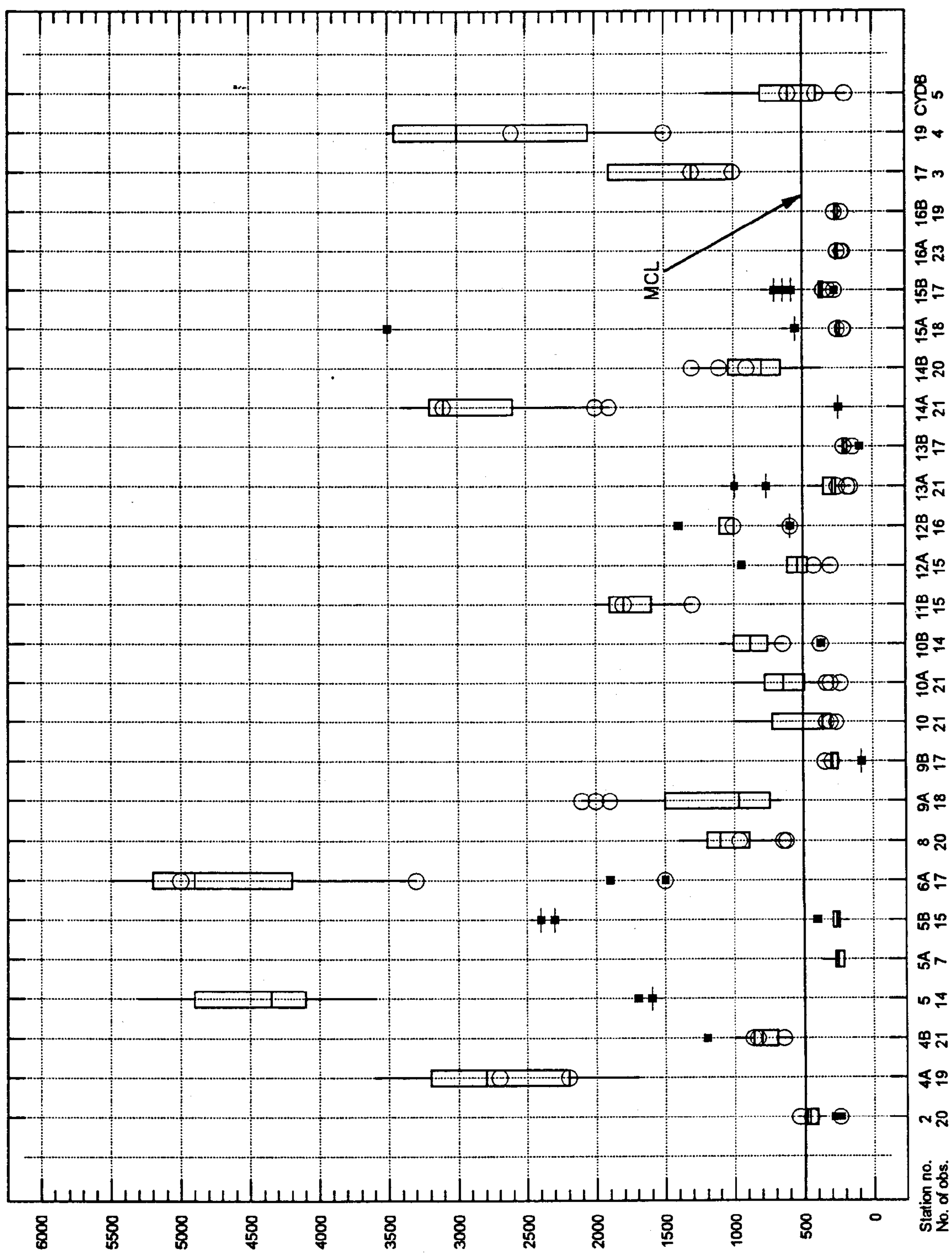


Figure 3-14. Total Dissolved Solids Groundwater Data Through April 1995

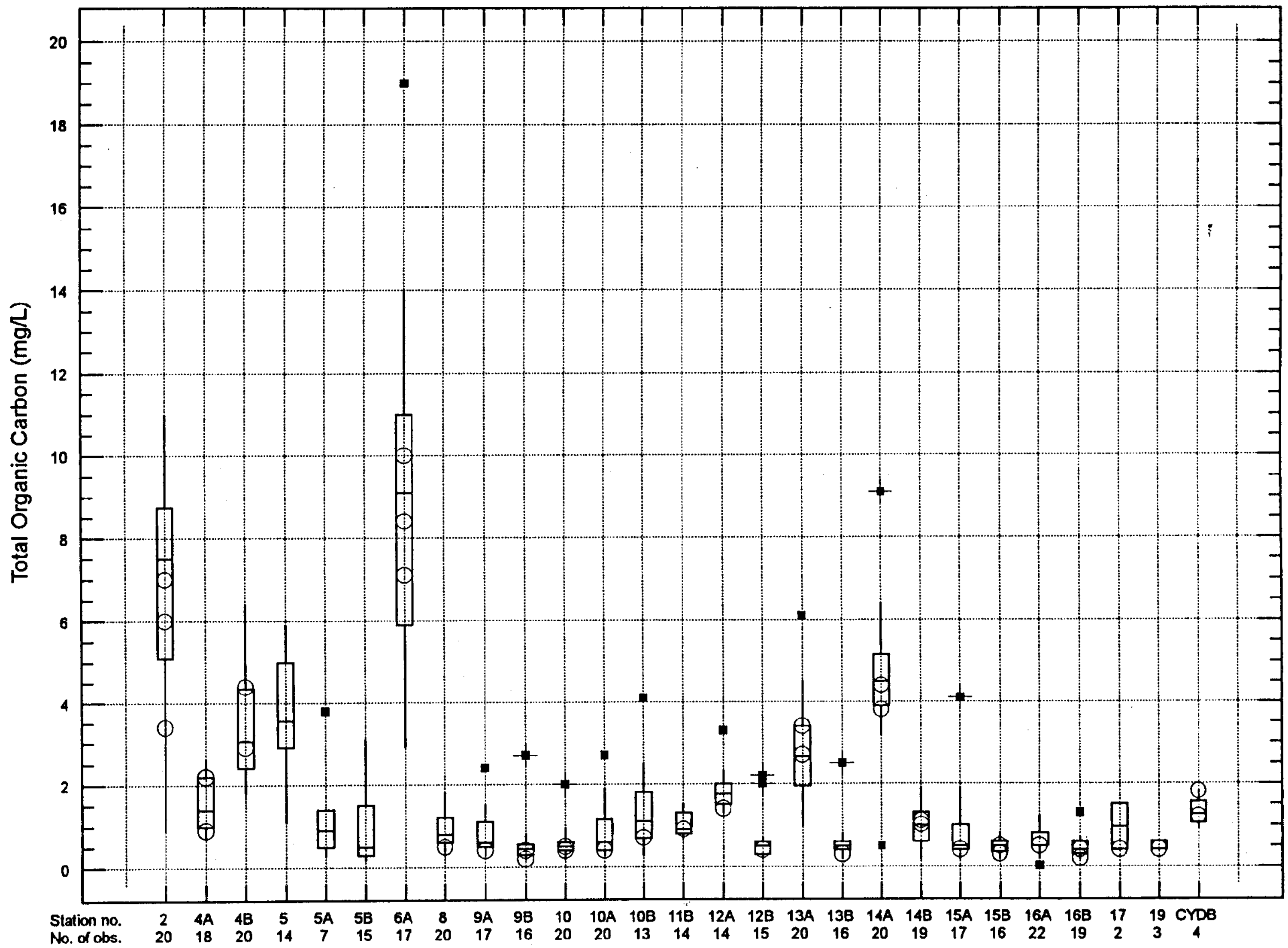


Figure 3-15. Total Organic Carbon Groundwater Data Through April 1995

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.

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

Figure 1-b. Wells and springs within [illegible] of Ash Pond Area.

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.

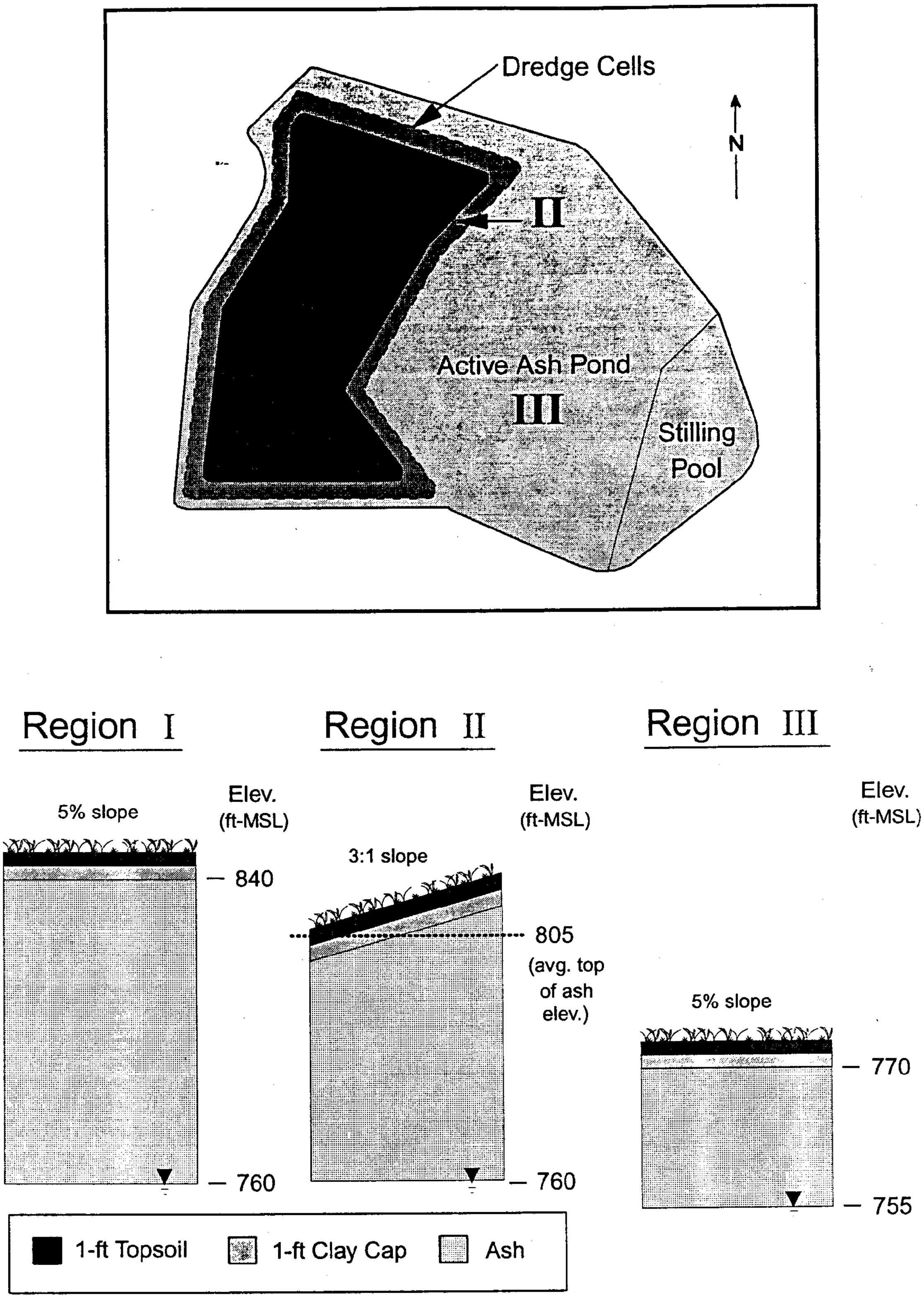


Figure 5-1. Subregion Areas and Profiles Used in HELP2 Simulations

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.,

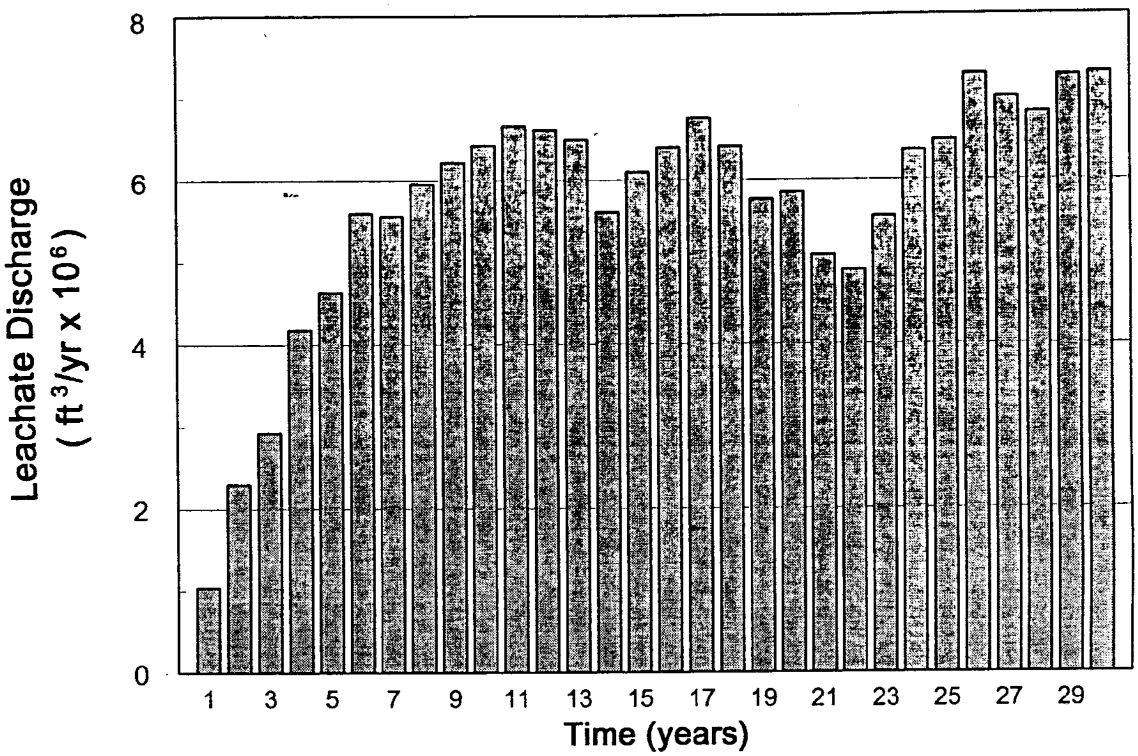


Figure 5-2. Predicted Leachate Discharge From Ash Pond Area During 30-Year Post-Closure Period

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.

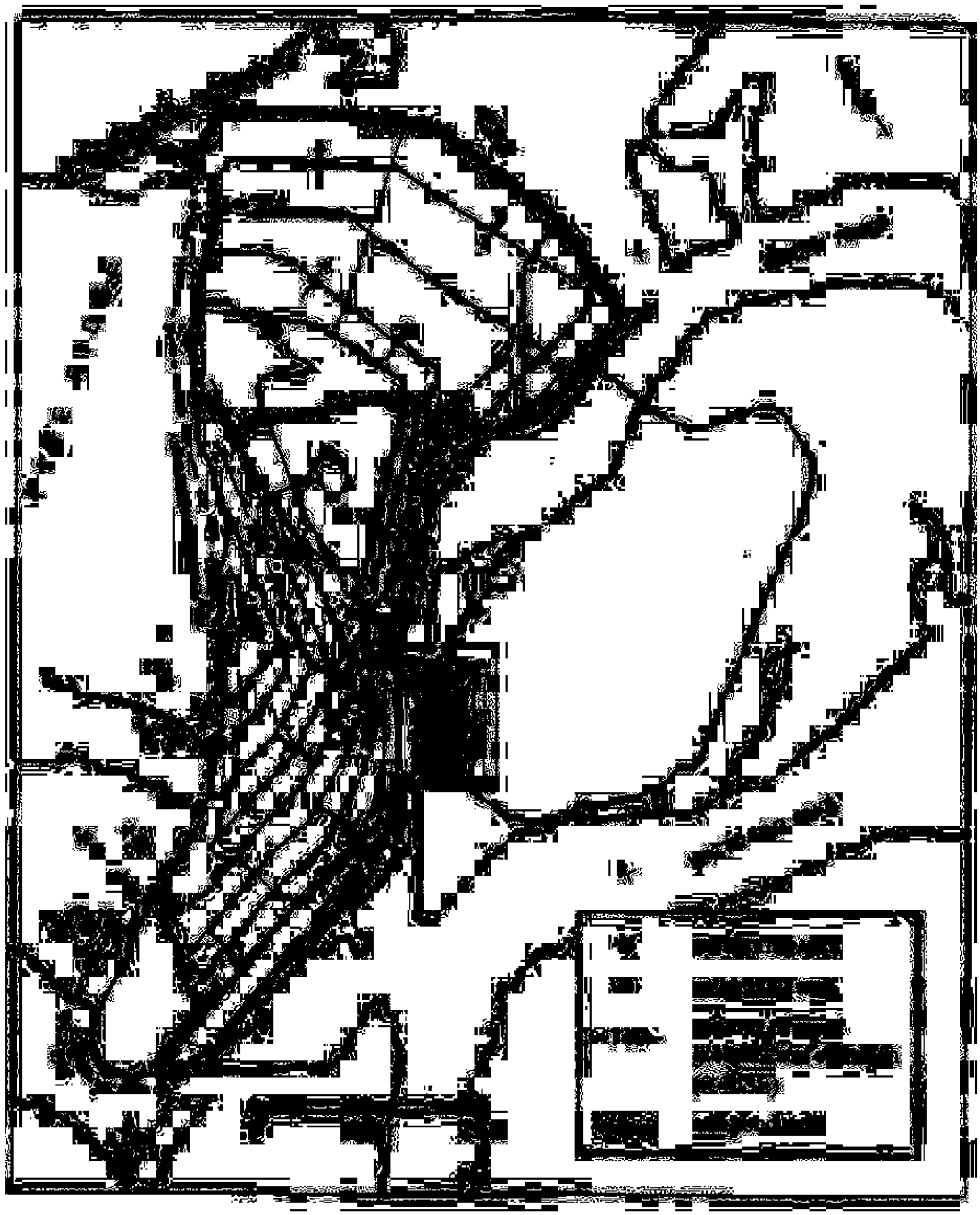


Figure 4-4. Location of [illegible]

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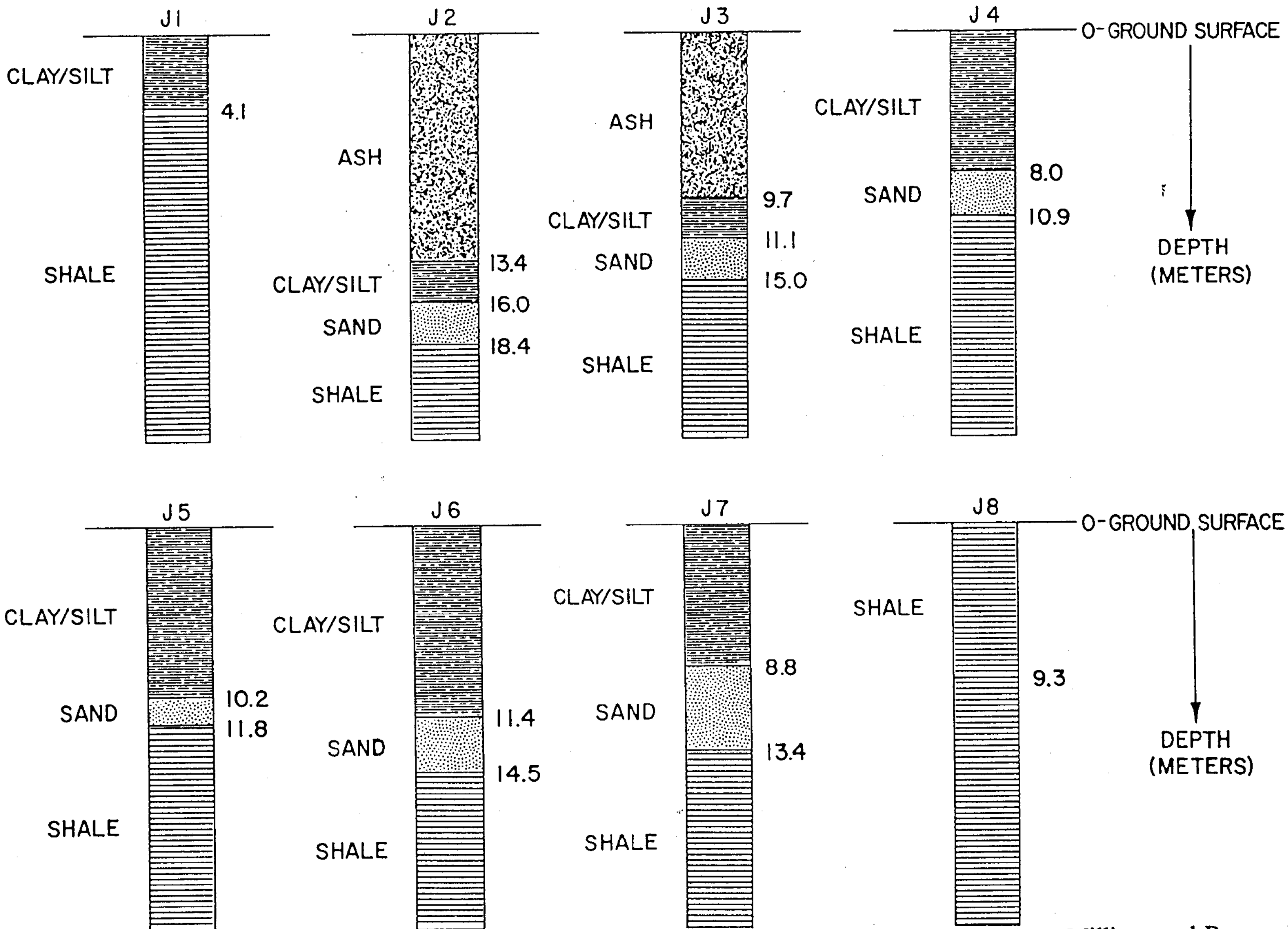
APPENDIX I

LITHOLOGIC LOGS

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



[from Milligan and Ruane, 1980]

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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

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BORING NUMBER J - 9A
DATE DRILLED 10-3-88
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 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

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Boring Record

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

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:

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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:

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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

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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

TVA-00012680

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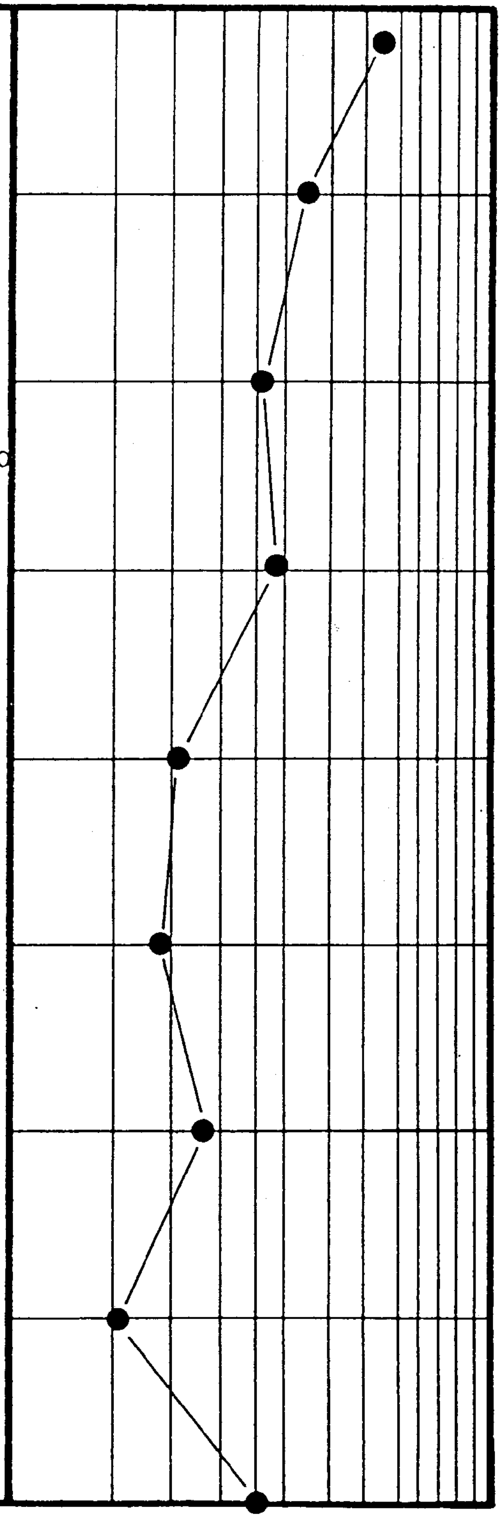
Soil Test Boring Record

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

5 10 20 30 40 50 60 80 100 "N"



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

REMARKS: * ELEVATION TO BE PROVIDED BY TVA

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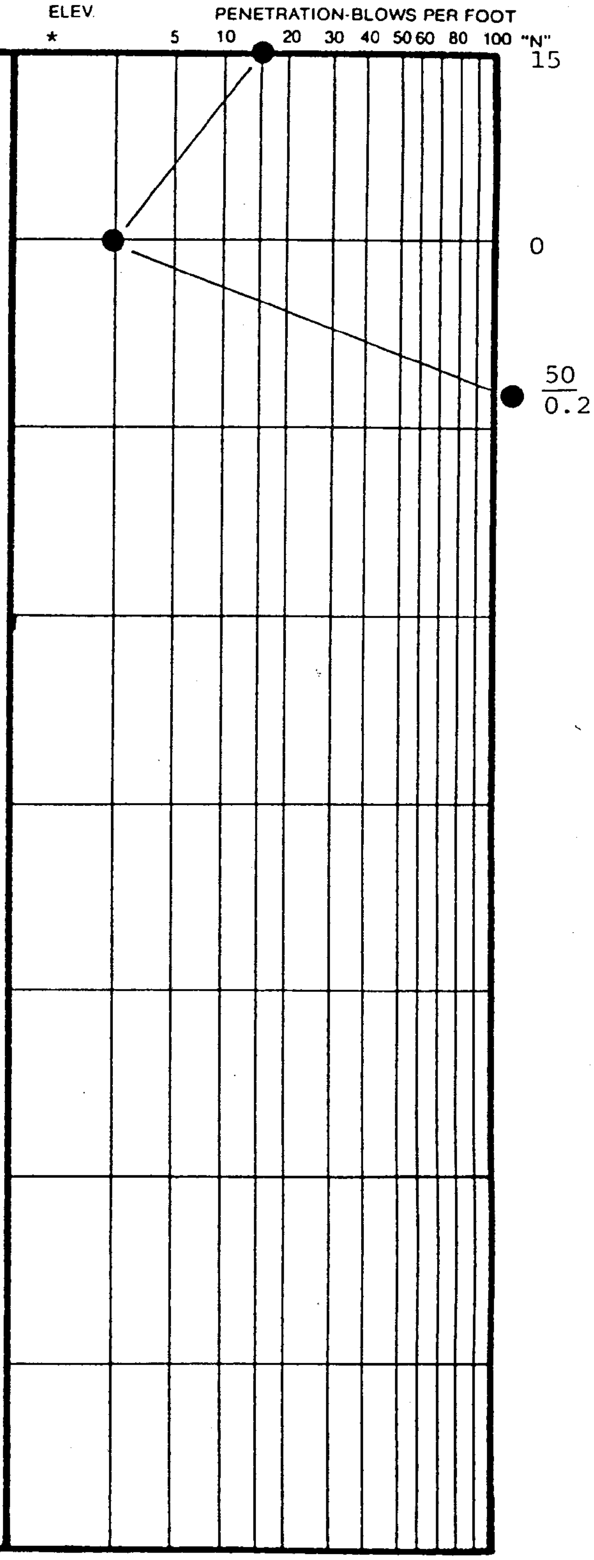
Soil Test Boring Record

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

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



REMARKS: * ELEVATION TO BE PROVIDED BY TVA

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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	RED SILTY CLAY-POSSIBLE FILL		
1.0	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

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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	"N"
0.0 – 0.2	TOPSOIL			
2.5	VERY STIFF BROWN CLAYEY DESICATED SHALE - RESIDUUM			21
5.2	VERY HARD GRAY VERY WEATHERED SHALE - RESIDUUM			50/0.2
	REFUSAL			

REMARKS: *ELEVATION TO BE PROVIDED BY TVA

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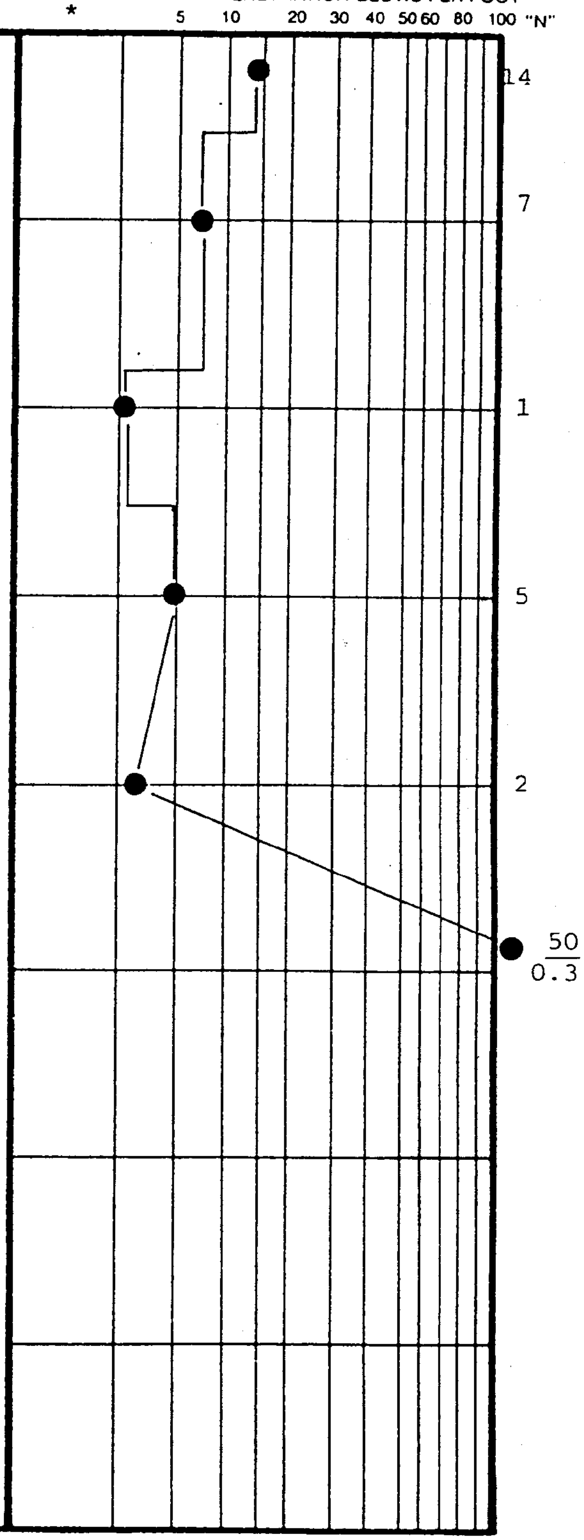
Soil Test Boring Record

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	(water level) 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
24.8	REFUSAL		50/0.3



REMARKS: * ELEVATION TO BE PROVIDED BY TVA

Law Engineering

BORING NUMBER J-12B
DATE DRILLED 9-26-88
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 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:

TVA-00012687

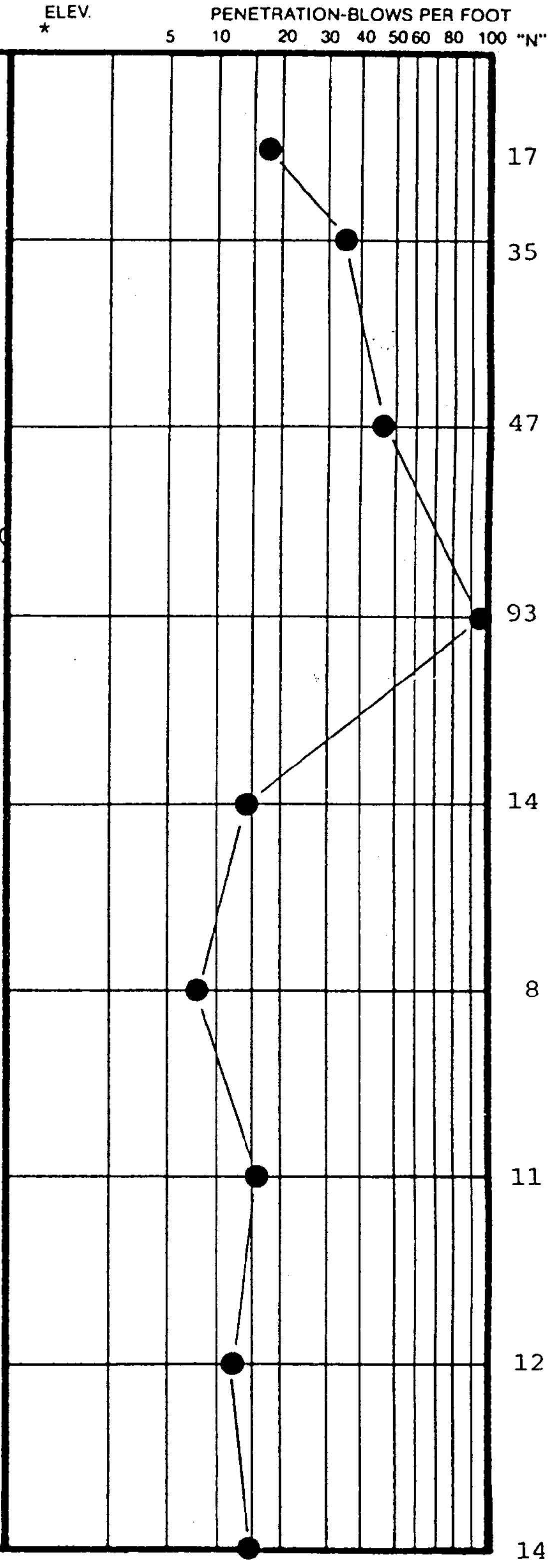
Law Engineering

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

PENETRATION-BLOWS PER FOOT



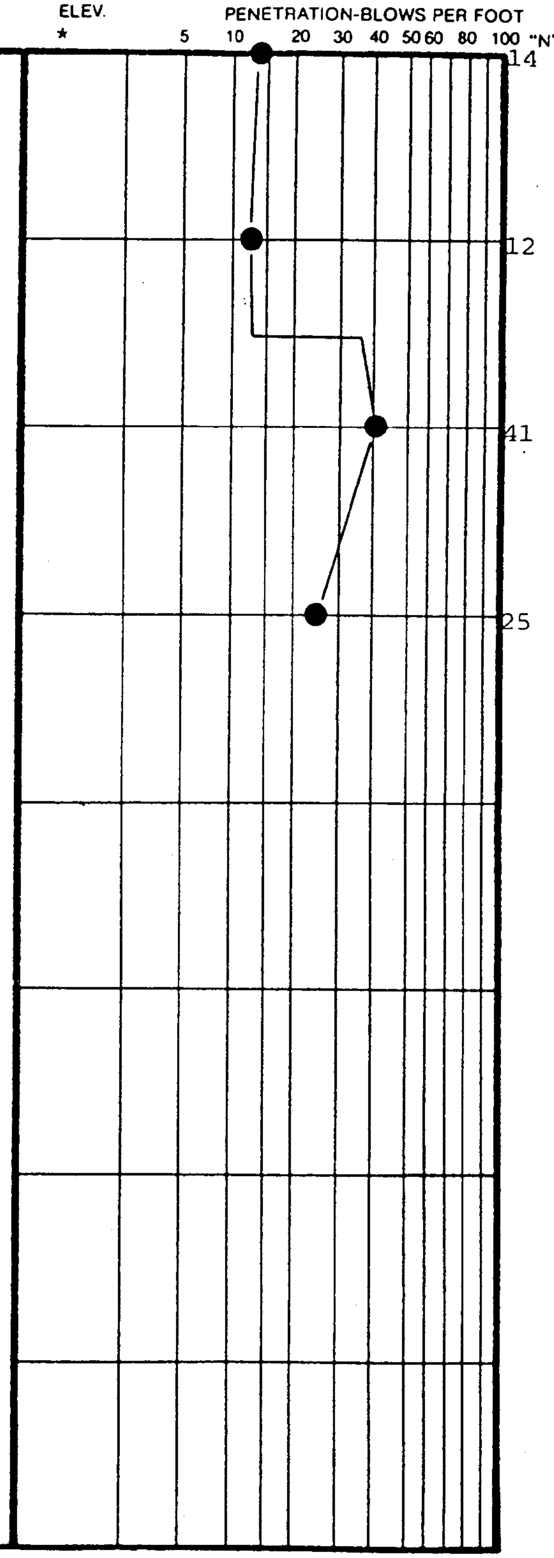
REMARKS: * ELEVATION TO BE PROVIDED BY TVA

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	ELEV. *
40.0	BLACK FLY ASH	
47.5	DENSE SAND AND GRAVEL -ALLUVIUM	
52.5	FIRM VERY SILTY CLAY - ALLUVIUM	
64.0	REFUSAL	



REMARKS: * ELEVATION TO BE PROVIDED BY TVA

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREV...

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 Record

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

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 NUMBER J-13B
DATE DRILLED 9/29 -30/88
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	GRAY SHALE WITH ZONES OF LIMESTONE AND SANDSTONE		
82.0	BORING TERMINATED		

REMARKS:

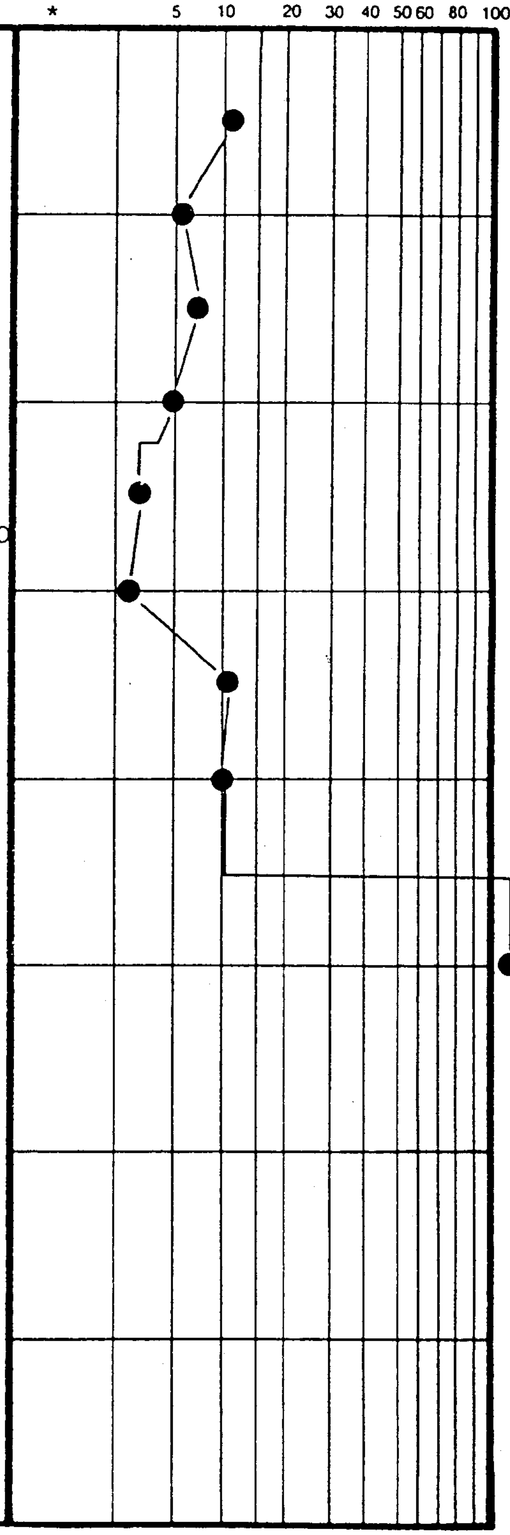
Law Engineering

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. *
0.0 – 1.0	GRAVEL	
1.0 – 3.5	STIFF RED-BROWN SILTY CLAY- FILL	
3.5 – 6.0	FIRM MOTTLED DARK BROWN SILTY CLAY FILL	
6.0 – 8.5	FIRM RED-BROWN SILTY CLAY WITH TRACE ORGANICS - FILL	
8.5 – 11.0	FIRM MOTTLED DARK BROWN SILTY CLAY - FILL	
11.0 – 16.0	VERY LOOSE BLACK SILTY SAND AND GRAVEL - ALLUVIUM	14.0
16.0 – 22.5	LOOSE BROWN AND GRAY SILTY CLAY WITH BLACK STAINING - ALLUVIUM	
22.5 – 25.3	VERY HARD GRAY WEATHERED SHALE	
25.3	BORING TERMINATED	

PENETRATION-BLOWS PER FOOT



"N": 11, 6, 7, 5, 2, 1, 11, 10, 50/0.3

REMARKS: *ELEVATION TO BE PROVIDED BY TVA

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

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

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

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

SEE KEY SHEET FOR EXPLANATION OF ...

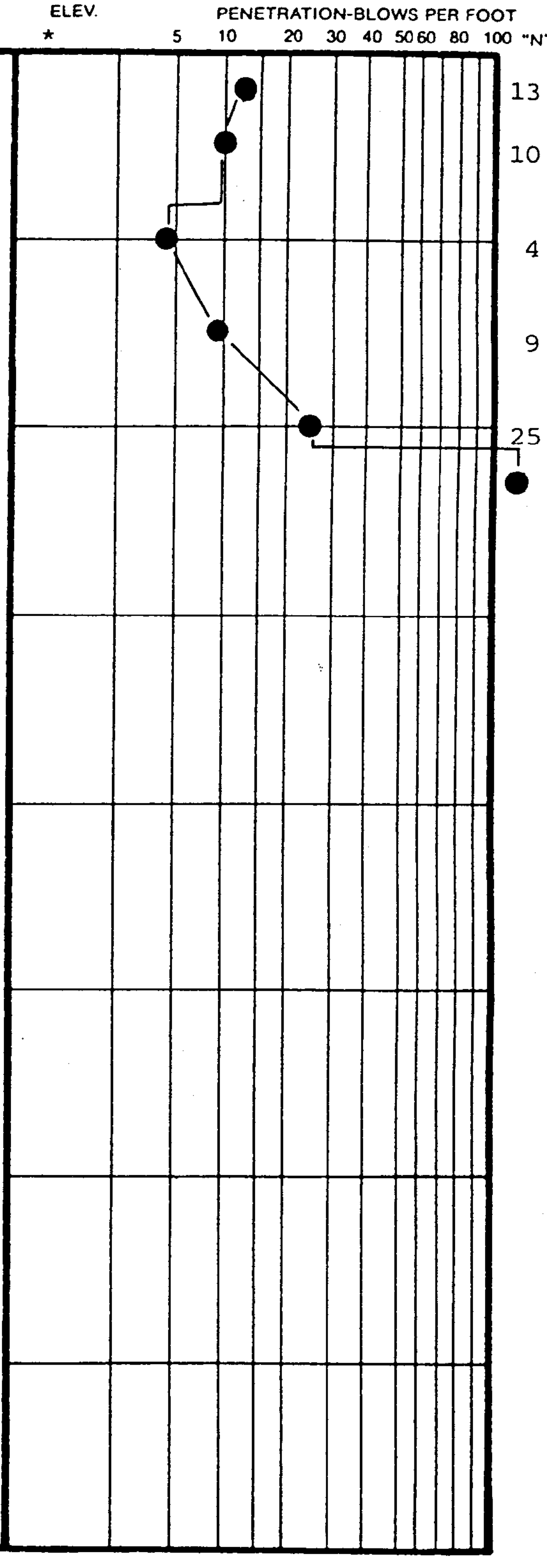
Law Engineering

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. *	"N"
0.0	STIFF MOTTLED REDDISH-BROWN SILTY CLAY - FILL		13
2.0	STIFF MOTTLED BROWN SILTY CLAY WITH ROCK FRAGMENT - FILL		10
4.0	SOFT TO FIRM REDDISH BROWN SILTY CLAY - RESIDUUM		4
			9
			25
10.5	LIGHT BROWN VERY WEATHERED SHALE-RESIDUUM		50/0.5
12.0	REFUSAL		

PENETRATION-BLOWS PER FOOT



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

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 Record

BORING NUMBER J-16B
DATE DRILLED 9-23-88
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 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 NUMBER J-16B
DATE DRILLED 9-23-88
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			
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:

TVA-00012703

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: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
	715		SM	27.6	NP	NP	10	GY SI SD, V MST (FA)
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
	760							
5		14	MH-CH	21.9	59	28	2	BRN SI CL w/GV, TR TS, D
	755							
10		10	MH-CH	22.8	59	28	2	R-BRN SI CL, TR GV, D
	750							
15		8	MH-CH	28.0	59	28	2	R-BRN SI CL, TR GV, MST
	745							
20		13	SM	25.6	NP	NP	10	GY SI SD w/TR GV (FA), V MST
	740							
25		-	SM	19.0	NP	NP	10	GY SI SD w/GV (FA), W
	735							
30		-	SM	28.1	NP	NP	3	BRN SD WI CL (FA), W
	730							
35								

1''=5'

* LAB CLASSIF.

TVA-00012706

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
		–	CL	33.6	26	8	9	BRN SI CL W/GY SI (FA). V MST
40	725	3	CL	20.1	26	8	9	ORNG & GY SI CL, V MST
45	720	28	ML	14.0	NP	NP	8	GY SD mix w/PKTS GY CL, MST
50	715	50+	ML	15.8	NP	NP	8	GY SD mix w/PKTS GY CL, MST
55	710							REFUSAL GROUND WATER LEVEL = 5'8"
60	705							
65	700							
70	695							

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: TA

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

SHEET 2 OF 2

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

SHEET 1 OF 2

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: TAL

DEPTH ft.	EL	SPT (N)	* LOG	W	LL	PI	GR	FIELD DESCRIPTION
5	760	18	MH-CH	19.6	59	28	2	R-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
	725							
40								
		2	SM	24.2	NP	NP	3	ORNG CL SD, V MST
	720							
45								
		2	CL	21.9	26	8	9	TN CL SI w/PKTS GY FA, V MST
	715							
50								
		30	SC/SM	10.8	NP	NP	4	LT BRN SI SD w/GV, V MST
	710							
55								
		50+	ML	13.9	NP	NP	12	BRN & GY CL SI, FA, MST
								REFUSAL
								GROUND WATER LEVEL = 20'
	705							
60								
	700							
65								
	695							
70								

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
	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

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	8	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.

SINGLETON LABORATORIES

SOIL PROFILE: SPLIT-SPOON

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
		5	SM	24.9	NP	NP	10	GY SD SI (FA), W
	710							
75		7	SC/SM	22.7	NP	NP	4	TN SI SD, V MST
	705							
								REFUSAL GROUND WATER LEVEL = 11' 3"
80								
	700							
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

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

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
	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: TAL

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								
	700							REFUSAL 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

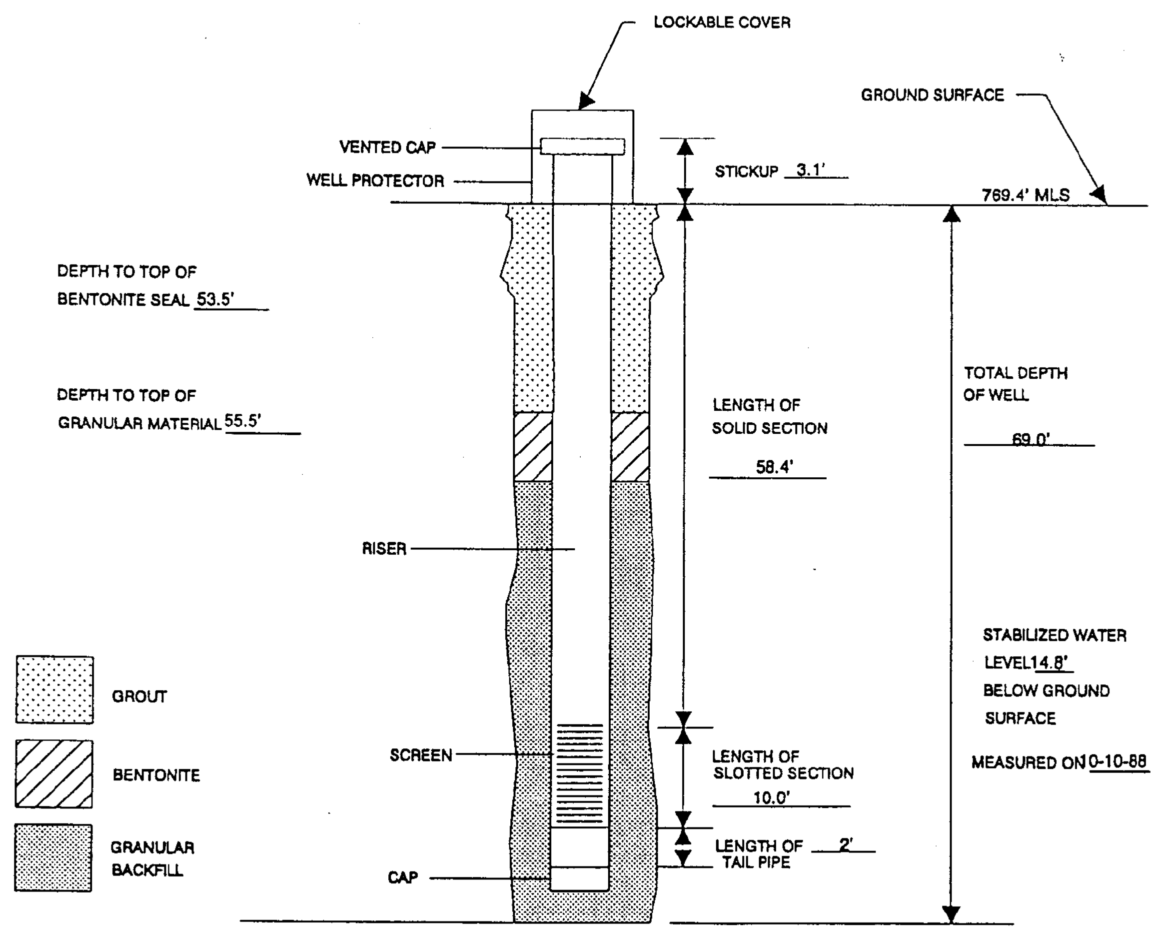
BOREHOLE DIAMETER: 11 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



ENG LAB 10/2/90

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

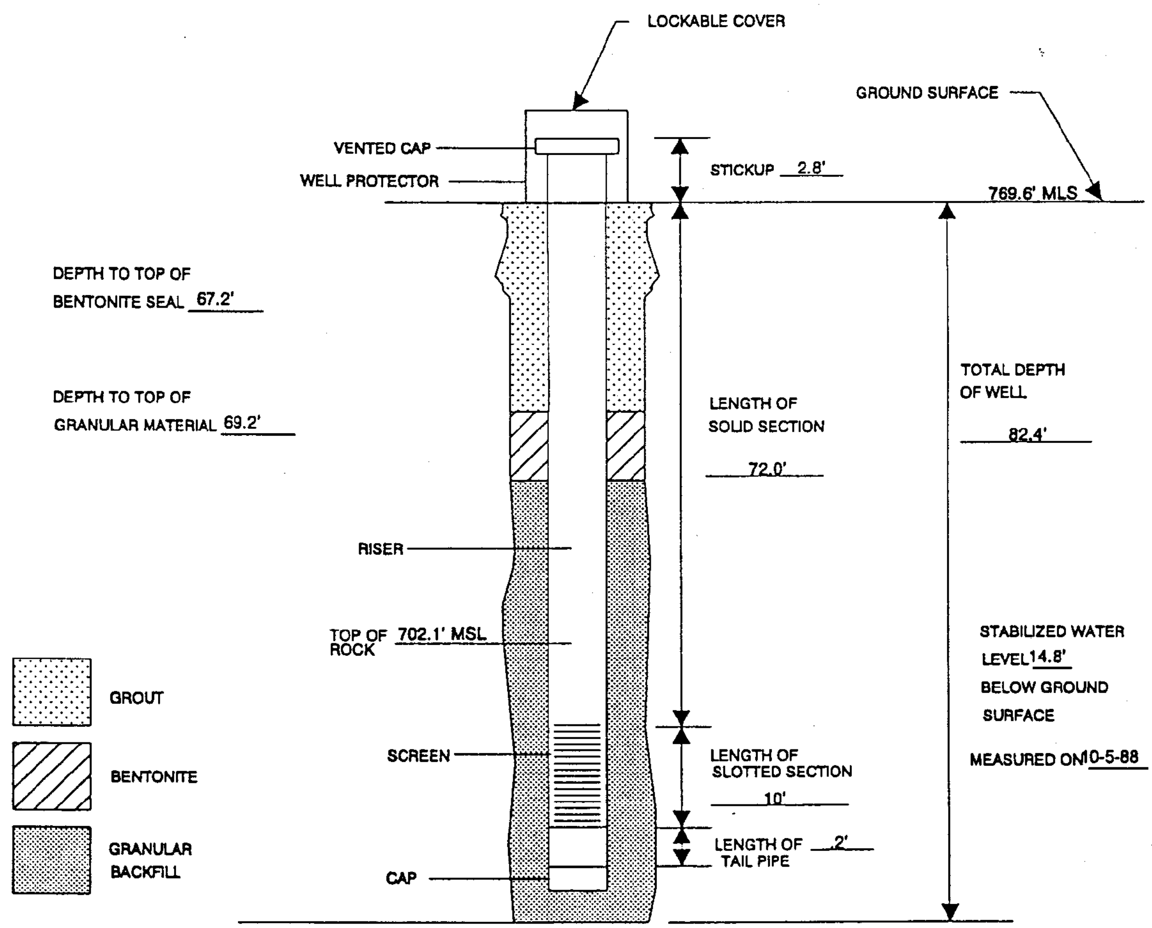
BOREHOLE DIAMETER: 5 7/8 (ROLLER CONE)
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)

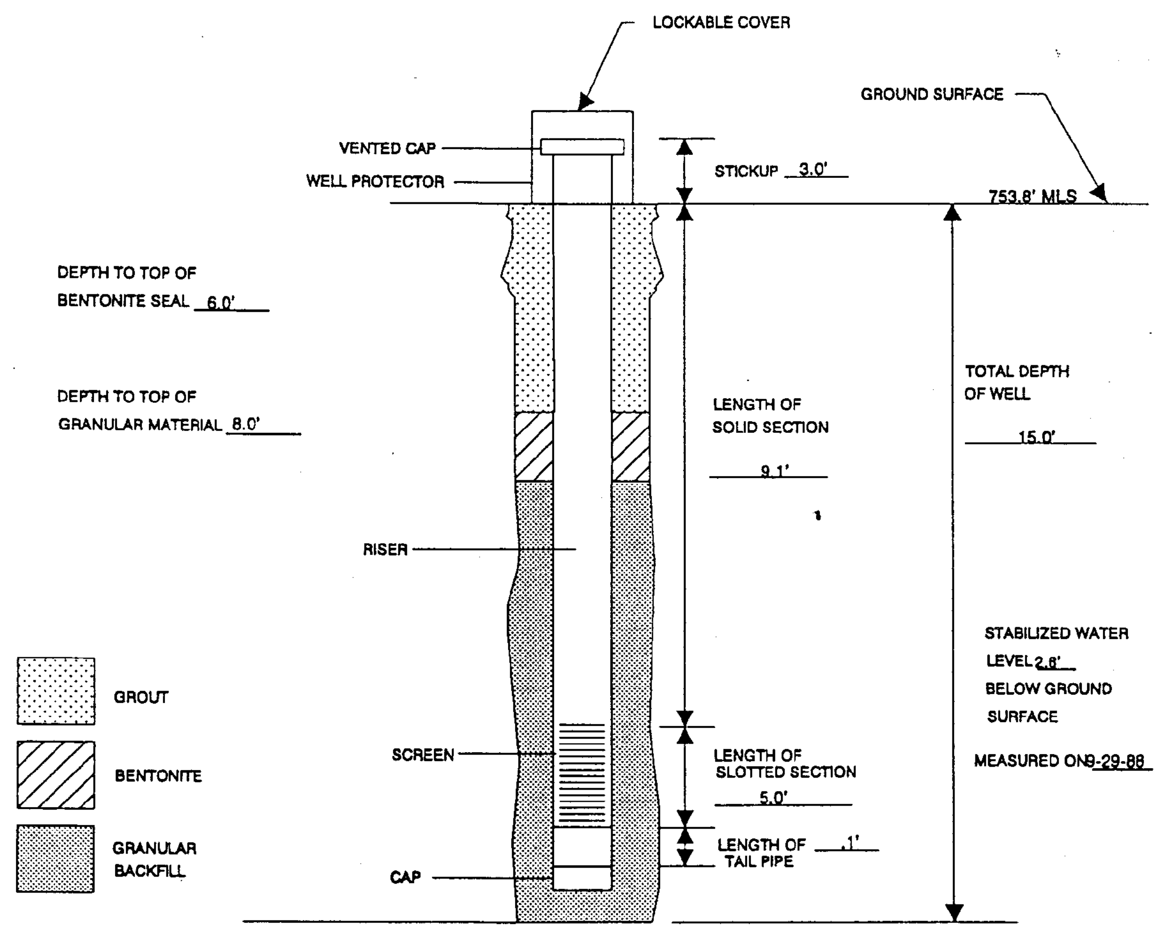


ENG LAB 10/2/90

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)

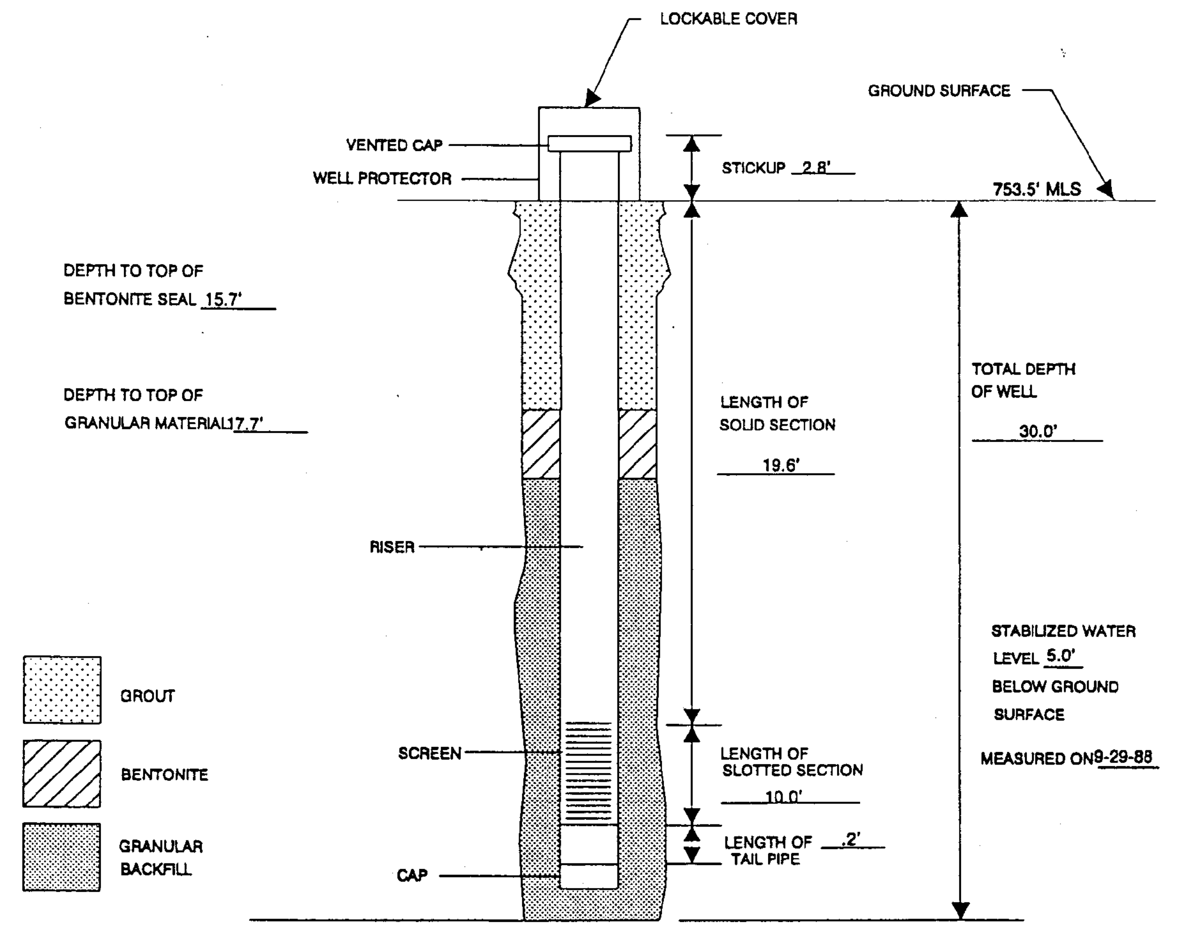


ENG LAB 10/2/90

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)



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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

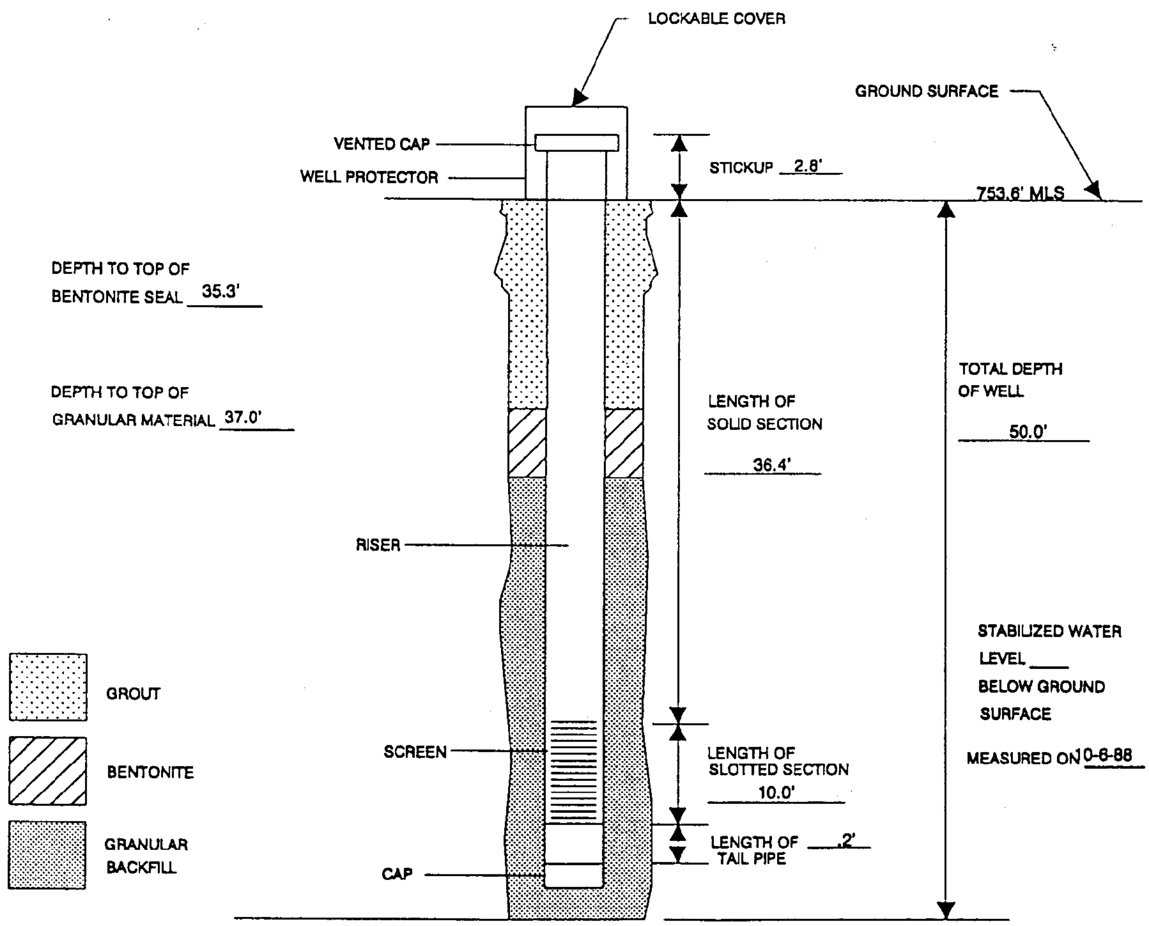
BOREHOLE DIAMETER: 11 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



ENG LAB 10/2/90

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

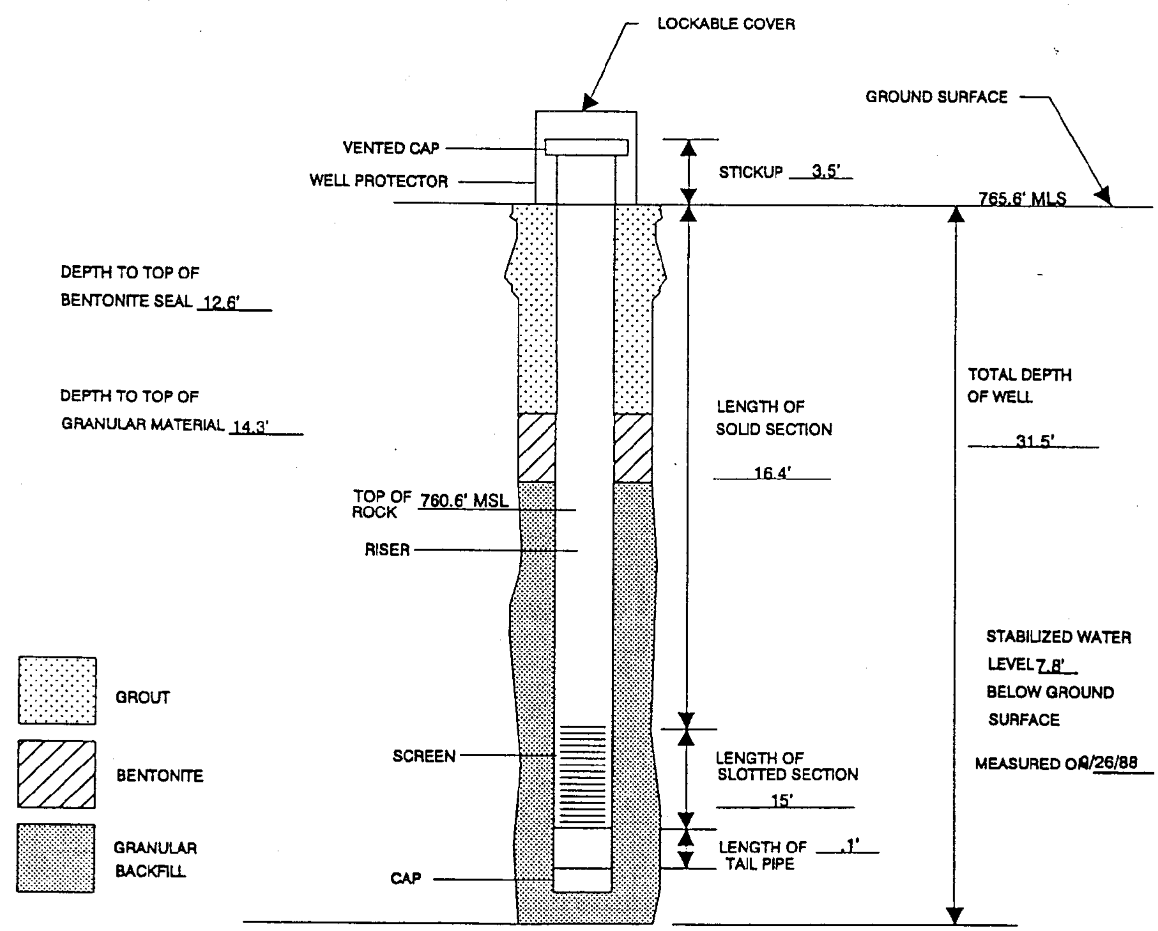
BOREHOLE DIAMETER: 8 INCHES
FIELD REPRESENTATIVE: H. W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



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TVA-00012731

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195

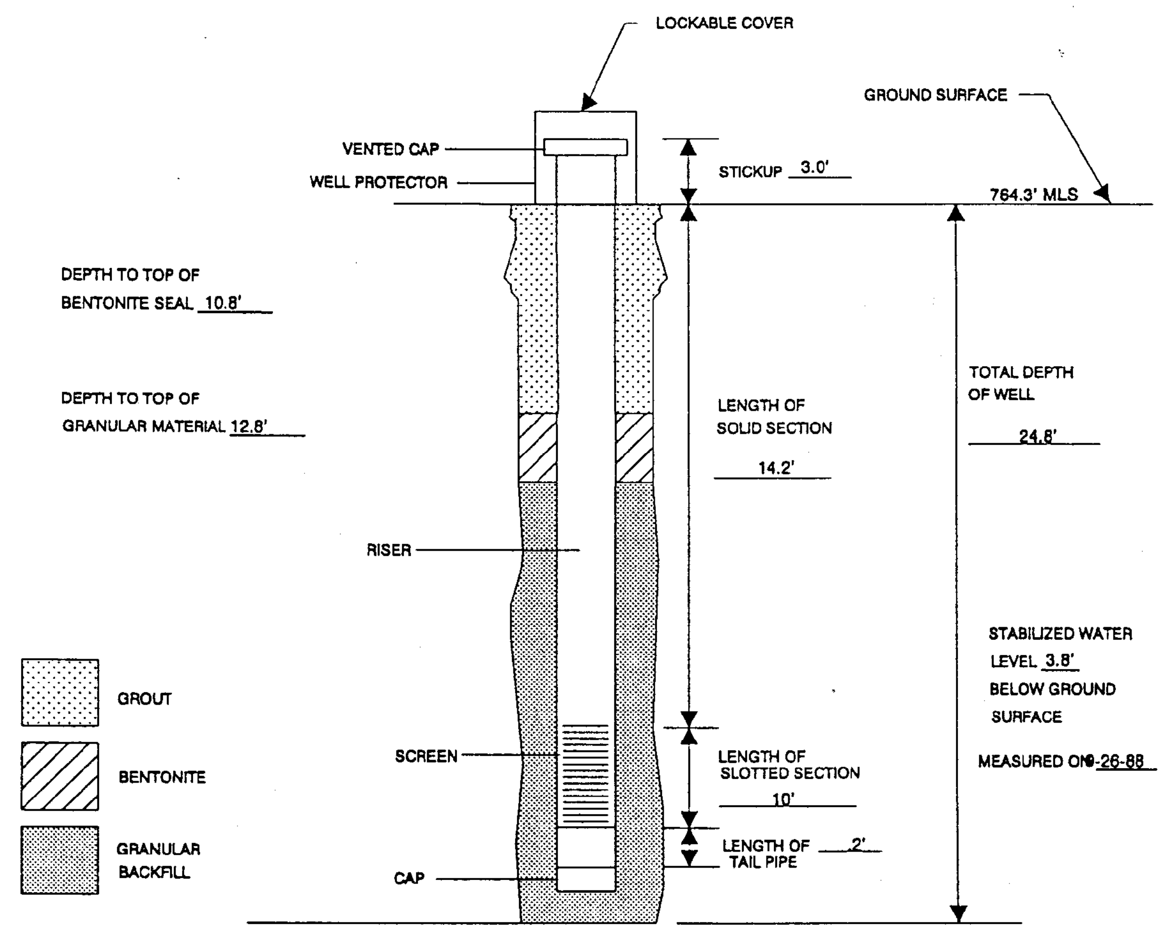
WELL NUMBER: J-12 A
INSTALLATION DATE: 9-22-88

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)



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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

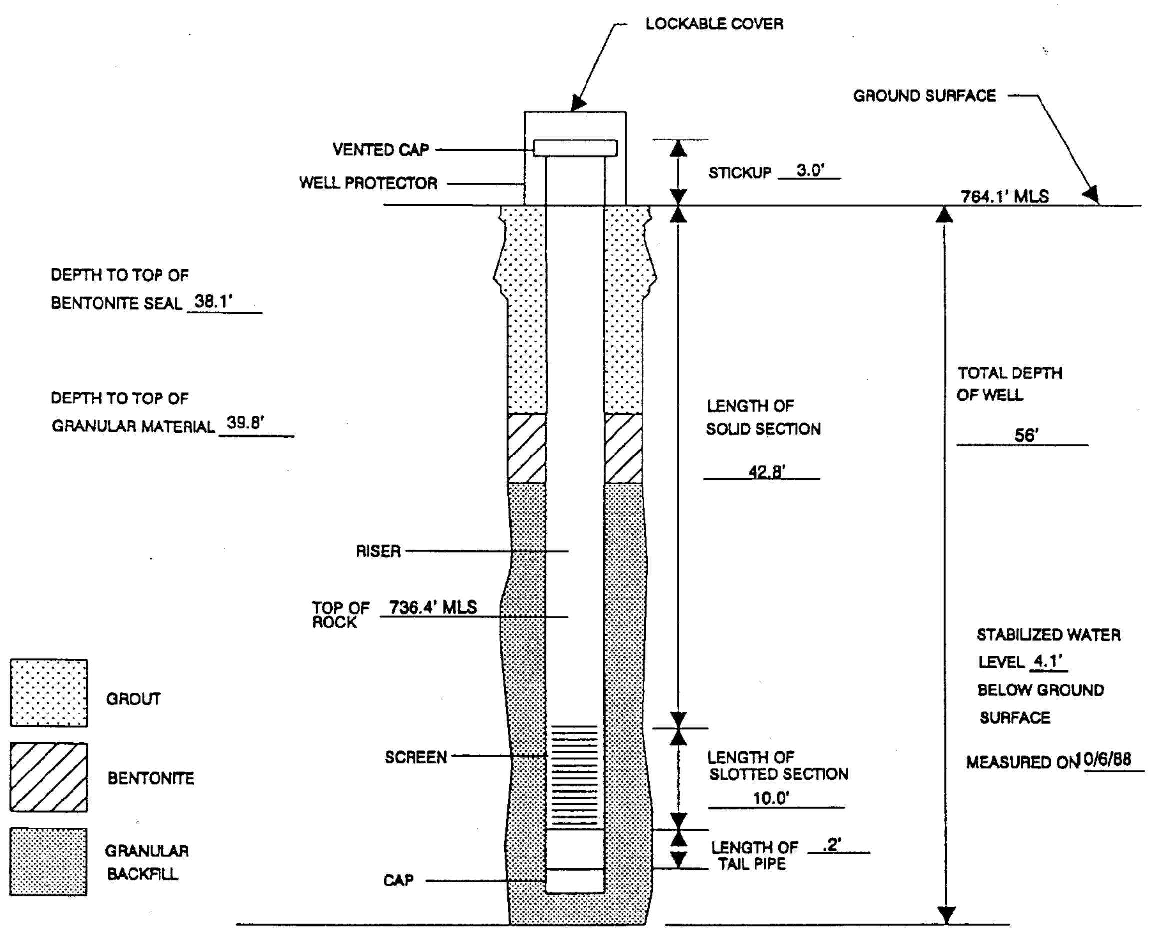
BOREHOLE DIAMETER AUGER 8" ROTARY 5 7/8" DIA. FIELD REPRESENTATIVE H.W. ROBINSON

LOCKABLE COVER ? YES KEY CODE/COMBINATION 2043

RISER MATERIAL PVC SCREEN MATERIAL PVC

COMMENTS

(NOT TO SCALE)



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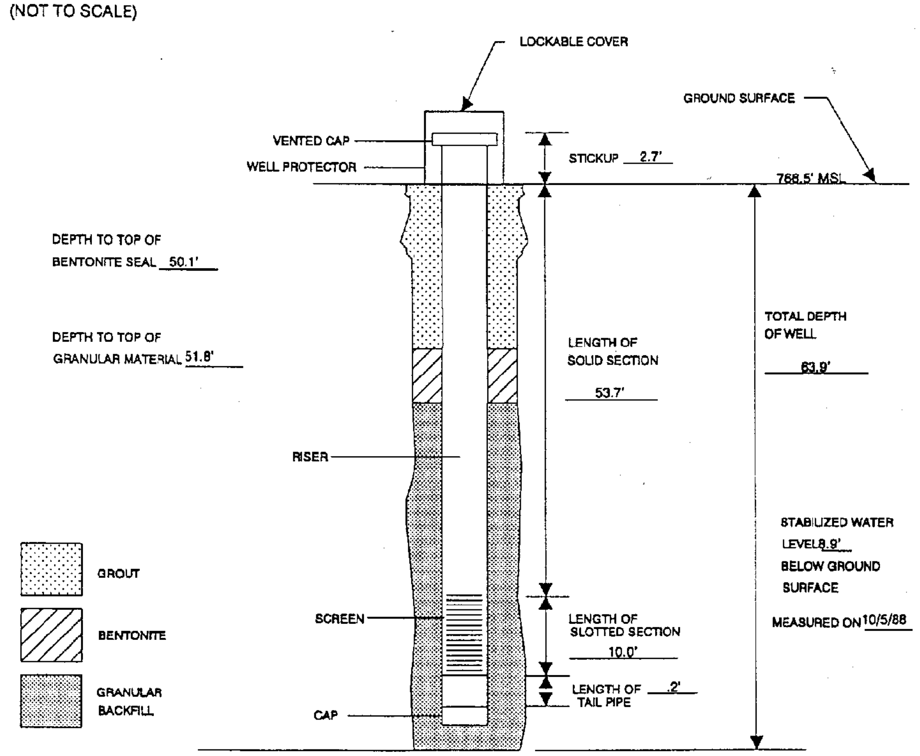
TYPE II MONITORING WELL INSTALLATION RECORD

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)



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JOHN: (13B IS V.I.P.!)

THE PLANT COORDINATES FOR 13A + 13B ARE THE SAME HERE IN THE REPORT. ACCORDING TO MAPS + SURVEYS 13B SHOULD BE:

W 7+34
N 31+04

(7-26-95)

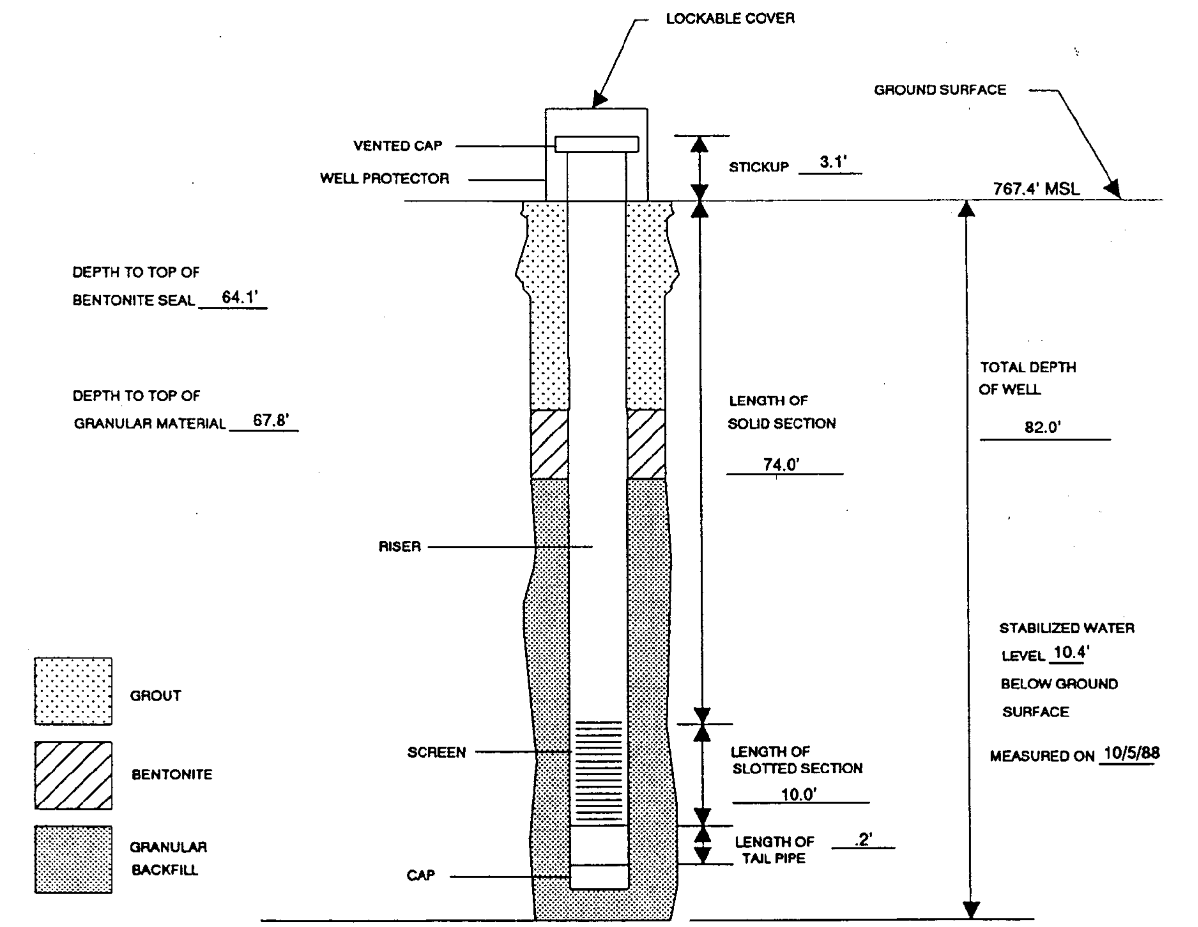
~~SH[illegible]~~ FIX ~~THIS OR GET MARK [illegible] TO REPAINT 13B~~!

TALKED TO MARK - HE IS SENDING [illegible].

TYPE II MONITORING WELL INSTALLATION RECORD

PROJECT: KINGSTON FOSSIL PLANT
JOB NUMBER: K-88195
WELL NUMBER: J-13 B
INSTALLATION DATE: 9-29 TO 9-30-88
LOCATION: PLANT COORDINATES W 7+13, N 31+23
GROUND SURFACE ELEVATION: 767.4' M.L.S.
TOP OF INNER CASING: 770.5' M.L.S.
GRANULAR BACKFILL MATERIAL: QUARTZ SAND
SLOT SIZE: .010 INCH
CASING MATERIAL: PVC
CASING DIAMETER: 2 INCHES
DRILLING TECHNIQUE: POWER AUGER
DRILLING CONTRACTOR: LAW ENGINEERING
BOREHOLE DIAMETER: 8" AUGER, 5 7/8" ROLLERCONE
FIELD REPRESENTATIVE: H. W. ROBINSON
LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043
RISER MATERIAL: PVC
SCREEN MATERIAL: PVC
COMMENTS:

(NOT TO SCALE)



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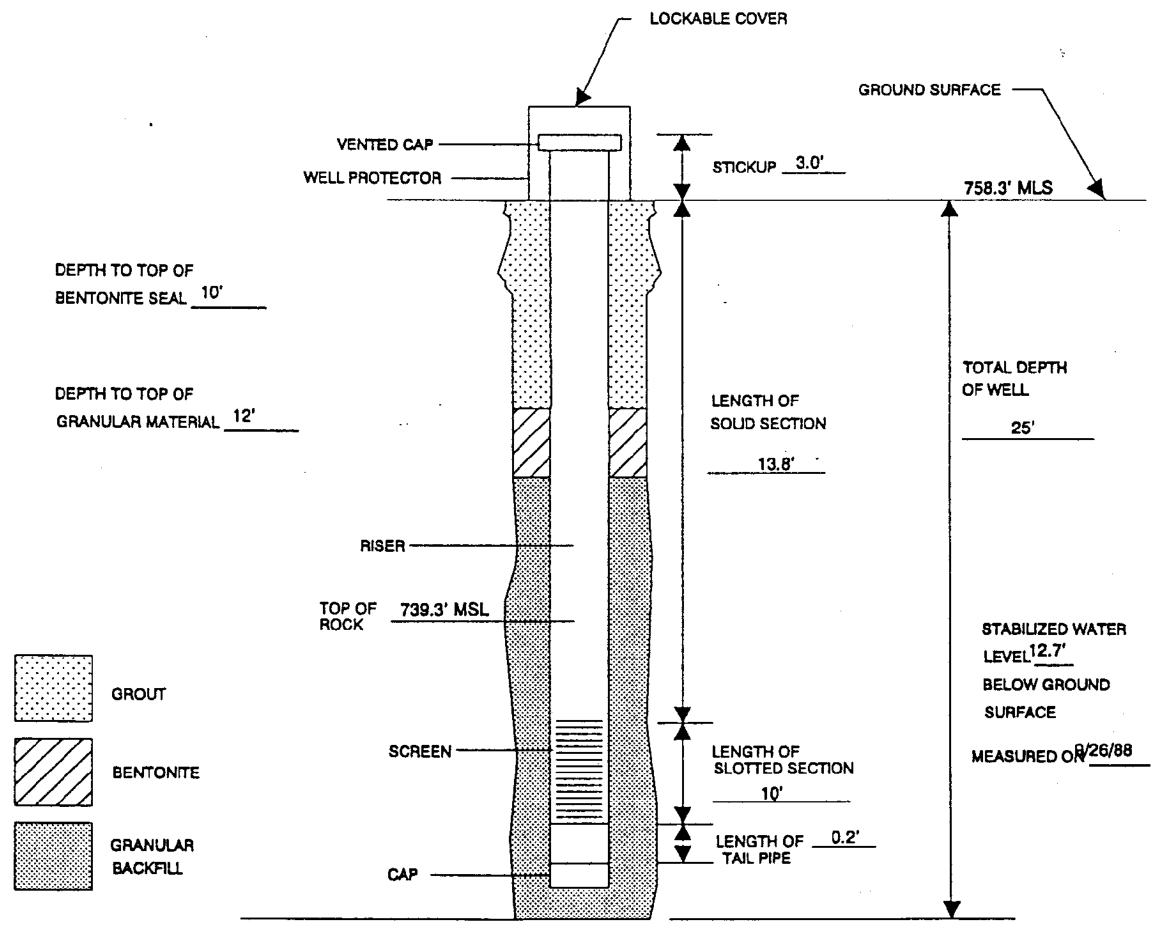
TYPE II MONITORING WELL INSTALLATION RECORD

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 DRILLLING
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)



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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

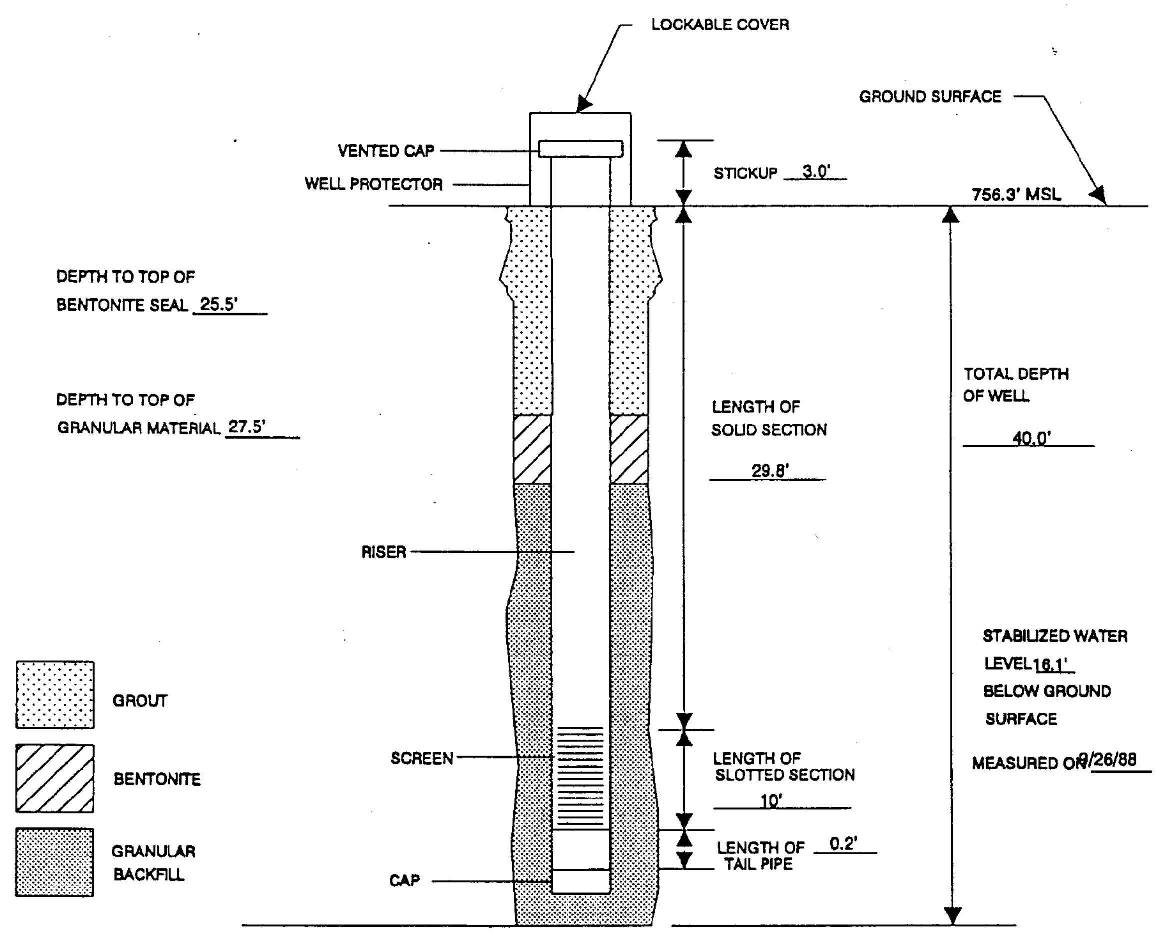
BOREHOLE DIAMETER: 8 INCHES
FIELD REPRESENTATIVE: H.W. ROBINSON

LOCKABLE COVER ?: YES
KEY CODE/COMBINATION: 2043

RISER MATERIAL: PVC
SCREEN MATERIAL: PVC

COMMENTS:

(NOT TO SCALE)



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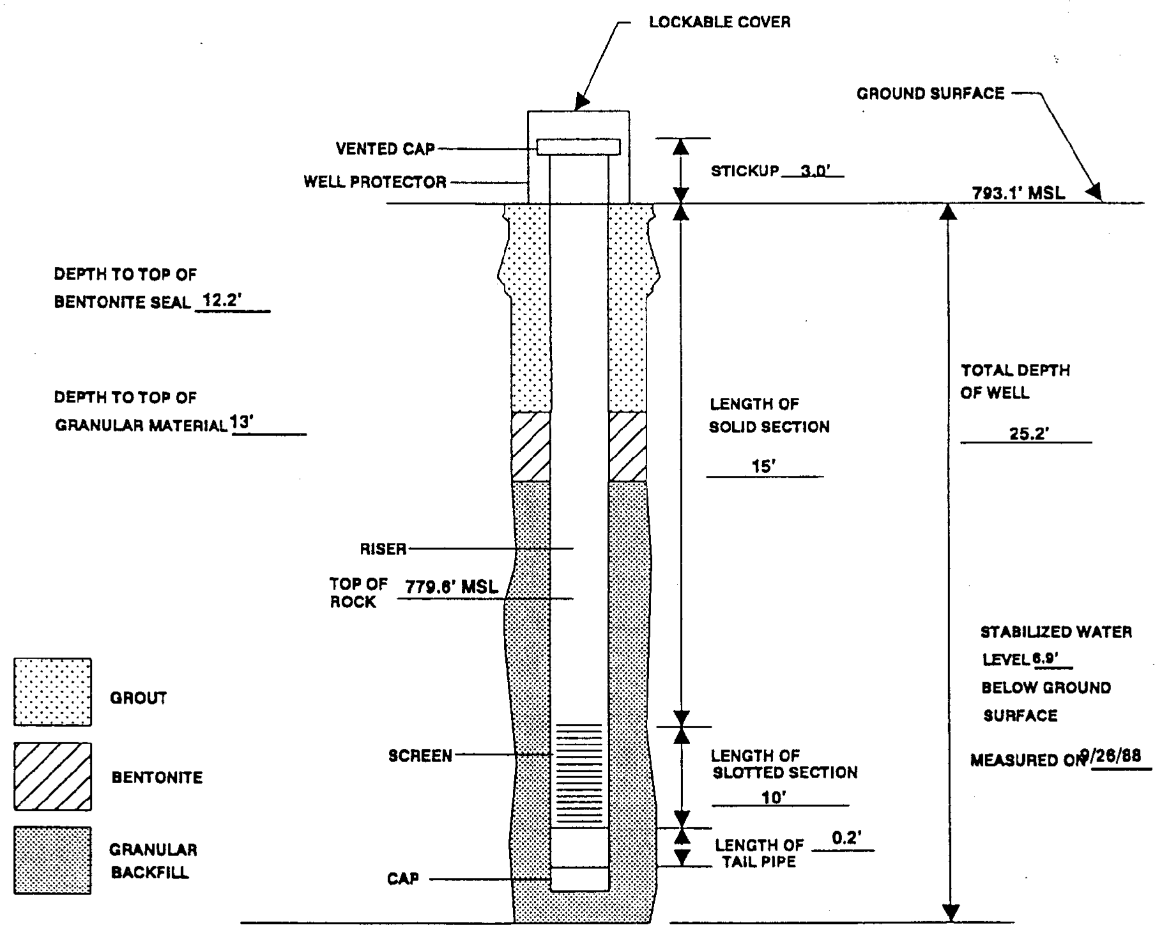
TYPE II MONITORING WELL INSTALLATION RECORD

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 10/2/88

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

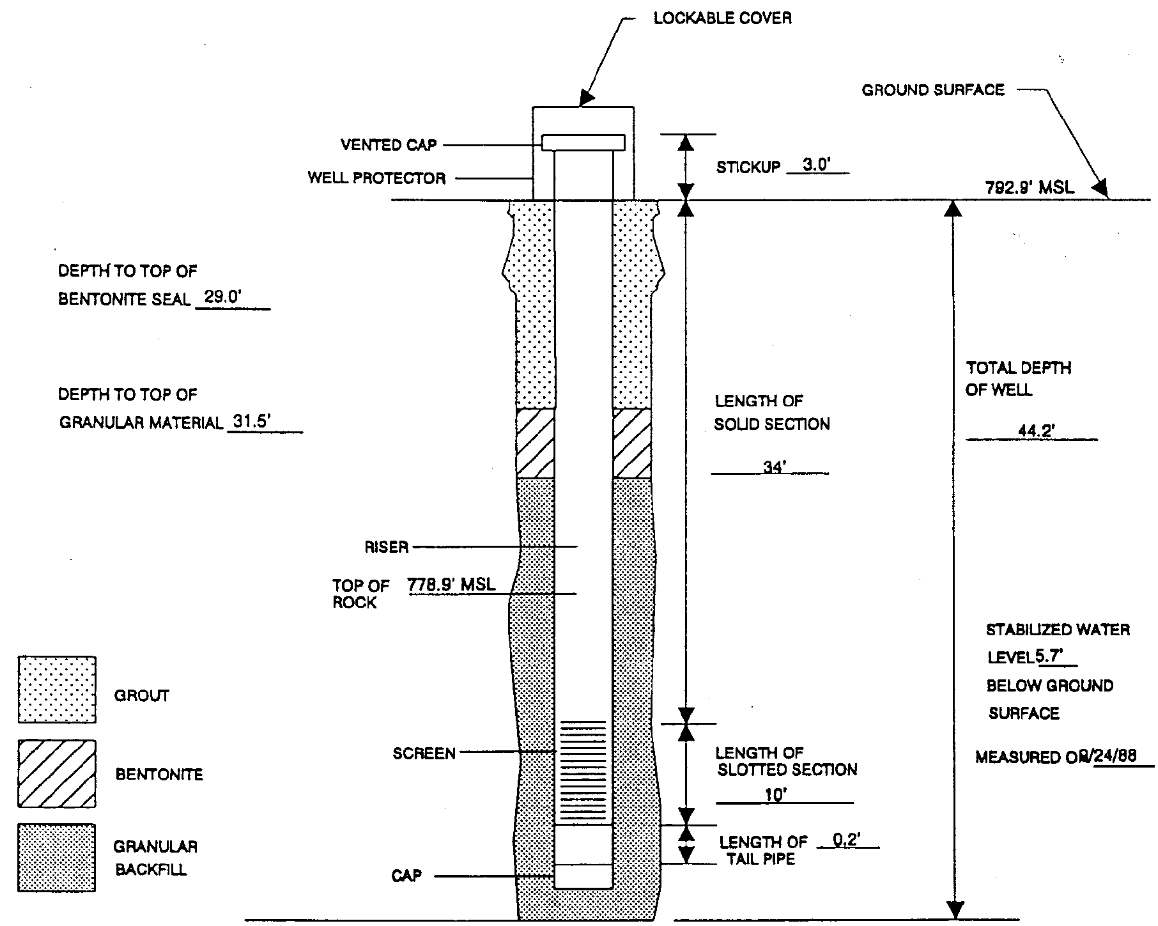
BOREHOLE DIAMETER 8 INCHES FIELD REPRESENTATIVE H.W. ROBINSON

LOCKABLE COVER ? YES KEY CODE/COMBINATION 2043

RISER MATERIAL PVC SCREEN MATERIAL PVC

COMMENTS

(NOT TO SCALE)

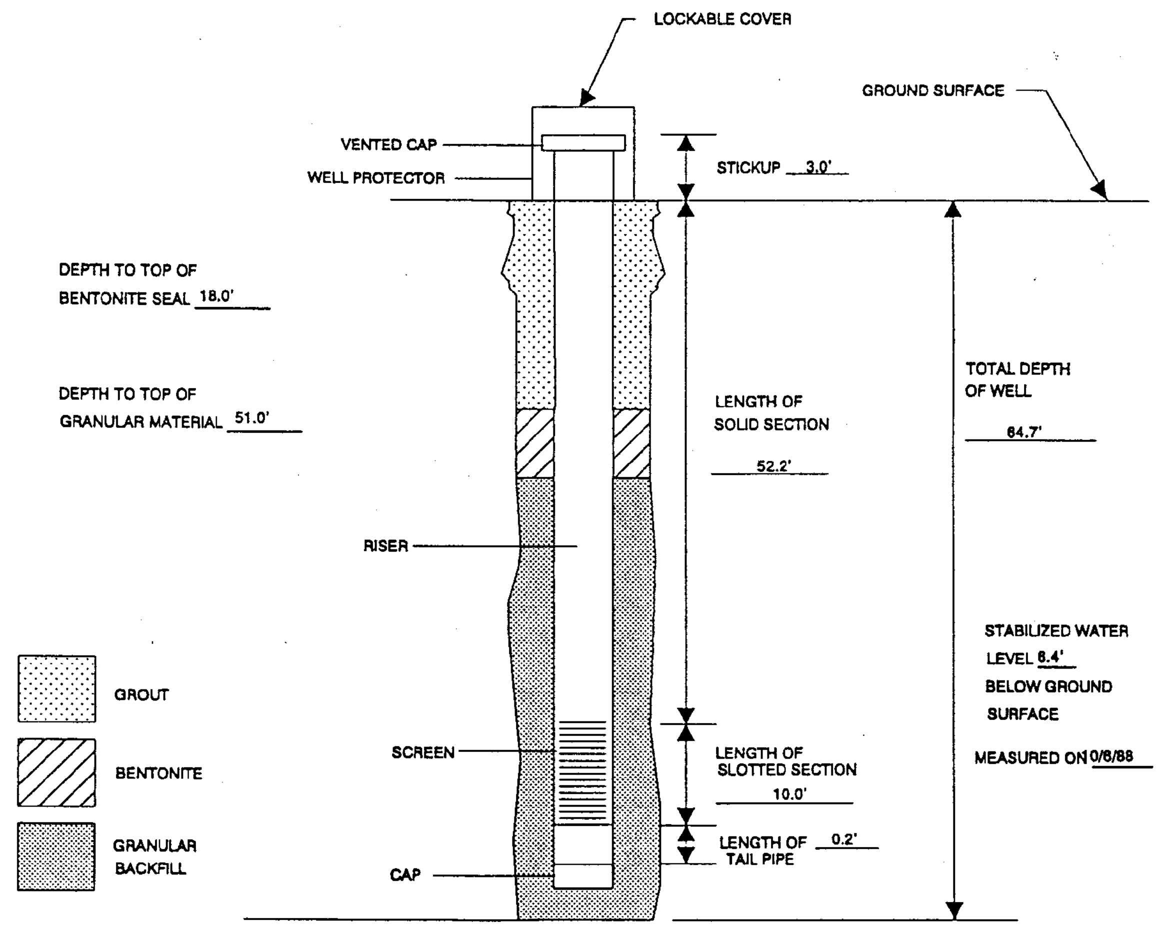


ENG LAB 10/2/90

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 10/2/90

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

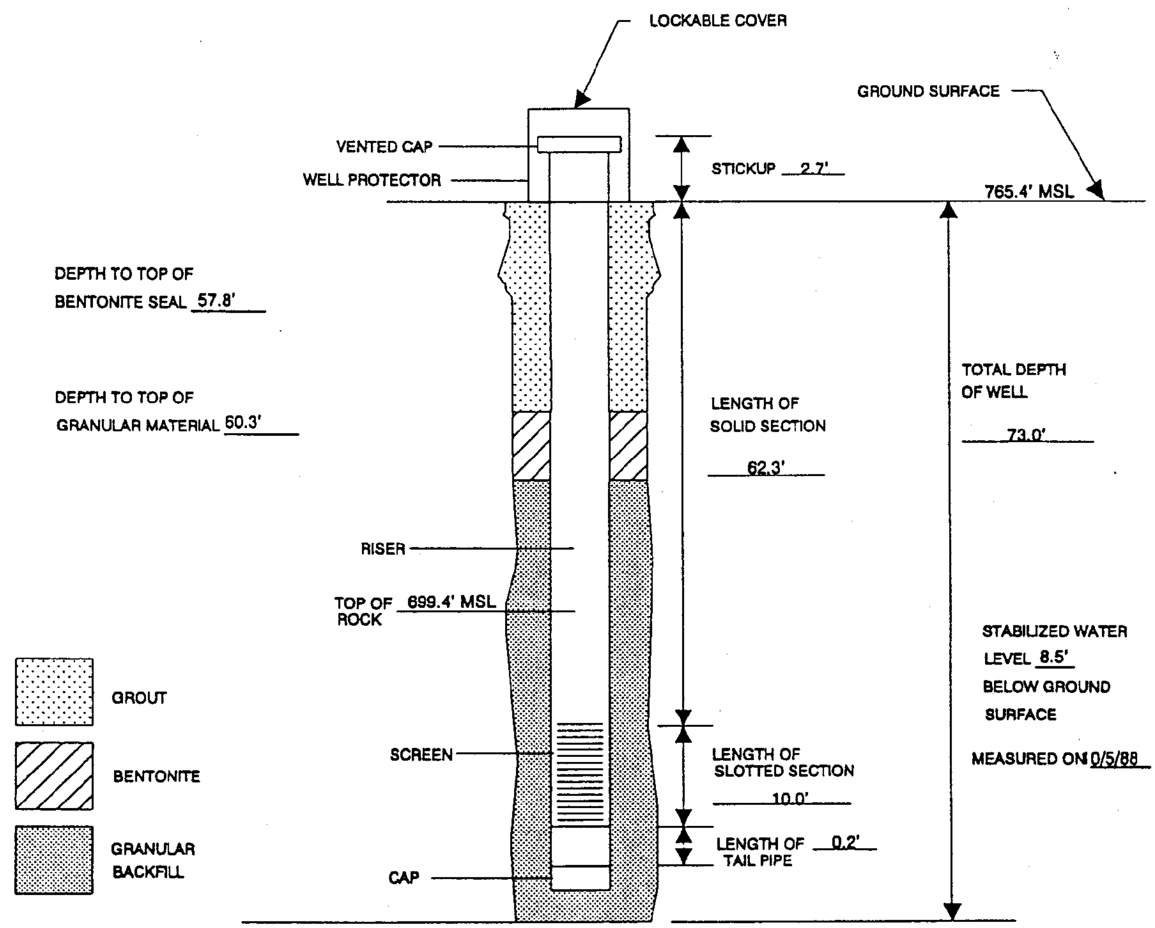
BOREHOLE DIAMETER 8" AUGER,5 7/8" AIR ROTARY FIELD REPRESENTATIVE H.W. ROBINSON

LOCKABLE COVER ? YES KEY CODE/COMBINATION 2043

RISER MATERIAL PVC SCREEN MATERIAL PVC

COMMENTS

(NOT TO SCALE)

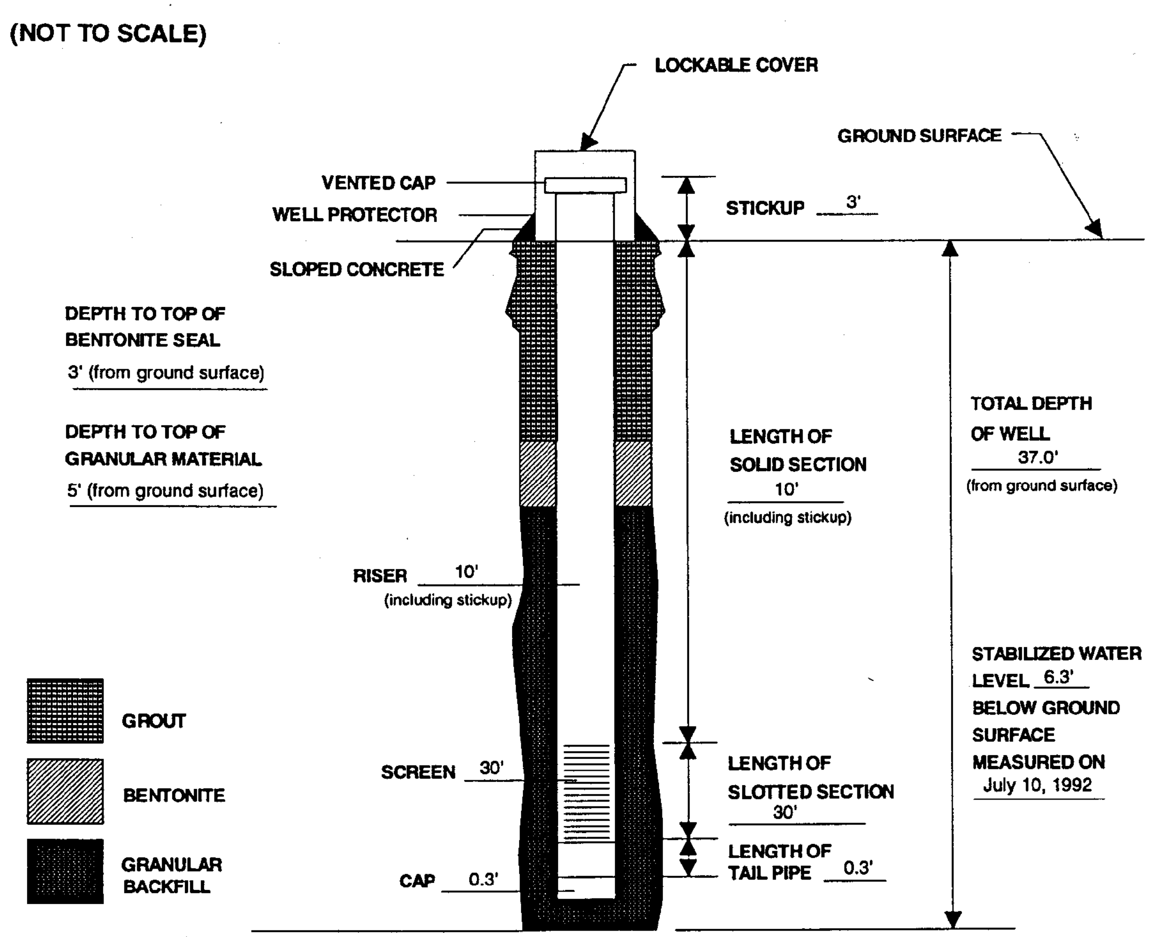


ENG LAB 10/2/90

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.



ENG LAB 6/19/95

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

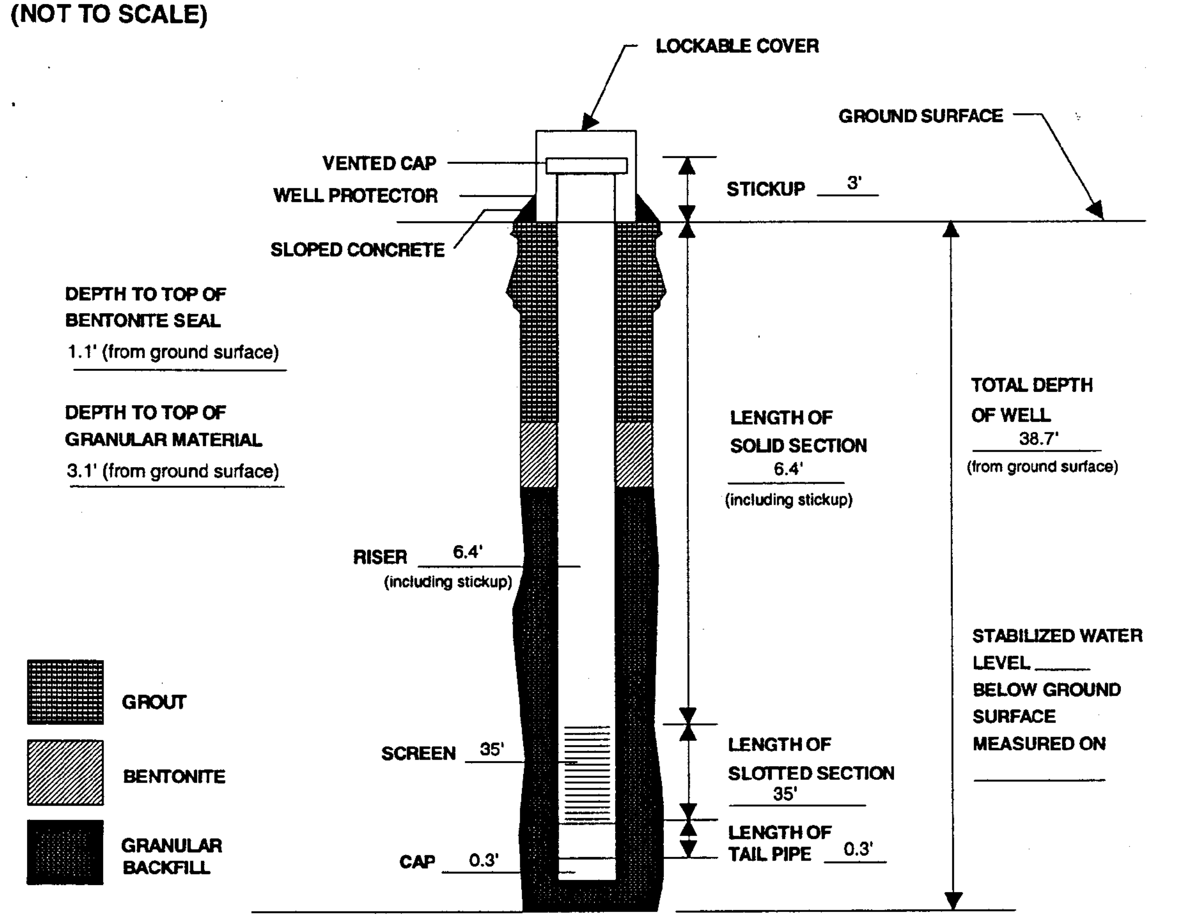
DRILLING TECHNIQUE HSA **DRILLING CONTRACTOR** John Voekel, Law Engr.

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 6/19/85

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

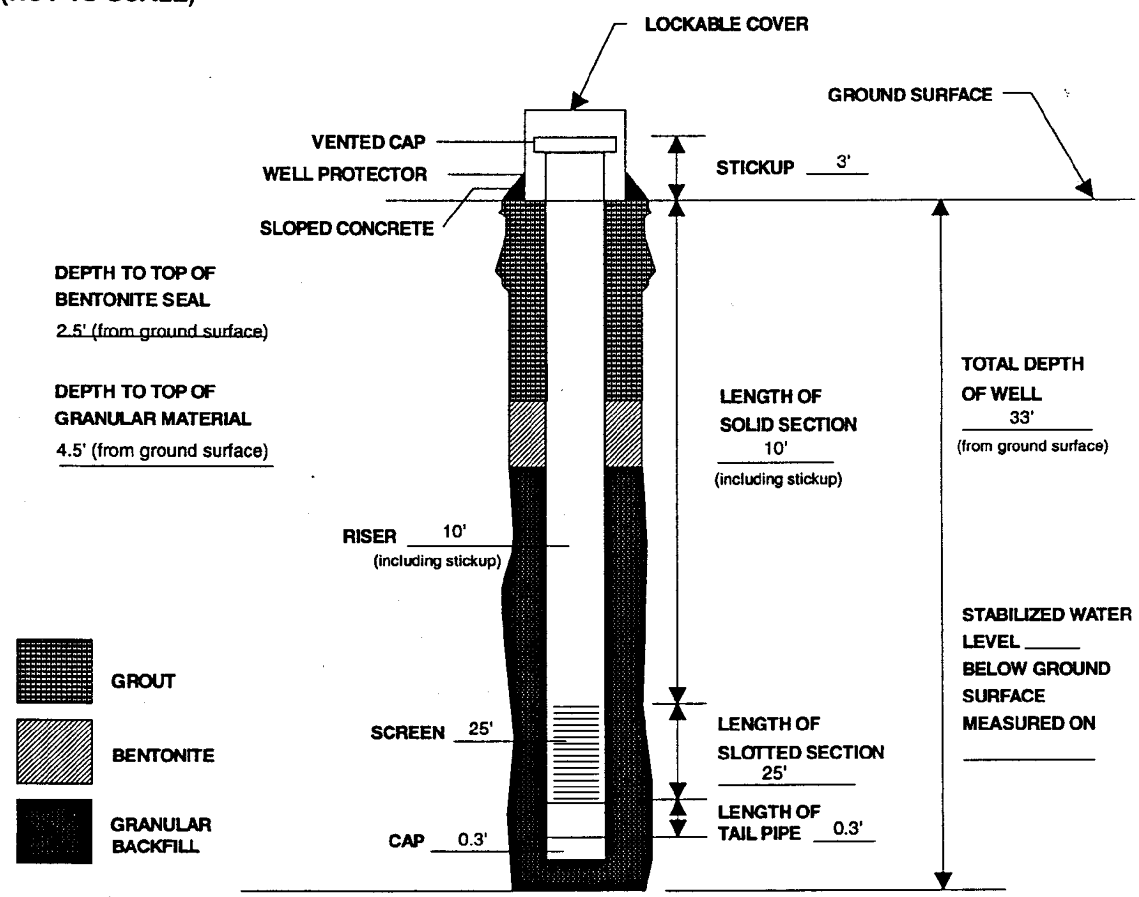
DRILLING TECHNIQUE HSA **DRILLING CONTRACTOR** John Voekel, Law Engr.

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 6/18/85

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

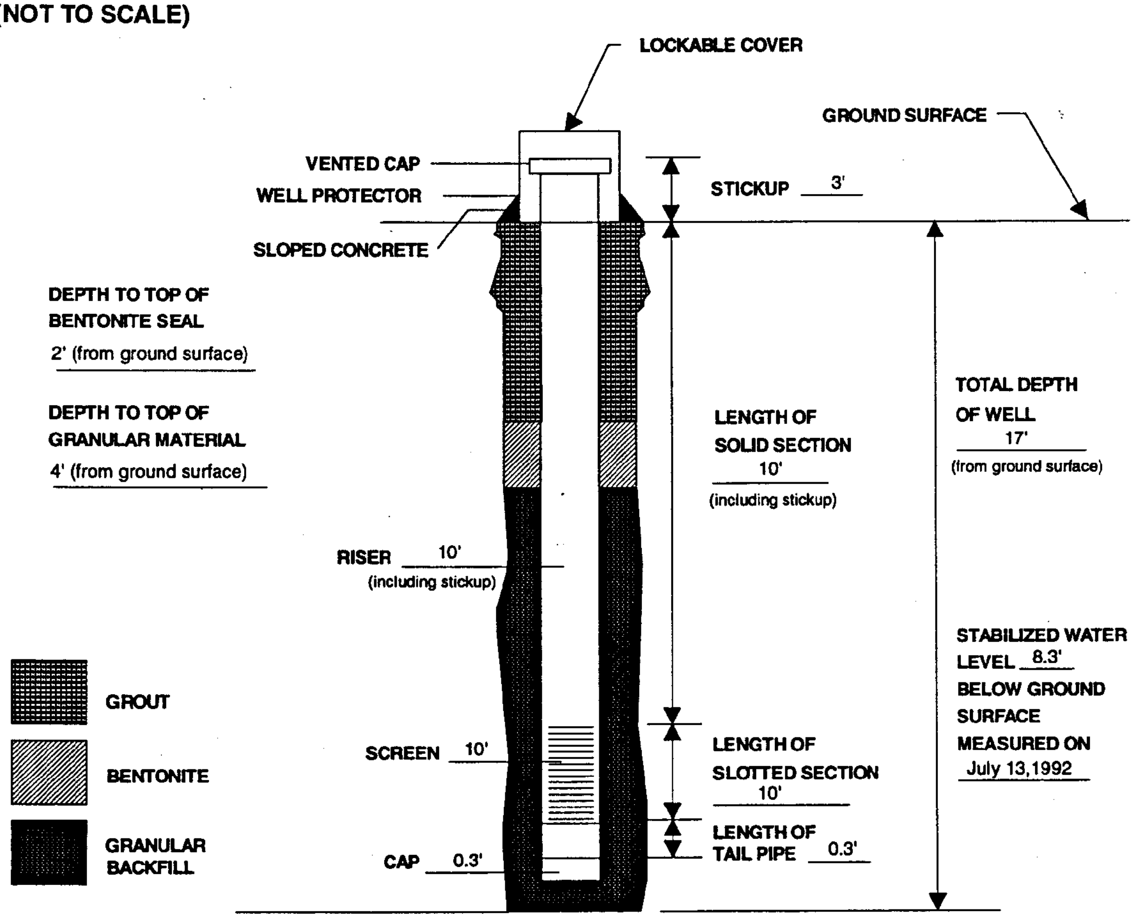
DRILLING TECHNIQUE HSA **DRILLING CONTRACTOR** John Voekel, Law Engr.

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 6/19/95

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 (ÜMHOS/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 (UMHOS/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 (UMHOS/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

Continued

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

Continued

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

Continued

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

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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
Emory R.	CADMIUM (UG/L)	132	1.2	1	0	30
Emory R.	CHROMIUM (UG/L)	125	4	1	1	113
Emory R.	COBALT (UG/L)	109	8.9	10	1	40
Emory 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

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.

LYNN

WE NEED TO DEVELOP AN OFFICIAL RESPONSE TO RICK BROWN'S COMMENT. PLEASE TAKE A LOOK AT THE ATTACHED DATA AND GIVE ME A CALL WHEN YOU GET A CHANCE

DUE MON

THANKS

DAVE

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

July XX, 1997

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

Dear Mr. Brown:

KINGSTON FOSSIL PLANT - CLOSURE/POST-CLOSURE PLAN FOR ASH POND DISPOSAL AREA - SECOND ALTERNATIVE FOR CAP

This letter is in response to your letter to Randy Cole dated November 21, 1996 concerning the use of a bentonite-impregnated fabric without a soil component in the cap.

We recognize the need for a soil "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 Kingston, 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. As for the possibility of tears or seams splitting during placement of the GCL we would be receptive to a higher level of Quality Assurance/Quality Control to prevent such problems.

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 strong capillary forces and an ability to store water. We believe that the clay would remain sufficiently moist from evaporation of the underlying ground water to prevent desiccation. In the consideration of such a low probability of a failure in the GCL, we believe the soil liner component of a synthetic cap is not necessary in this unique case.

We would be happy to discuss this issue further. There may be other economic and innovative possibilities that we could jointly explore.

J:fossil/site/kifgcl.doc

Between now and the time the cap is actually placed there may well be advances in the technology associated with synthetic liners. We want to keep an open mind toward using any liner which may be better.

Field tests (tensiometers 200 square foot of claymax set up in the dredge cell area.)

In the unlikely event of a failure, some consideration should be given to the non/low hazard nature of the ash being stored. The consequences do not merit the use of a cushion in this situation.

Propose the use of the intermediate cover as a redundant cushion in lieu of the underlying clay.

ash will be as follows (from top layer downward):

- Soil suitable for support of vegetation twelve inches (12")
- Soil compacted to achieve a maximum hydraulic conductivity of 1×10^{-7} cm/sec twelve inches (12")

Appendix A is a printout of the HELP model that provides the justification for using this final cap. In summary, the printout is to be used to evaluate the cap design only in regards to the anticipated average annual percolation through the cap. The results indicate that for the 20 years modeled the average annual percolation through the cap is predicted to be 1.2447 inches/year. The proposed cap design will provide sufficient protection from the percolation of water into fly ash stack. (1) **This is further supported by the field experiments and analyses conducted by TVA that indicate that the fly ash exhibits strong capillary forces and an ability to store water.** (2) **Reference is also made to the report "Design, Construction and Maintenance of Cover Systems for Hazardous Waste - An Engineering Guidance Document" prepared by the Army Engineer Waterways Experiment Station for EPA, May** 1987. Reference is also made to Sheet 5 of 5 the plans submitted as part of this Closure/Post-Closure Plan for additional details regarding the final cap.

From: C/PCP TOF Rail Loop
Tribble & Richardson, Inc.
LAW

July XX, 1997

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Environmental Engineer
Division of Solid Waste Management
Department of Environment and Conservation
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Division of Solid Waste Management

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cc: DSWM-Nashville Central Office