

TECHNICAL DIVISION
SAVANNAH RIVER LABORATORY

DPST-83-607

APP. NO. 104541

CC: W. R. Stevens, III
J. R. Wiley
O. A. Towler
D. L. Peterson
M. D. Dukes
C. A. Langton
H. C. Wolf
A. J. Garrett
T. V. Crawford
J. C. Corey
I. W. Marine
D. E. Gordon
H. W. Bledsoe
SRL File (4)

MEMORANDUM

June 27, 1983

TO: E. L. Albanesi

FROM: James R. Cook *JRC*

TIS FILE
RECORD COPY

ESTIMATION OF HIGH WATER TABLE LEVELS
AT THE SALTSTONE DISPOSAL SITE (Z-AREA)

INTRODUCTION AND SUMMARY

The design of the saltstone disposal site is such that the nitrate/nitrite will be slowly released over time, so that the concentration of nitrate/nitrite in the ground water leaving the disposal site boundary never exceeds the Environmental Protection Agency drinking water standards for these compounds. The methods for attaining the low concentration levels include placing a low permeability cap over the monoliths to minimize water percolation to the monoliths, making the permeability of the monoliths very low to minimize flow through them, and placing the bottom of the monoliths three meters above the historic high water table.¹ This memorandum, done at the request of the DWPF Liason Group, addresses the last of these design objectives.

Based on rainfall data from 1854 to the present, the minimum depth to the water table should have occurred in 1965, and in that year the water table at wells within the saltstone disposal site should have ranged from 44 to 55 feet below ground surface.

RECORDS ADMINISTRATION



R1010062

DISCUSSION

Water table wells were installed in and around Z-Area to determine the depth to water at a number of locations in the vicinity of the area. The oldest of these, well SDS-1, has been measured regularly since December 1979. A search was made to find another water table well as close as possible to SDS-1 with a longer history of regular measurements. Well ZW-10, which has been measured since 1952 and is 0.91 miles from SDS-1, was selected. The locations of these wells are shown in Figure 1.

Variations from the mean water table measurements for wells SDS-1 and ZW-10 for the years 1980 through 1983 are shown in Figure 2. The means for wells ZW-10 and SDS-1 for this time period were 255.2 and 231.7 feet above mean sea level, or 45.2 and 62.7 feet below grade elevation, respectively. The correlation coefficient for the two sets of data is 0.76. The similarity in the two curves indicates that the processes governing fluctuations in the wells, i.e., precipitation, evapotranspiration, and ground water flow regime, are very similar. The response of well SDS-1 is somewhat slower than that of ZW-10, most likely because the soil in the vicinity of SDS-1 has a lower permeability.

The elevation of a water table surface balances the inflow and outflow of subsurface water in an area. As inflow increases, the water table rises, which increases the hydraulic head, which in turn increases the flow rate, and tends to return the water table to an equilibrium elevation. The primary driving force for water table fluctuations at SRP is precipitation. In a humid climate, with deeply weathered surficial material, the source of ground water is rainfall, and the ground water sink is flow to streams.

Figure 3 shows water level variations in well ZW-10 and total annual precipitation at SRP from 1952 to 1982. During this time period the mean elevation of the water table at ZW-10 was 253.7 feet above mean sea level. The 71.36 inches of precipitation in 1964 caused ZW-10 to peak 12.2 feet above its mean in April of 1965. Other years of high precipitation, for example 1959 and 1971, also produced elevated water table levels.

To extrapolate further back in time, precipitation data were needed for at least 100 years for a location close to SRP. A. J. Garrett of the SRL Meteorology group provided precipitation data for Aiken, South Carolina, dating back to 1854. Figure 4 compares the SRP and Aiken precipitation data for the years 1952 to 1980, the years for which both sets of data exist. The correlation coefficient is 0.86. Therefore, one can estimate the SRP precipitation using Aiken data with some degree of confidence. Figure 5 shows the Aiken precipitation data from 1854 to 1980. It can be seen that in this time period the highest

precipitation was that of 1964. Though 1964 had the highest precipitation on record, several other years had precipitation totaling over 60 inches. These were 1888, 1928, 1929, 1948, 1959, and 1971.

Based on the above, the problem becomes estimating the depth to the water table in Z-Area in 1964, given information on well ZW-10 from 1952 through 1982, and on wells ZW-10 and SDS-1 for 1980 through 1982. The known information is:

- 1) In the period 1952-1982 well ZW-10 peaked in 1964 at 12.2 feet above its mean for that time period.
- 2) In the period 1980 through 1982 well ZW-10 peaked at 6.8 feet above its mean for that time period.
- 3) For well ZW-10 the mean for 1980 through 1982 was 1.5 feet higher than the mean for 1952 through 1980.
- 4) In the period 1980 through 1982 well SDS-1 peaked at 5.2 feet above its mean for that time period.

To convert the 1964 peak at ZW-10 to an equivalent peak in terms of the 1980 through 1982 mean the difference in the means must be subtracted:

$$12.2 \text{ ft} - 1.5 \text{ ft} = 10.7 \text{ ft}$$

The 1964 peak at SDS-1 can then be estimated by multiplying 10.7 feet by the ratio of the SDS-1 peak to the ZW-10 peak for the period 1980 through 1982:

$$\text{SDS-1}_{\text{peak}} = 10.7 \text{ ft} * (5.2 \text{ ft} / 6.8 \text{ ft}) = 8.2 \text{ ft above mean}$$

Since the mean depth to the water table at SDS-1 was 62.7 feet, the depth to water in 1964 was:

$$\text{SDS-1}_{\text{min.}} = 62.7 - 8.2 = 54.5 \text{ ft}$$

Nineteen other water table wells were installed in and around Z-Area, and have been measured since late 1981. Four of these, SDS-5, SDS-6, SDS-7D, and SDS-12C are within the area planned for saltstone disposal trenches. Figure 6 is a plot of water table variations of these four wells and SDS-1. The correlation coefficients for all of these wells with SDS-1 are greater than 0.90. Table 1 lists the minimum, maximum, and mean of the depth to water measurements for these five wells in 1982. Using the same methodology, but now using SDS-1 as the base well, and 1982 as the year with data for all wells, the minimum depth to the water table for these wells in 1964 can be estimated. The known information is:

- 1) In 1964 SDS-1 peaked at 8.2 feet bove its mean for 1980-1983.
- 2) In 1982 SDS-1 peaked at 1.1 feet above its 1982 mean.
- 3) For SDS-1 the 1982 mean was 3.7 feet lower than the mean for 1980-1982.
- 4) In 1982 wells SDS-5, SDS-6, SDS-7D, and SDS-12C peaked at 0.9, 1.0, 1.1, and 0.7 feet above their respective means.

To convert the 1964 peak at SDS-1, which was calculated on the 1980-1983 mean, the difference must be subtracted:

$$8.2 - (-3.7) = 11.9$$

The 1964 peak at any of the wells within Z-Area is then the 1982 average depth to water for that well minus 11.9 times the 1982 peak for the well in question divided by the 1982 peak for SDS-1. That is:

SDS-5	SDS-6
$11.9 * (0.9/1.1) = 9.8$	$11.9 * (1.0/1.1) = 10.8$
$53.7 - 9.8 = \underline{43.9}$	$59.5 - 10.8 = \underline{48.7}$
SDS-7D	SDS-12C
$11.9 * (1.1/1.1) = 11.9$	$11.9 * (0.7/1.1) = 7.6$
$60.5 - 11.9 = \underline{48.6}$	$57.3 - 7.6 = \underline{49.7}$

CONCLUSIONS

During the last 129 years the highest water table levels in the vicinity of Z-Area should have occurred in the period 1964-1965. Estimates for the depth to water in that year for wells within Z-Area range from 44 to 55 feet.

REFERENCE

1. R. L. Hooker and M. D. Dukes, Technical Data Summary, Decontaminated Salt Disposal as Saltcrete in a Landfill, Revision 1, Supplement 1, May 2, 1983.

Figure 1. Locations of Wells ZW-10 and SDS-1

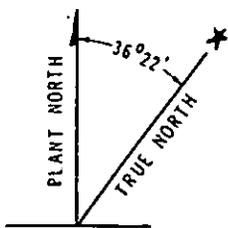
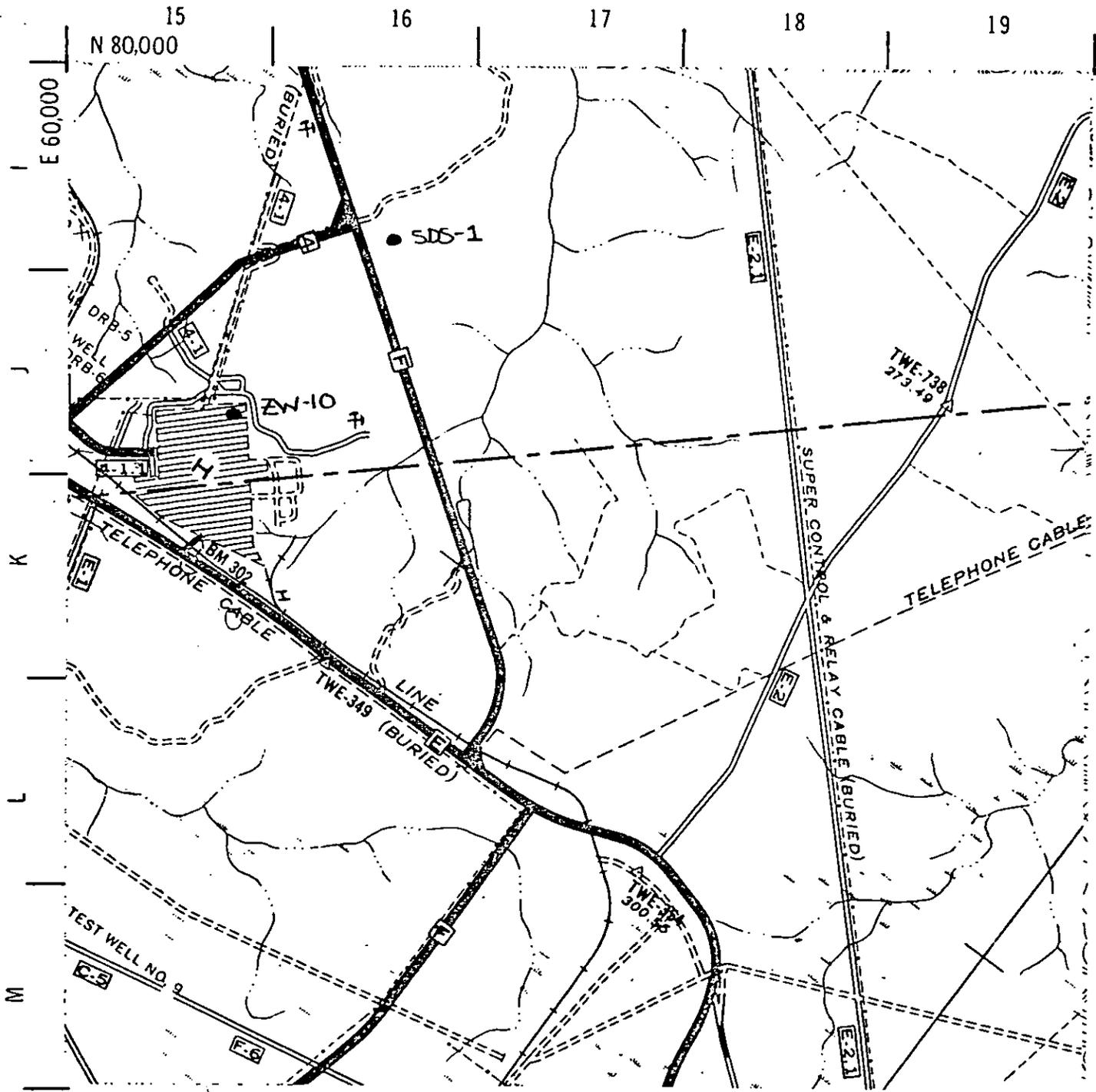


FIGURE 2. WATER TABLE VARIATIONS
SDS-1 AND ZW-10 1980-1983

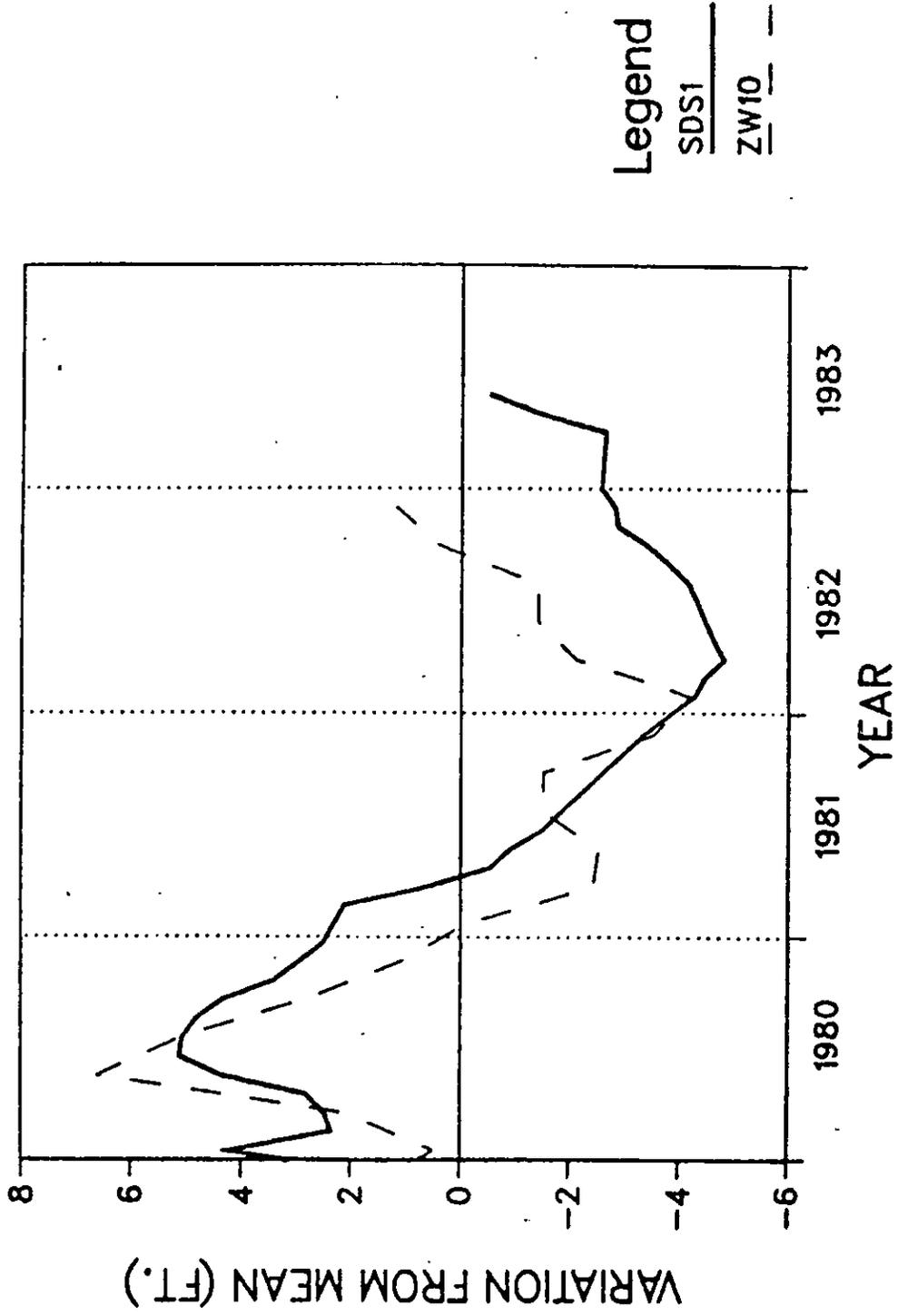


FIGURE 3. ANNUAL PRECIPITATION AND
WELL ZW-10 VARIATIONS 1952-1982

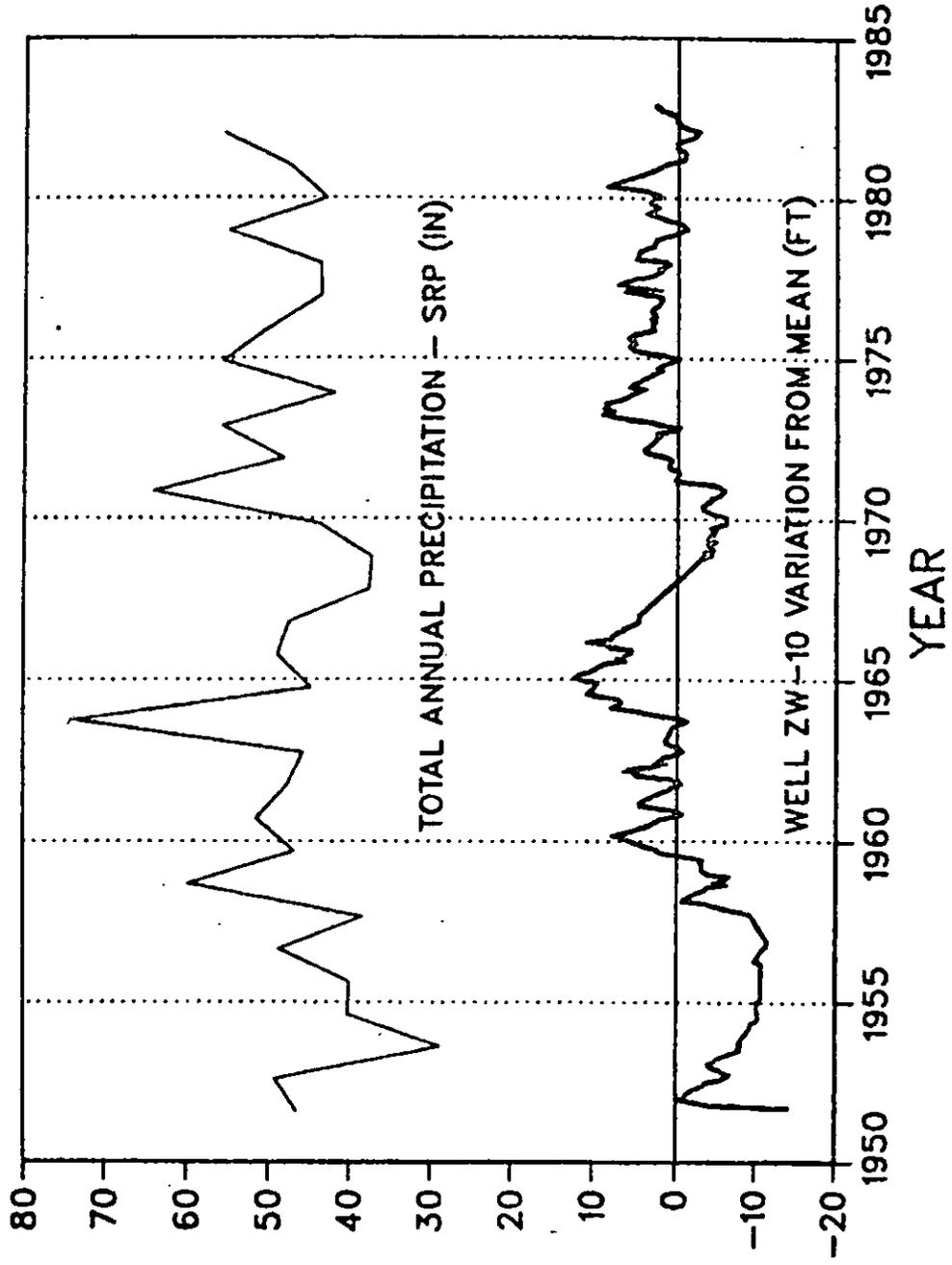


FIGURE 4. SRP AND AIKEN PRECIPITATION 1952-1980

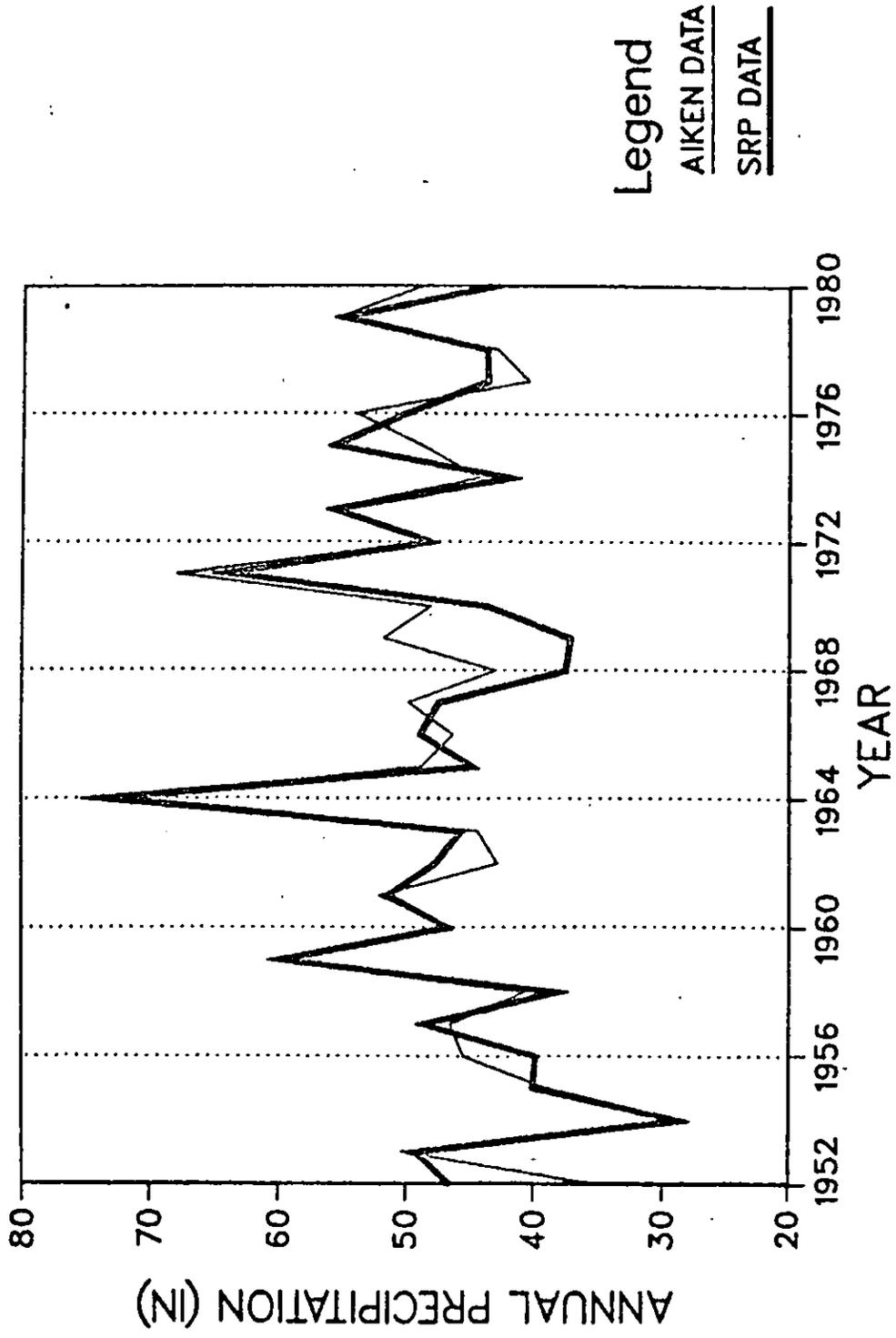


FIGURE 5. AIKEN PRECIPITATION 1854-1980

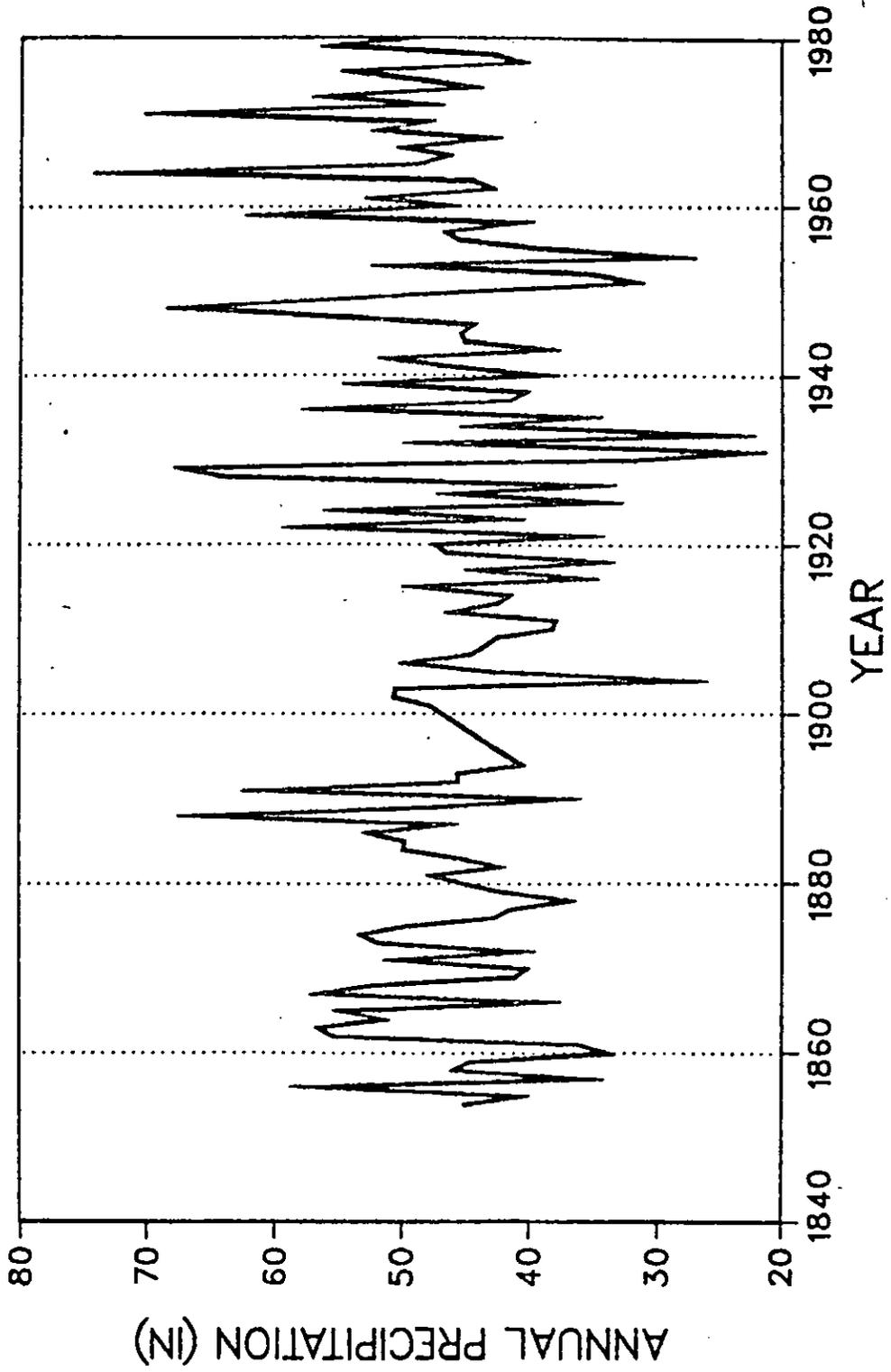


FIGURE 6. WATER TABLE VARIATIONS, Z-AREA WELLS 1982

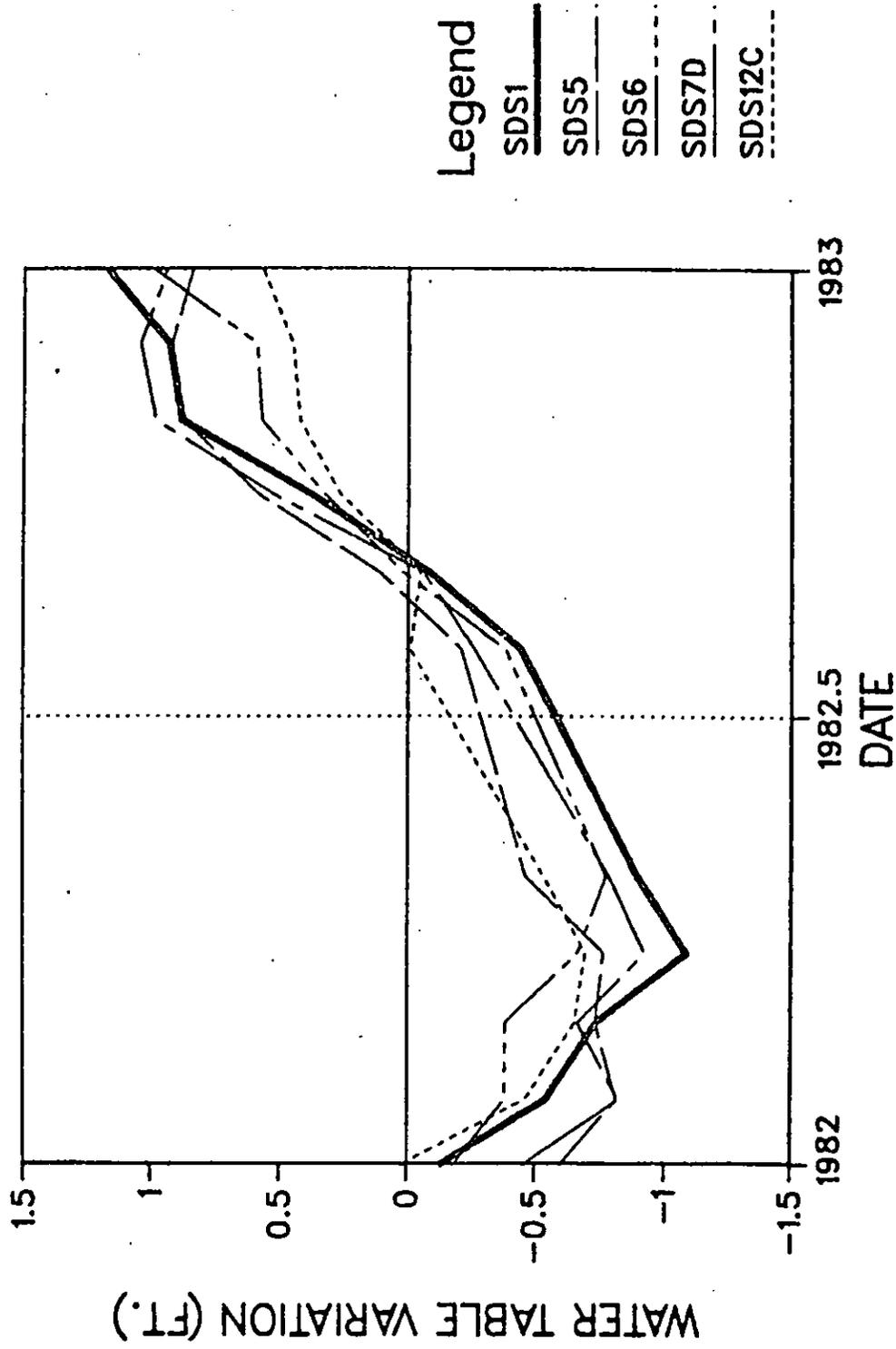


Table 1. Depth to Water Statistics for Z-Area Wells - 1982

<u>Well</u>	<u>Minimum</u>	<u>Maximum</u>	<u>Mean</u>
SDS-1	65.3	67.5	66.4
SDS-5	52.8	54.5	53.7
SDS-6	58.5	60.2	59.5
SDS-7D	59.4	61.4	60.5
SDS-12C	56.6	58.0	57.3

DPST-83-607-TL

CC: R. Maher, SRP, 703-A
E. B. Sheldon, 703-A
J. D. Heffner, 703-A
R. L. Hooker, 773-A
S. Mirshak, SRL, 773-A
W. R. Stevens, 773-A
G. T. Wright, 773-A
M. D. Dukes, 773-A
J. R. Cook, 773-A
SRL Record Copy (2)

September 26, 1983

ACC. NO. 104541

J. T. GRANAGHAN, MANAGER
SAVANNAH RIVER PLANT

ATTENTION: D. C. NICHOLS (30)

TIS FILE
RECORD COPY

HISTORIC HIGH WATER TABLE AT Z-AREA

- Ref: 1. DPST-83-607, Estimation of High Water Table Levels at the Saltstone Disposal Site (Z-Area), June 27, 1983.
2. DPSTD-82-65, Revision 1, Technical Data Summary, Decontaminated Salt Disposal as Saltcrete in a Landfill, December 21, 1982.

Reference 1 estimates the historic high water table levels at wells within Z-Area. Precipitation data from 1854 to the present indicate that, over this time period, the highest water tables would have occurred in 1964, and that in that year the water table in Z-Area would have ranged from 44 to 55 feet below grade elevation.

According to reference 2 the Z-Area design is such that the saltstone monoliths will be 25 feet thick, with the top 16.4 feet below grade elevation, and the bottom 10 feet above the historic high water table. These vertical dimensions total 51.4 feet, which is greater than the depth to water estimated in reference 1 in four of the five wells within Z-Area.

These findings do not mean that the Z-Area site is unsuitable for the disposal of saltstone. The water levels in wells SDS-1 and SDS-5 differ by about 13 feet, even though they are only 300 feet apart. Well SDS-5 is the shallowest well within Z-Area. This may indicate that well SDS-5 is not operating properly. Additional wells will be installed to verify the data.

Possible methods to reconcile water levels with saltstone disposal include raising grade level with additional overburden, decreasing the monolith thickness, and changing the criterion to a five foot distance between the monolith bottom and the historic high water table. For example, if the ten foot depth to water criterion was changed to five feet, then all the wells within Z-Area except SDS-5, the suspect well, would be acceptable. These and perhaps other options are under study, and a report with recommendations will be issued in the near future.

E. L. Albenesius

E. L. Albenesius, Research Manager
Waste Disposal Technology Division

ELA:jrc
Att

DOE AND MAJOR CONTRACTOR RECOMMENDATIONS FOR
ANNOUNCEMENT AND DISTRIBUTION OF DOCUMENTS

See instructions on Reverse Side

1. DOE Report No. DPST-83-607	2. DOE Contract No. DE-AC09-76SR00001	3. Distribution Category No. UC-11
----------------------------------	--	---------------------------------------

4. Title ESTIMATION OF HIGH WATER TABLE LEVELS AT THE SALTSTONE DISPOSAL SITE Z-AREA

5. Type of Document ("x" one)
 a. Scientific and technical report
 b. Conference paper: Title of conference _____ Date of conference _____

Exact location of conference _____ Sponsoring organization _____
 c. Other (Specify) _____

6. Copies Transmitted ("x" one or more)
 a. Copies being transmitted for unclassified standard distribution by OSTI/TIC.
 b. Copies being transmitted for classified documents as contained in M-3679.
 c. Copies being transmitted for special distribution.
 d. Two completely legible, reproducible copies being transmitted to OSTI/TIC.
 e. Thirty copies being transmitted to OSTI/TIC for OSTI processing and NTIS sales.

7. Recommended Distribution ("x" one)
 a. Unrestricted, unlimited distribution.
 Make available only b. Classified—to M-3679 addressees only. f. To DOE and any DOE contractor.
 c. To U. S. Government agencies and their contractors. g. Within USA only.
 d. To DOE offices only. h. Other—specify in item 14 below.
 e. To DOE and WPAS contractors. i. Refer all requests to _____

8. Recommended Announcement ("x" one)
 a. Unrestricted, unlimited announcement. e. Limit to section 148 contractors.
 b. Limit to U. S. Govt. agencies and contractors. f. Limit to authorized classified sites only.
 c. Limit to DOE and WPAS contractors. g. Archives only—No announcement.
 d. Limit to applied technology contractors.

9. Future Handling of Limited Reports
 After _____, this report may be reprocessed as item 7. _____ and 8. _____
 (Date)

10. Reason for Restriction Recommended in 7 or 8 above. (Explain fully) _____

11. Patent and Technology Transfer Information
 Does this information product disclose any new equipment, process, or material? No Yes If so, identify page nos. _____
 Has an invention disclosure been submitted to DOE covering any aspect of this information product? No Yes
 If yes, identify the DOE disclosure number and to whom the disclosure was submitted. _____
 Are there any patent-related objections to the release of this information product? No Yes If so, state these objections.
 ("x" one) a. DOE patent clearance has been granted by responsible DOE patent group.
 b. Document has been sent to responsible DOE patent group for clearance.

12. Does this information product contain? (Check all applicable boxes)
 Copyrighted material (attach release) Restricted data Section 148
 Proprietary information (page numbers _____) Formerly restricted data Other (explain) _____
 National security information Applied technology _____

13. Copy Reproduction and Distribution
 Total number of copies reproduced _____ Number of copies distributed outside originator (exclude copies to OSTI/TIC) _____

14. Additional information or Remarks (Continue on separate sheet, if necessary)

15. Submitted by (Name and Position) (Please print or type) C. J. Banick, Process Specialist	Phone 239-2606
Organization Information & Publication Services	Signature <i>CJ Banick</i> Date 3/13/85

EXTERNAL RELEASE OF TECHNICAL INFORMATION

Description of Material No. DPST-83-607 January 28, 1985

Title: ESTIMATION OF HIGH WATER TABLE LEVELS AT THE SALTSTONE DISPOSAL SITE (Z-AREA)

Author(s) James R. Cook

Type of Material:

- () Classified DP Report
- () Classified Paper
- () Unclassified DP Report
- (XXX) Unclassified Paper
- () Classified Letter
- () Classified Abstract or Summary
- () Unclassified Letter
- () Unclassified Abstract or Summary

Technical Content

Approved by E. L. Albenesius Date 1/30/85
E. L. Albenesius

Classification

Approved by E. L. Albenesius Date 1/30/85
E. L. Albenesius

Approved by C. J. Barnick Date 1/29/85
AED Classification Officer

Authority

CG-UF-3, Topic 2.2

Category if DP Report

Approved by N/A Date _____
Supervisor, I&PS

Released by:

A. F. Westerdahl 2/11/85

E. L. Bowser 2/8/85

2/15/85 by phone notified R.L. Hooker

TO: Senior Information Specialist, I&PS, SRL, 773-A DATE: 2-8-85

DOCUMENT NO.: DPST-83-607 "ESTIMATION OF HIGH WATER LEVELS AT THE
SALTSTONE DISPOSAL AREA (Z-AREA)"

P&ME
RECEIVED ~~XXXX~~/SR ON: 2 / 1 / 85

The above referenced document has been reviewed by SR staff and is:

/ Approved for release as written.

/ Approved for release subject to the following changes:

Unclassified - no Section 148

/ Not Approved for release.

ADDITIONAL COMMENTS: _____


E. L. Bowser, Technical Information
Officer, DOE-SR

~~CONFIDENTIAL~~

Attachment

Environ



CC: E. L. Bowser, DOE-SR
J. S. Roberts, SRP
W. R. Stevens - E. L. Albenesius, SRL
G. T. Wright - J. R. Cook
E. L. Wilhite
File (DPST-83-607)

January 28, 1985

TO DISTRIBUTION

Attached is a copy of the following:

DPST-83-607, "ESTIMATION OF HIGH WATER TABLE LEVELS AT THE SALTSTONE DISPOSAL SITE (Z-AREA)", by James R. Cook.

Document will be sent to DOE/OSTI for distribution to the general public.

If any technical clarification is needed please call C. J. Banick whose Document Review is attached.

If there are comments about its release, notify the Records Management Office within 14 days (Ext. 2606).

For any technical clarification, we suggest you call:

E. L. Albenesius, Research Manager
Waste Disposal Technology Division
Savannah River Laboratory



E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED

ATOMIC ENERGY DIVISION

SAVANNAH RIVER PLANT
AIKEN, SOUTH CAROLINA 29808-0001

(TWX 810-771-2670; TEL-803-725-6211; WU- AUGUSTA, GA.)

CC: A. F. Westerdahl, DOE-SR
 J. M. Stogner

January 28, 1985

TO: J. M. STOGNER

FROM: C. J. BANICK 

DOCUMENT REVIEW

Document DPST-83-607

Title: ESTIMATION OF HIGH WATER TABLE LEVELS AT THE SALTSTONE
DISPOSAL SITE (Z-AREA)

Author(s) James R. Cook

Contractual Origin: DE-AC09-76SR00001

Present Classification: Unclassified Paper

References:

No items were noted that, in my opinion, should be called to the attention of the DOE for patent consideration.



E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED

ATOMIC ENERGY DIVISION

SAVANNAH RIVER PLANT
AIKEN, SOUTH CAROLINA 29808-0001
(TWX 810-771-2670 TEL. 803-725-6211, WU: AUGUSTA, GA.)

 CC: J. M. Stogner

January 28, 1985

Mr. A. F. Westerdahl, Chief
Patent Branch
U. S. Department of Energy
Aiken, South Carolina 29808

Dear Mr. Westerdahl:

REQUEST FOR PATENT REVIEW

Please review for patent matter:

DPST-83-607, "ESTIMATION OF HIGH WATER TABLE LEVELS AT THE SALTSTONE DISPOSAL SITE (Z-AREA)", by James R. Cook.

If any technical clarification is needed please call C. J. Banick whose Document Review is attached.

Please telephone your comments to the Records Management Office (Ext. 2606) and notify me by signing and returning to C. J. Banick the original of this letter. A copy is provided for your file.

If you decide to pursue a patent on any development covered, I shall be happy to supply additional information required such as appropriate references and the names of persons responsible for the development.

Very truly yours,

J. M. Stogner, Chief Supervisor
Records Management

The above item is approved
for release.

By: 

A. F. Westerdahl
Chief Patent Branch
DOE-SR

Date

CC: E. L. Bowser, DOE-SR
J. S. Roberts, SRP
W. R. Stevens - E. L. Albenesius, SRL
G. T. Wright - J. R. Cook
E. L. Wilhite
File (DPST-83-607)



January 28, 1985

TO DISTRIBUTION

Attached is a copy of the following:

DPST-83-607, "ESTIMATION OF HIGH WATER TABLE LEVELS AT THE SALTSTONE DISPOSAL SITE (Z-AREA)", by James R. Cook.

Document will be sent to DOE/OSTI for distribution to the general public.

If any technical clarification is needed please call C. J. Banick whose Document Review is attached.

If there are comments about its release, notify the Records Management Office within 14 days (Ext. 2606).

For any technical clarification, we suggest you call:

E. L. Albenesius, Research Manager
Waste Disposal Technology Division
Savannah River Laboratory

CC: E. L. Bowser, DOE-SR

J. S. Roberts, SRP

 W. R. Stevens - E. L. Albenesius, SRL

G. T. Wright - J. R. Cook

E. L. Wilhite

File (DPST-83-607)

January 28, 1985

TO DISTRIBUTION

Attached is a copy of the following:

DPST-83-607, "ESTIMATION OF HIGH WATER TABLE LEVELS AT THE SALTSTONE DISPOSAL SITE (Z-AREA)", by James R. Cook.

Document will be sent to DOE/OSTI for distribution to the general public.

If any technical clarification is needed please call C. J. Banick whose Document Review is attached.

If there are comments about its release, notify the Records Management Office within 14 days (Ext. 2606).

For any technical clarification, we suggest you call:

E. L. Albenesius, Research Manager
Waste Disposal Technology Division
Savannah River Laboratory