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PROGRAM REVIEW - GROUND DISPOSAL OF REACTOR EFFLUENT

R. G. Geier

October 18, 1967

DOUGLAS UNITED NUCLEAR, INC.
RICHLAND, WASHINGTON

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PROGRAM REVIEW -
GROUND DISPOSAL OF REACTOR EFFLUENT

I. INTRODUCTION

With the exception of N Reactor the plutonium production reactors operated by Douglas United Nuclear, Inc., use treated Columbia River water as coolant on a once through basis. Thus, radionuclides formed by neutron activation of Columbia River salts not removed in the water treatment process and water treatment additives are discharged to the river. Although the quantity and possible effects of the radionuclides released are well within nationally accepted limits, emphasis has been placed for some time on reducing the releases to as low a level as possible. More recently increasing concern has been evidenced with regard to the heat which is also discharged to the river. A concept which not only would drastically reduce the radionuclide content of the river but which would also substantially decrease the heat discharge is the disposal of the reactor effluent to the ground either to a pond or to a network of trenches.

The concept of disposing of reactor effluent to the ground is not new. It was first documented by Honstead[1] in 1955 and later reexamined by Keene[2] in 1962. In as much as no experimental work had been carried out in the intervening time Keene's conclusions were little different from Honstead's, i.e., a great deal of information would be required to insure the workability of a ground disposal system. Some of the studies required to resolve the unknowns include:

1) The development of additional geological data with particular emphasis on the locations and extent of underground formations such as basalt layers, the ringold formation, and glacial and sedimentary deposits.

2) The development of additional hydrological data, particularly north of Gable Mountain, so that ground water flow paths, travel times, and groundwater elevations can be predicted. The information will permit an assessment of the effect of the disposal of reactor effluent not only on the groundwater in the disposal area but also on the groundwater under the entire Hanford reservation.

3) The demonstration of infiltration rates and the effect of time on the infiltration rates.

4) The demonstration of the degree of radioactive decontamination achievable.

5) An assessment of the potential problems of radionuclides reaching the public through game birds and game animals and the degree of radionuclide concentration in the disposal area by biolcgical means.

6) An estimate of the problems associated with airborne radioactive material, shore line mud, shore line plants and insects, and direct gamma radiation from the disposal site.

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A proposal was made by Nelson and Alkire (3) in 1963 to carry out a field test to demonstrate some of the facets of ground disposal of reactor effluent. Although the proposal was not carried through as suggested, two relatively modest scale tests were carried out, one at F Area in 1964 and one at D Area in 1967, in an effort to provide at least a small fraction of the answers required. It is the purpose of this report to report the results of those tests as well as to describe a test to be carried out at B Area as well as potential tests which might be carried out at K and C Reactors.

II. SUMMARY

The program directed toward the ground disposal of reactor effluent has proceeded in a stepwise fashion. The test recently completed at D Area infiltrated 27,500 gpm which was about twice the infiltration in the F Area. The test was carried out for a three month period which was several times the length of operation of the F Area test. In addition, more sophisticated monitoring was utilized during the D Area test. It is planned to initiate a test at B Area prior to November 1, 1967, in which an infiltration of 40,000 - 50,000 gpm appears possible. This is about twice the infiltration in the D Area test but is still modest if one is considering infiltrating the total reactor effluent flow. The test is expected to continue for at least one year.

Useful information has been obtained from the two previous tests. High infiltration rates and good radioactivity decontaminations have been demonstrated. Nothing has appeared to date to make the concept of ground disposal technically unfeasible. It is anticipated that substantially more information will be obtained during the B Area test. However, there will remain major areas of investigation to be carried out in connection with the concept. If there is expected to be further interest in ground disposal of reactor effluent, a preliminary assessment of the B Area data should be made after about 6 months of operation. At that time, if results have still not been obtained to render the concept technically unfeasible, preparations for a still larger test, such as using the natural depression south of C Reactor, should begin.

III. F AREA TEST

A. Summary

The elevation of the F Area trench with respect to other locations in the area resulted in early termination of the test because of the formation of ponds and the potential for flooding the area sanitary tile field. The test did demonstrate that initial infiltration rates on the order of 1500 gallons per square foot per day were achievable.

B. Description of Facility

The test was carried out in the existing F Area trench located southeast of the 107 F retention basin. The location of the trench with respect to the 107 F basin and the 105 F building is shown in Figure 1. The trench was 525 ft. long, 12 ft. wide at the bottom and 30 ft. wide at the top. This resulted in a wetted surface area of 15,000 sq. ft. when the water level was about 7 ft. above the bottom. The trench was 1100 ft. from the river at the closest point. Effluent was introduced to the trench by reactivating a portion of an unused 42 in. diameter effluent line and constructing a narrow ditch from the line to the trench.

C. Operating Chronology

December 2-8, 1964
Average flow rate - 14000 gpm
Average infiltration rate - 1000 gal/sq. ft./day

January 4-17, 1965
Average flow rate - 16000 gpm
Average infiltration rate - 1530 ga/sq. ft./day

February 12-19, 1965
Average flow rate - 8000 gpm
Less than 25 percent of the trench area submerged.

March 3-16, 1965
Average flow rate - 8000 gpm

D. Groundwater Potential Measurements

By February 1, 1965 the water table elevation as measured in well 199-F5-3, 400 ft. east of the 107 F retention basin, increased 13 ft. Ponds and springs had developed in and near the sanitary tile field located southwest of the basin, and it was believed prudent to reduce the flow rate to a point below incipient ponding.

E. Infiltration Rates

The test showed that large volumes of effluent can be infiltrated into the soil in the vicinity of F Area. No decrease in the infiltration rate was observed during a ten day period in which 2.3×10^8 gallons of effluent were disposed of.

F. Decontamination

The rates of travel of the groundwater through the sediments at 100 F should have been at or near steady state since large volumes of effluent have infiltrated into the ground from 107 basin leakage for a long period of time. It was determined that the water moves through the ground at a rate of about 8 feet per hour. The decontamination factors for Cr-51 and Zn-65 between the retention basin and the river at the closest point were 2.6 and 120, respectively. The decontamination factor based on total beta activity was 21.

G. Miscellaneous

Two observations were made which could become significant in long term trench disposal. One was the accumulation of salt (mostly calcium sulfate) on the soil surfaces at spring sites near the river and the other was the accumulation of tumble weeds (Salsola koli) in the trench. The latter could result in a maintenance problem during prolonged disposal.

IV. D AREA TEST

A. Summary

An infiltration test was carried out for a four month period using a trench in D Area. During the period 3.4 x 10^9 gallons of effluent were infiltrated at an average rate of 1500 gallons per day per square foot. Groundwater elevations and temperatures increased in the vicinity of 100 D Area; however, no significant decrease in infiltration rate occurred. Decontamination factors ranged from 2.5 for Cr-51 to greater than 280 for Zn-65. Following termination of the test, groundwater elevations returned to pretest levels quickly, but groundwater temperatures are decreasing slowly.

B. Description of Facility

The test was carried out in the existing D Area trench located to the east of the 107 DR retention basin. The location of the trench with respect to the retention basins and the 105 buildings is shown in Figure 2. The trench was 450 feet long, 40 feet wide at the bottom, and 90 feet wide at the top for most of the length. Thus, the trench had a wetted area of 22,000 sq. ft. when the water level was 10 ft. above the bottom. The trench was 1600 ft. from the river at the closest point. Effluent entered the crib via three separate routes:

1. Pumping through a 6 in. diameter line from the 107 D basin. (1000 gpm)
2. Gravity flow through a 12 in. diameter line from 107 DR basin. (3500 gpm)
3. Through a 24 in. diameter siphon from the 107 DR basin. (23,000 gpm)

C. Operating Chronology

After obtaining well temperature and groundwater elevation measurements, the 12 in. line from the 107 DR basin was opened on March 7, 1967, and the pumps in the line from the 107 D basin were started on March 9, 1967. At this flow, 4500 gpm, less than 50 percent of the trench bottom was submerged by hot effluent. On March 17 the siphon was started and with a total flow of 27,500 gpm the liquid level stabilized about 10 ft. above the bottom of the trench. From March 17 to June 26, 1967, 27,500 gpm of effluent were maintained to the trench during reactor operation. During shutdowns the use of the siphon was discontinued, but the other two supplies were maintained. It is of interest to note

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that during prolonged outages 4500 gpm of cold effluent completely submerged the bottom of the trench.

D. Grounwater Potential Measurements

Groundwater potentials were measured in all available wells near the 100-D trench during and after the test to determine the response of the aquifer to the disposal of large quantities of reactor effluent. The initial groundwater elevations and the location of the wells used for monitoring are plotted in Figure 3 and show that a groundwater mound did exist under 100-D Area prior to the test due to leakage from the retention basins and effluent lines. Prior to the test springs had developed along the river due to this leakage. The flow rate of the Columbia River fluctuated daily during the test from approximately 40,000 cfs to 110,000 cfs until the end of May when high water caused a significant rise in the flow rate. High water was reflected in wells near the river and complicated the interpretation of data collected during that period. The maximum groundwater elevations plotted in Figure 4 were determined before the high water period. The maximum groundwater elevations show that a significant change in the size of the groundwater mound occurred due to the trench test. Initial to maximum groundwater elevation differences were plotted in Figure 5 to show the groundwater potential changes caused by the test. The storage volume based on the change in groundwater elevations is approximately 8.2×10^8 gallons based on a porosity of 30 percent. The average discharge rate during the test was 3×10^7 gal/day with a total discharge of 3.4×10^9 gallons, which would mean that during the test, approximately 25 percent of the discharged volume was accounted for in the groundwater mound which formed. The influence of the 4 month infiltration was clearly felt one mile from the trench. Figure 6 shows groundwater elevations collected September 11, 1967 (77 days after the termination of the test). They show that the mound under the trench has subsided and the groundwater contours show only a slight distortion which may still be due to the trench test.

During the test the trench had an average infiltration rate of 1500 gal/day/ft^2 with a maximum of 1600 gal/day/ft^2.

The average permeability of the material from the trench to the river was calculated using the equation, $P = \frac{7.48\,pu}{I}$ (4) where P is the permeability (gpd/ft^2), p is the porosity, u is the groundwater velocity (ft/day) and I is the hydraulic gradient (ft/ft). The permeability was found to be 3740 gpd/ft^2 using a groundwater velocity of 50 ft/day determined by correcting the I-131 travel time (28 day) calculated by decay for the 25 percent lag which has been observed in 100-N area tests (5).

Transmissibility coefficients were calculated for several wells and are listed in Table I. The values were obtained by using a non-equilibrium method of calculating transmissibility described by L. K. Wenzel (6).

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TABLE I

Coefficients of Transmissibility

Well	Distance from Trench (feet)	Direction	Transmissibility gal/day/ft.
699-97-51	3000	N28°E	860,000
699-96-49	3200	N55°E	777,000
699-93-50	2700	S50°E	573,000
199-D5-12	2600	S14°W	523,000

E. Decontamination

Samples of reactor effluent and effluent from river bank springs were obtained prior to the test and bi-weekly during the test and analyzed for Cr-51, Zn-65, P-32 and I-131. The location of the river bank springs is shown in Figure 3.

Table II gives the average concentrations of selected radionuclides in effluent collected during the test at the basin and at spring sampling sites SP-1 and SP-4. These concentrations are not significantly different from concentrations determined at the same locations prior to the test. The averages reported for I-131, P-32, and Cr-51 at the spring include some less than (undetectable) values. All Zn-65 spring concentrations were less than values. In addition to concentrations Table II also gives the decontamination factors obtained and hold-up time between the trench and river bank springs. These data agree well with laboratory adsorption results (7) and anticipated DF's given by Nelson and Alkire (3).

TABLE II

Average Radionuclide Concentrations of Basin and Spring Effluents

	I-131	P-32	Zn-65	Cr-51
Basin	2.3×10^{-6}	2.3×10^{-5}	3.7×10^{-5}	3.2×10^{-4}
SP-1	2.0×10^{-7}	8.7×10^{-8}	$<1.4 \times 10^{-7}$	2.3×10^{-4}
SP-4	2.0×10^{-7}	1.3×10^{-7}	$<1.3 \times 10^{-7}$	1.3×10^{-4}
Hold up time (days)	28	11	>186	36
DF	11	211	>27	2.5

Since no concentration increase occurred at the spring as a result of the test it can be assumed that an adsorption equilibrium had been attained prior to the test. The near steady state was established as a result of leakage from the effluent basins and effluent lines during many years of reactor operation.

F. Groundwater Temperature Measurement

Groundwater temperatures were measured in all available wells during and after the test on a weekly basis to determine the changes in the temperature patterns due to the test. Pre-test temperature measurements shown in Figure 7 demonstrate the influence of the leakage of reactor effluent to the ground. The maximum groundwater temperatures plotted in Figure 8 shows that a significant increase in the overall temperature pattern occurred due to the test. Figure 9 is a plot of temperature change (ΔT) from the initial to the maximum. This figure shows an elongated pattern particularly for the $10^{\circ}\Delta T'$ contour. The temperature contours and transmissibility indicate that more groundwater moved to the Northeast from the trench than to the Southeast. Figure 10 shows groundwater temperatures collected September 11, 1967 (77 days after terminating the test). They show a slight decrease from the maximum, but the general pattern persists and is expected to decrease slowly over a significant period of time. The groundwater mound, in contrast, has nearly completely subsided.

Figure 11 shows thermal profiles observed in Well 699-96-49 which is 3200 feet Northeast of the 100-D trench. The well intercepts approximately 50 feet of Pasco gravels which overly the Ringold Formation. The contact is reflected by a temperature break which is caused by the permeability difference in the materials. An initial increase in temperature at depth was observed May 8, 1967 and is difficult to account for. A more normal pattern was observed June 26, 1967 with a high temperature ($\sim$51 C) surface water measurement. The temperature profile of September 11, 1967 indicates that warmer water from the trench area is still moving through this well.

G. Thermal Degradation

The effluent leaving the reactor during the test was at 95 C. The fact that both the 107 D and 107 DR basins were being used to handle the D Reactor effluent would indicate the effluent temperature at the basin discharge (near the siphon) to be in the range of 85 to 90 C. Temperature measurements taken at the extreme east end of the trench at the water surface indicated an equilibrium temperature of 70 C. Temperature patterns at the river bank spring sample points shown in Figure 3 varied according to location. The easternmost sample point (SP-0) showed a pretest temperature of 30 C. The middle sample point (SP-1) showed a pretest temperature of 50 C. The westernmost sample point (SP-4) showed a pretest temperature of 60 C and the temperature remained at about that value throughout the test. The temperatures at SP-0 and SP-1 increased as the test progressed and appeared to be also coming to an equilibrium at about 60 C.

Assuming a reactor inlet temperature of 10 C as an average for the period, 35 percent of the heat associated with the effluent entering the trench was dissipated. About 5 percent was dissipated in the basins, 20 percent in the trench, and 10 percent in the travel through the ground.

H. Radiation Levels

After completion of the test radiation readings were taken around the perimeter of the trench two feet below the high water mark. The CP readings at about one foot from the surfaces were:

	Radiation Level, mR/hr	
	Window Open	Window Closed
Northwest Corner	140	100
Southwest Corner	160	120
Center	220	20
Northeast Corner	280	190
Northeast Corner	410*	360*

* Readings probably high due to the presence of tumble weeds which acted as collection points.

The readings indicate no significant residual radiation problem.

V. PLANNED B AREA TEST

A. General

The shutdown of D Reactor terminated the test using the D Area trench. In order to continue a modest effort in the area of ground disposal, it is planned to initiate a test in the trench located in B Area which was formerly used by C Reactor. It is anticipated that the test will get underway prior to November 1, 1967.

B. Description of Facility

The test will be carried out in the existing B Area trench located east of the 107 C retention basins. The location of the trench with respect to the 105 B and 105 C buildings and the 107 C retention basins is shown in Figure 12. The trench is 500 ft. long, 40 ft. wide at the bottom, and 200 ft. wide at the top. This will result in a wetted surface of 52000 sq. ft. when the water level is 10 ft. above the bottom. The trench is 850 ft. from the river at the closest point. Effluent will be introduced to the trench through two 42 in. diameter pipes which are tied to the 66 in. diameter line which runs from the west 107 C retention basin to the river.

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C. Potential Benefits

Both the test at F Area and the test at D Area were of short duration. It is anticipated that the B Area test will run for at least a year and possibly longer. The infiltration rate of the trench is unknown. However, if infiltration rates approximating those found in F and D Areas are achieved, an input of 40,000 - 50,000 gpm would not be out of the question. With the higher input and longer time it is expected that the B Area test will provide information concerning:

1. Infiltration rates in B Area soils.
2. The effect of groundwater mound buildup on infiltration rates.
3. The rate of loss of infiltration rate due to silting.
4. Groundwater flow paths and travel times in the vicinity of the disposal area.
5. Confirmation of the decontamination factors previously demonstrated.

D. Disadvantages

Although, as indicated above, the B Area test is expected to provide useful information. However, the proximity to the river may result in shoreline discharges of sufficient magnitude to cause a significant increase in the K Reactor inlet temperatures. This would result in early termination of the test. In addition, the test will not supply any information regarding possible radiological effects of ground disposal nor would it provide much information pertinent to the questions concerning the effects of ground disposal on the overall Hanford hydrology.

VI. PROPOSED K AREA TRENCH TEST

A. Description of Facility

It has been proposed that a 42 in. diameter pipe tap into the 72 in. diameter pipe which supplies effluent to the east 107 KE retention basin. The pipe would extend eastward until well beyond K Area (about 900 ft.). From this point an open trench would be dug to join to the Hanford irrigation ditch (about 1600 ft). The Hanford irrigation ditch could then be used for effluent disposal to a point somewhere near the intersection of the 100 N and 100 D roads (about 7600 ft.). A schematic of the proposed layout is shown, in Figure 14.

B. Potential Benefits

The trench test proposed for K Area would provide largely the same type of information to be obtained at B Area except that a larger area would be involved. It would also pinpoint any problems associated either with transporting effluent long distances through open ditches or the disposal of effluent through one or a series of trenches.

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C. Disadvantages

As in the case of the B Area test the K test would result in the shoreline discharge of large quantities of hot water. It is problematical whether or not this would have a detrimental effect at N Reactor.

VII. PROPOSED C AREA LAKE

A. Description of Facility

A test proposal has been made to tie a 60 in. diameter pipe into the 66 in. diameter normal effluent pipe near the 105 C Building. The 60 in. diameter pipe would head generally southwest from the 105 C Building. At a point 800 ft. from the 105 C Building the flow splits into two parallel 42 in. diameter pipes which continue for an additional 800 ft. At this point effluent will enter a narrow ditch which transports the effluent to a natural depression. A schematic view of the layout is shown in Figure 14.

In addition to the main disposal pond an area would be created to the northeast in which depth and temperature could be controlled so that the radiological effects of ground disposal could be studied.

B. Site Conditions

A series of water infiltration tests have demonstrated that the surface sandy-silt and the thin caliche-cemented gravel immediately beneath the surficial material exhibited low permeability and infiltrated only a few gal. per sq. ft. per day. However, the gravel beneath the caliche zone had a very high permeability exhibiting infiltration rates of 1800 gal per sq. ft. per day at one foot of head and increased to about 3000 gal. per sq. ft. per day at five foot of head. The high permeability of the grave indicates that only a few acres (perhaps up to 5) would require appropriate surface treatment to dispose of 80,000 - 100,000 gpm or essentially all of the C Reactor effluent.

During the initial site considerations a well (699-65-83) was drilled. The temperature of the water was 38 C indicating that the water resulted from 100 B-C Reactor effluent basin and line leakage. However, no radioactivity was found in the water.

A pumping and recovery test was run on the well to estimate aquifer coefficients of transmissibility and permeability. The well was pumped at 300 gpm for 24 hours, and water level draw down was monitored. Also, water level recovery was followed after the pumping stopped. The coefficient of permeability, K, is defined as the rate of flow of water through an aquifer cross-sectional area of one square foot under a one foot per foot hydraulic gradient (100 percent). The coefficient of transmissibility, T, is defined as the rate of water flow through a

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vertical strip of aquifer one foot wide extending the full height of the aquifer under a hydraulic gradient of 100 percent.

Aquifer transmissibility was estimated to be 8×10^6 gal. per sq. ft. per day at 38 C. The coefficient of permeability assuming an aquifer thickness is 1×10^5 gal. per sq. ft. per day at 38 C. Correcting to a groundwater temperature of 16 C (normal groundwater temperature), $T = 4.8 \times 10^6$ gal. per sq. ft. per day and $K = 6.4 \times 10^4$ gal. per sq. ft. per day. These very high values are the same order of magnitude as glaciofluvial aquifer constants observed at other locations on the Hanford project. They indicate that 80,000 - 100,000 gpm of infiltrated effluent could readily be conducted away from the disposal site. The existance of Gable Butte structure as an impermeable boundary immediately to the south of the test site will lower aquifer transmissitility, but groundwater mound buildup will increase the transmissibility by saturating additional segments. Using a conservative transmissibility of 3×10^{-6} gal. per sq. ft. per day would indicate a water table rise of less than 60 feet near the input site after 1000 days of disposal. It is anticipated that most of the subsurface flow of the disposed effluent will be toward the north and northeast from the site.

C. Potential Benefits

The site conditions discussed above indicate the test to be practicable. Operation of the test for a two year period would provide extensive information on infiltration, groundwater flow rates and direction, radioactive decontamination, and the dissipation of thermal energy. The test will also supply information on the potential radiological effects associated with the ground disposal of reactor effluent. In addition, the major fraction of the heat and radioactivity with C Reactor effluent would be removed from the river during the test.

D. Disadvantages

The only disadvantage envisioned with respect to the test is the cost. It has been estimated that $300,000 would be required to provide the test site as described. In addition, it is estimated that hydrological and radiological monitoring would cost $200,000 per year.

R. G. Geier, Specialist
Research and Engineering

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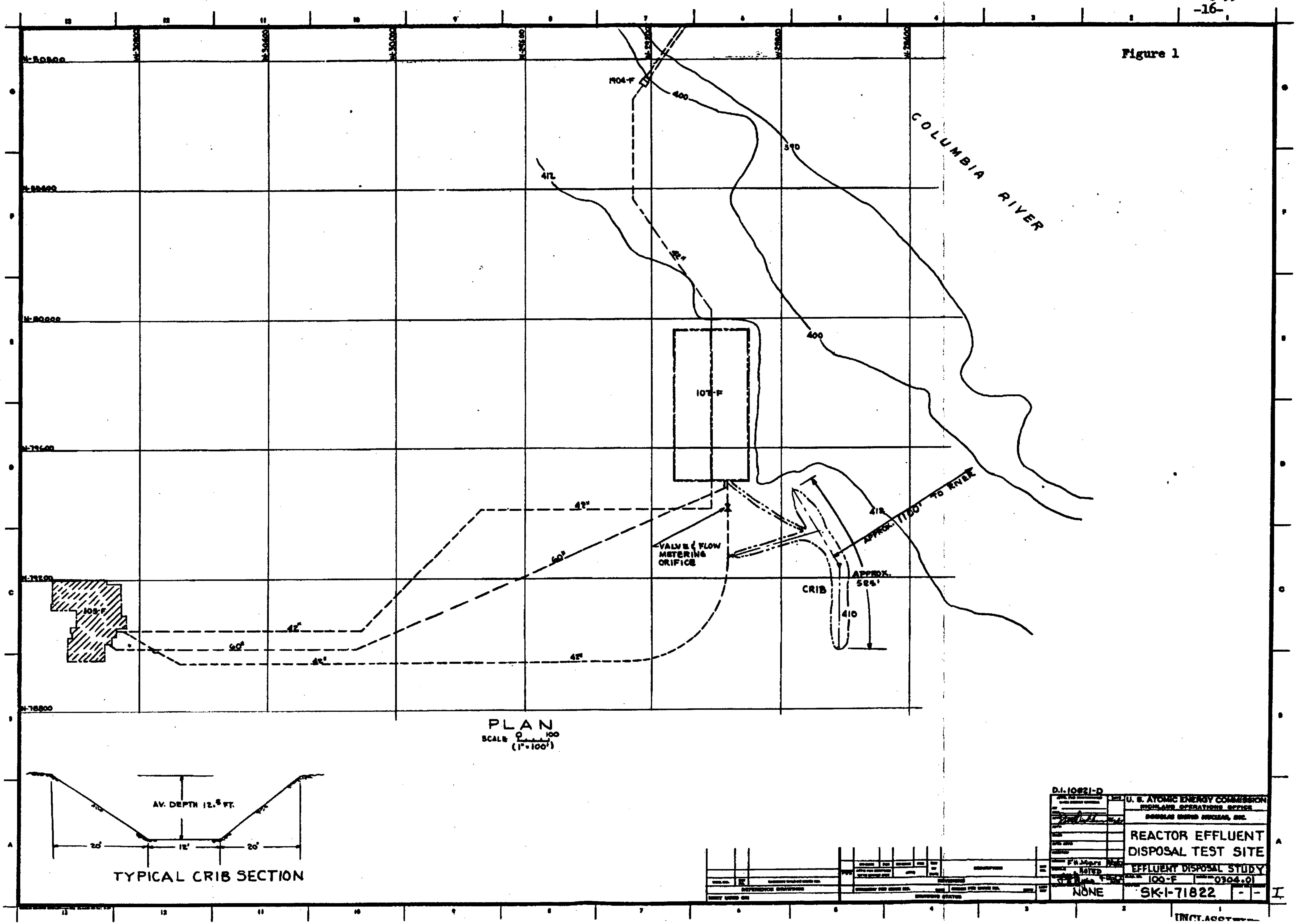
Figure 1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D.I.10821-D

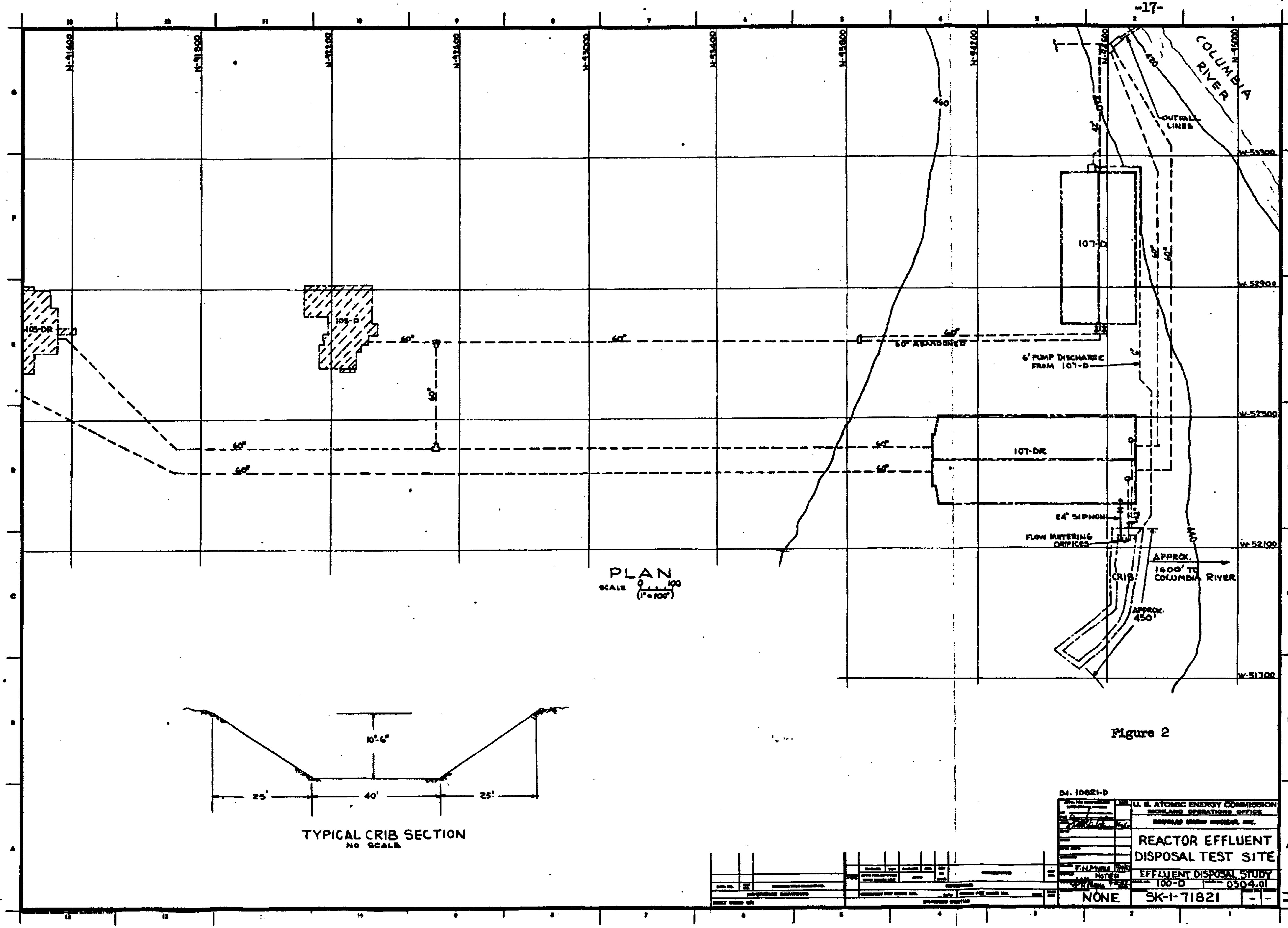

COLUMBIA RIVER
OUTFALL LINES
107-D
105-DR
105-D
60" ABANDONED
6" PUMP DISCHARGE FROM 107-D
107-DR
24" SIPHON
FLOW METERING ORIFICES
CRIB
APPROX. 1600' TO COLUMBIA RIVER
APPROX. 450'
PLAN
TYPICAL CRIB SECTION
NO SCALE
10'-6"
25'
40'
25'
DJ. 10621-D
U. S. ATOMIC ENERGY COMMISSION
REACTOR EFFLUENT
DISPOSAL TEST SITE
EFFLUENT DISPOSAL STUDY
100-D
0304.01
NONE
SK-1-71821

Figure 2

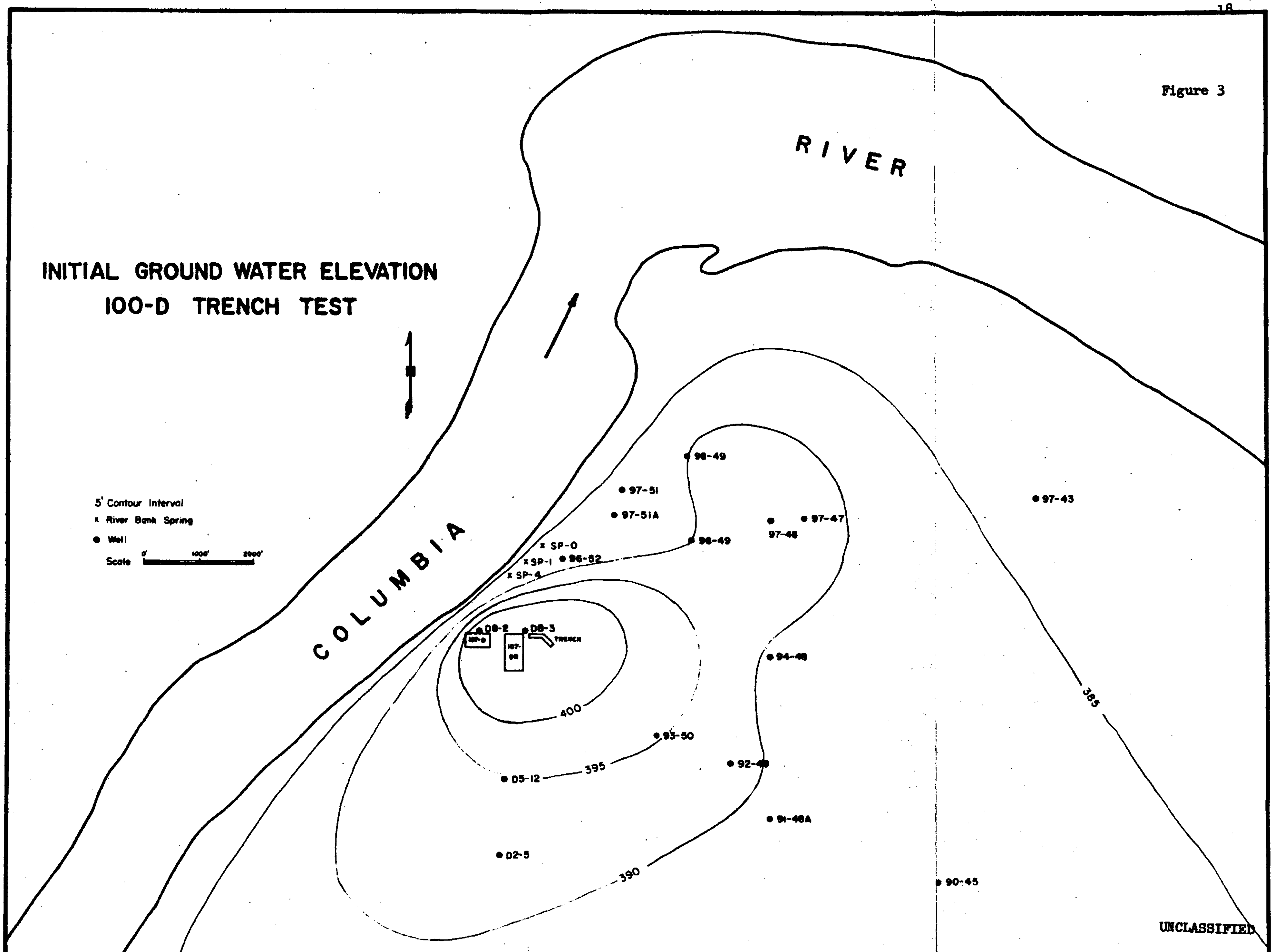


Figure 3
INITIAL GROUND WATER ELEVATION
100-D TRENCH TEST
COLUMBIA
RIVER
5' Contour Interval
x River Bank Spring
● Well
Scale 0' 1000' 2000'
98-49
97-51
97-51A
97-47
97-48
96-49
x SP-0
x SP-1
x SP-4
96-52
DB-2
DB-3
TRENCH
107-DR
94-48
400
93-50
395
D5-12
92-4
91-48A
D2-5
390
90-45
97-43
385

Figure 4

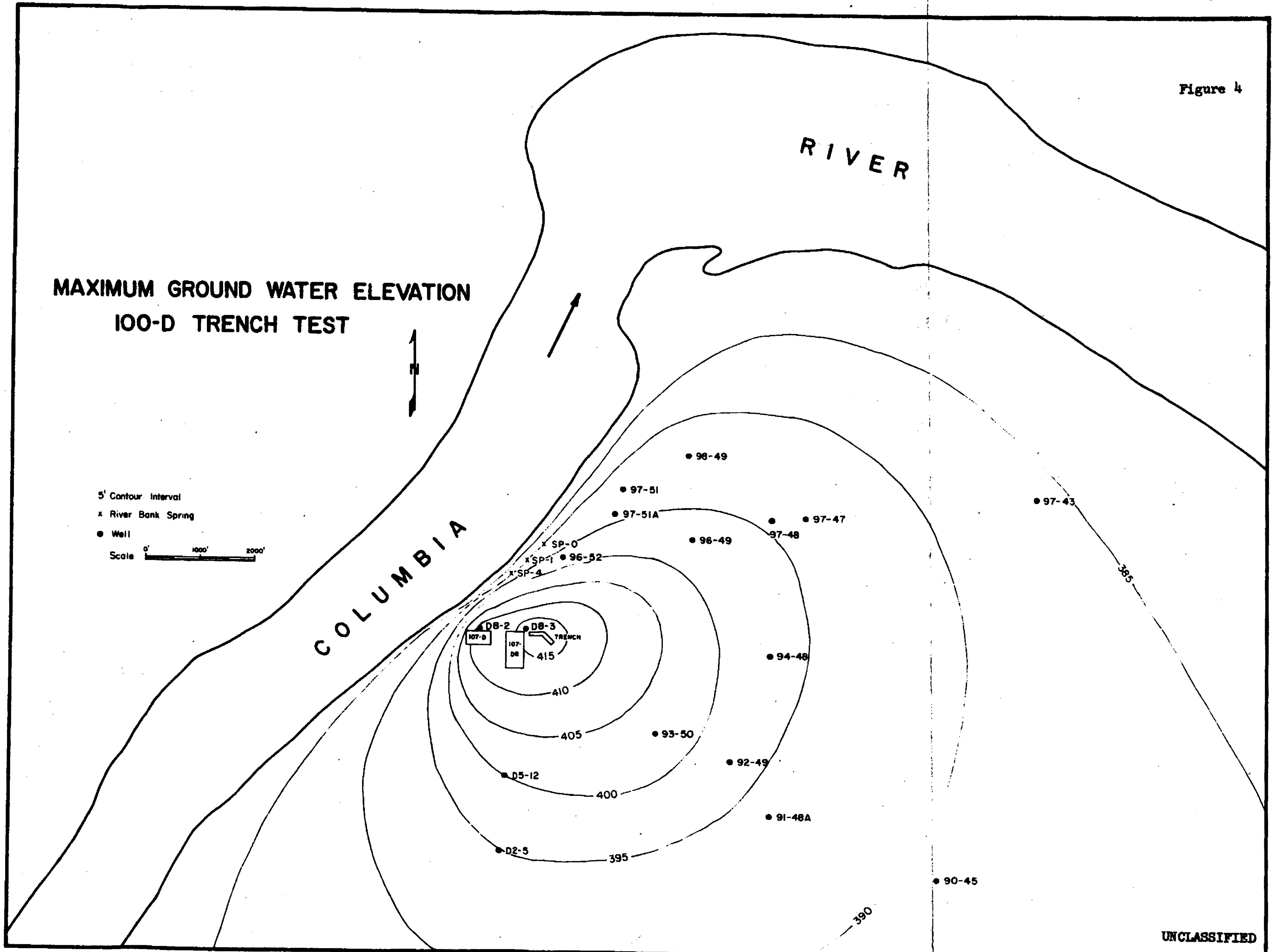

MAXIMUM GROUND WATER ELEVATION
100-D TRENCH TEST
N
RIVER
COLUMBIA
5' Contour Interval
x River Bank Spring
● Well
Scale 0' 1000' 2000'
98-49
97-51
97-51A
97-47
97-48
97-43
96-49
96-52
SP-0
SP-1
SP-4
D8-2
D8-3
107-D
107-DR
TRENCH
415
410
405
400
395
390
385
94-48
93-50
92-49
91-48A
90-45
D5-12
D2-5

Figure 5

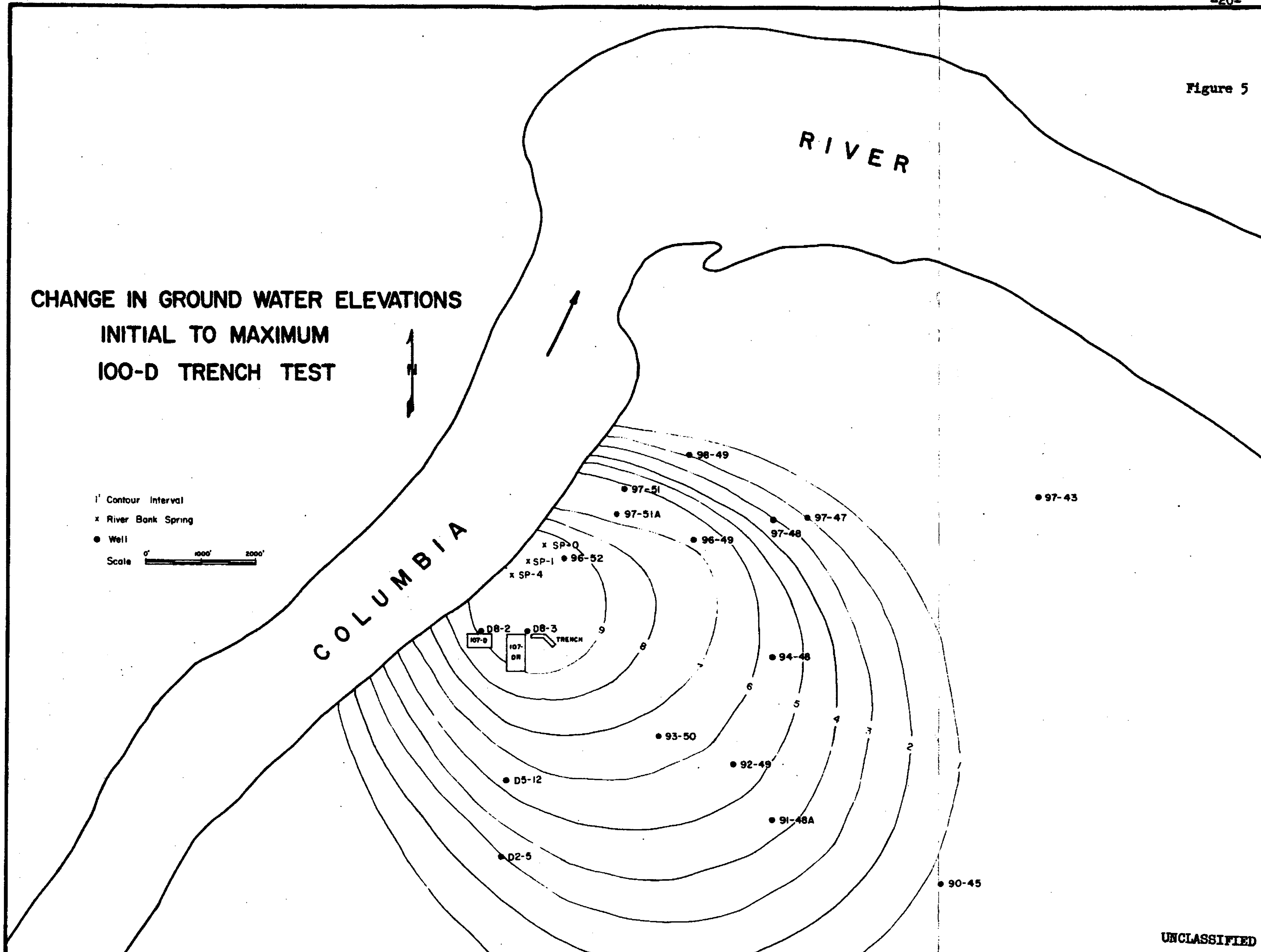

CHANGE IN GROUND WATER ELEVATIONS
INITIAL TO MAXIMUM
100-D TRENCH TEST
N
RIVER
COLUMBIA
1' Contour Interval
x River Bank Spring
● Well
Scale
0'
1000'
2000'
98-49
97-51
97-51A
97-47
97-48
97-43
96-49
SP-0
SP-1
SP-4
96-52
D8-2
D8-3
107-D
107-DR
TRENCH
94-48
93-50
92-49
D5-12
91-48A
D2-5
90-45
9
8
6
5
4
3
2

Figure 6

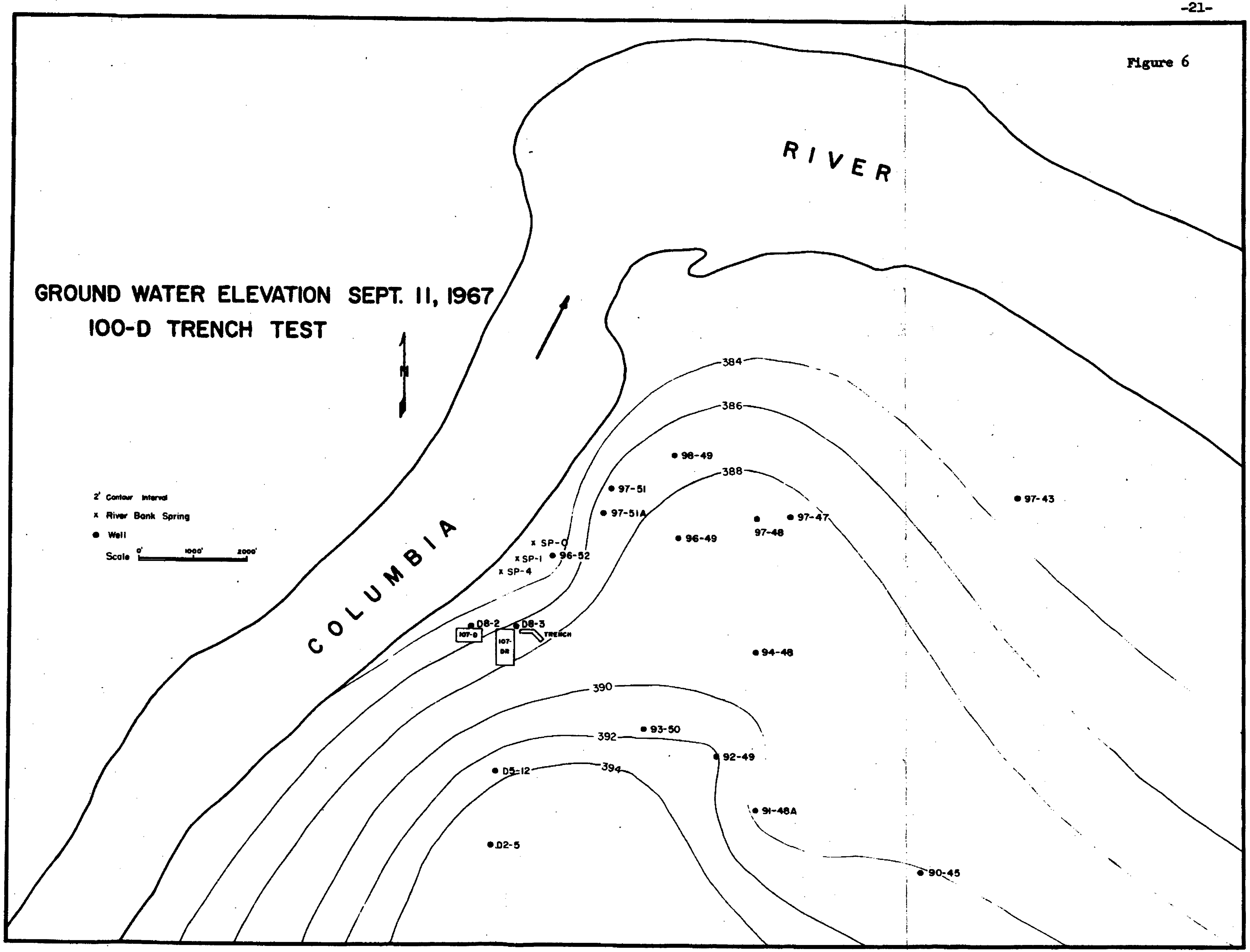

GROUND WATER ELEVATION SEPT. 11, 1967
100-D TRENCH TEST
N
RIVER
COLUMBIA
2' Contour Interval
x River Bank Spring
● Well
Scale 0' 1000' 2000'
384
386
388
390
392
394
98-49
97-51
97-51A
97-47
97-48
97-43
96-49
96-52
SP-0
SP-1
SP-4
D8-2
D8-3
107-D
107-DR
TRENCH
94-48
93-50
92-49
D5-12
91-48A
D2-5
90-45

Figure 7

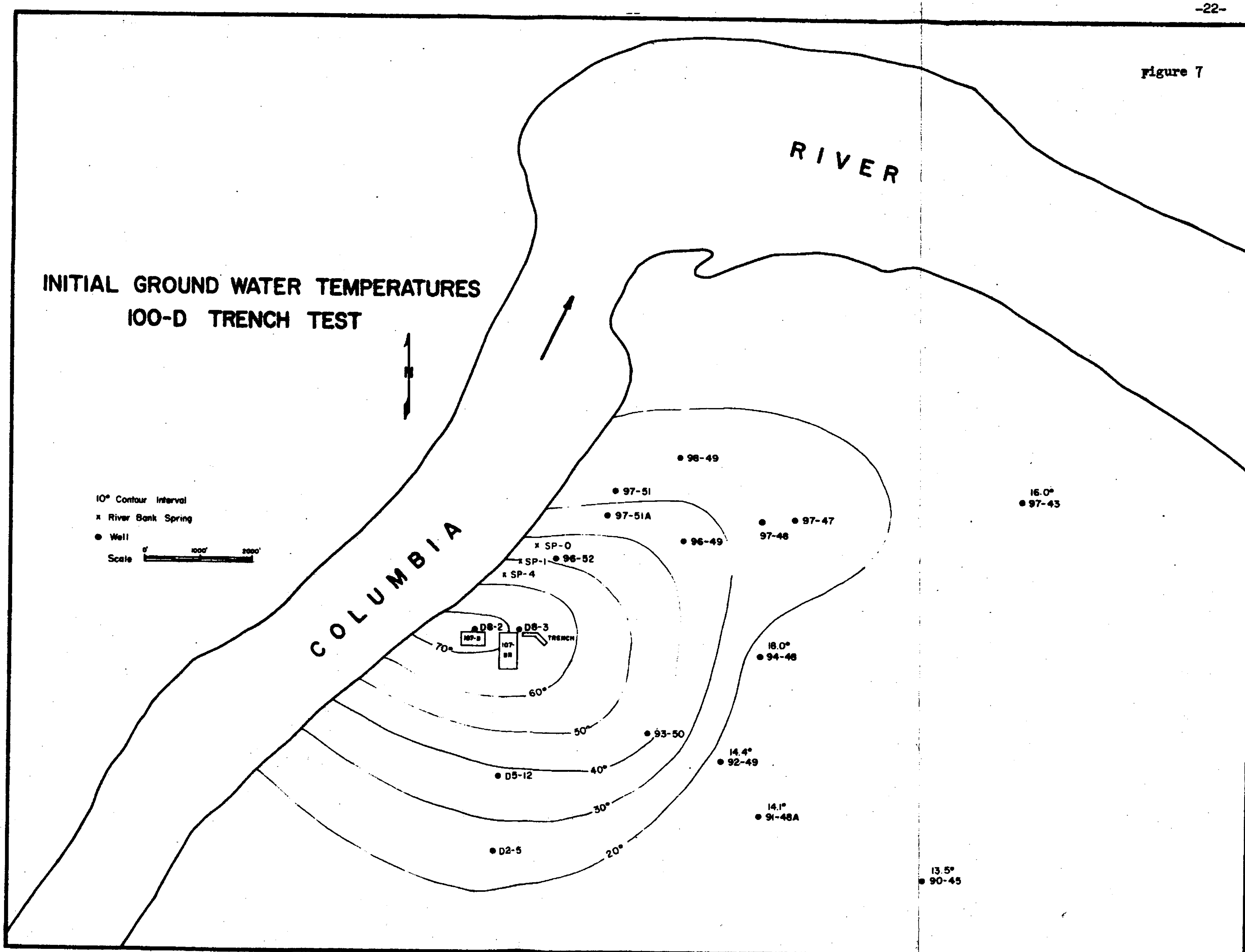

INITIAL GROUND WATER TEMPERATURES
100-D TRENCH TEST
N
RIVER
COLUMBIA
10° Contour Interval
x River Bank Spring
● Well
Scale 0' 1000' 2000'
98-49
97-51
97-51A
97-47
97-48
96-49
16.0°
97-43
SP-0
SP-1
96-52
SP-4
D8-2
D8-3
107-D
107-DR
TRENCH
70°
60°
50°
40°
30°
20°
18.0°
94-46
93-50
14.4°
92-49
D5-12
14.1°
91-48A
D2-5
13.5°
90-45

Figure 8

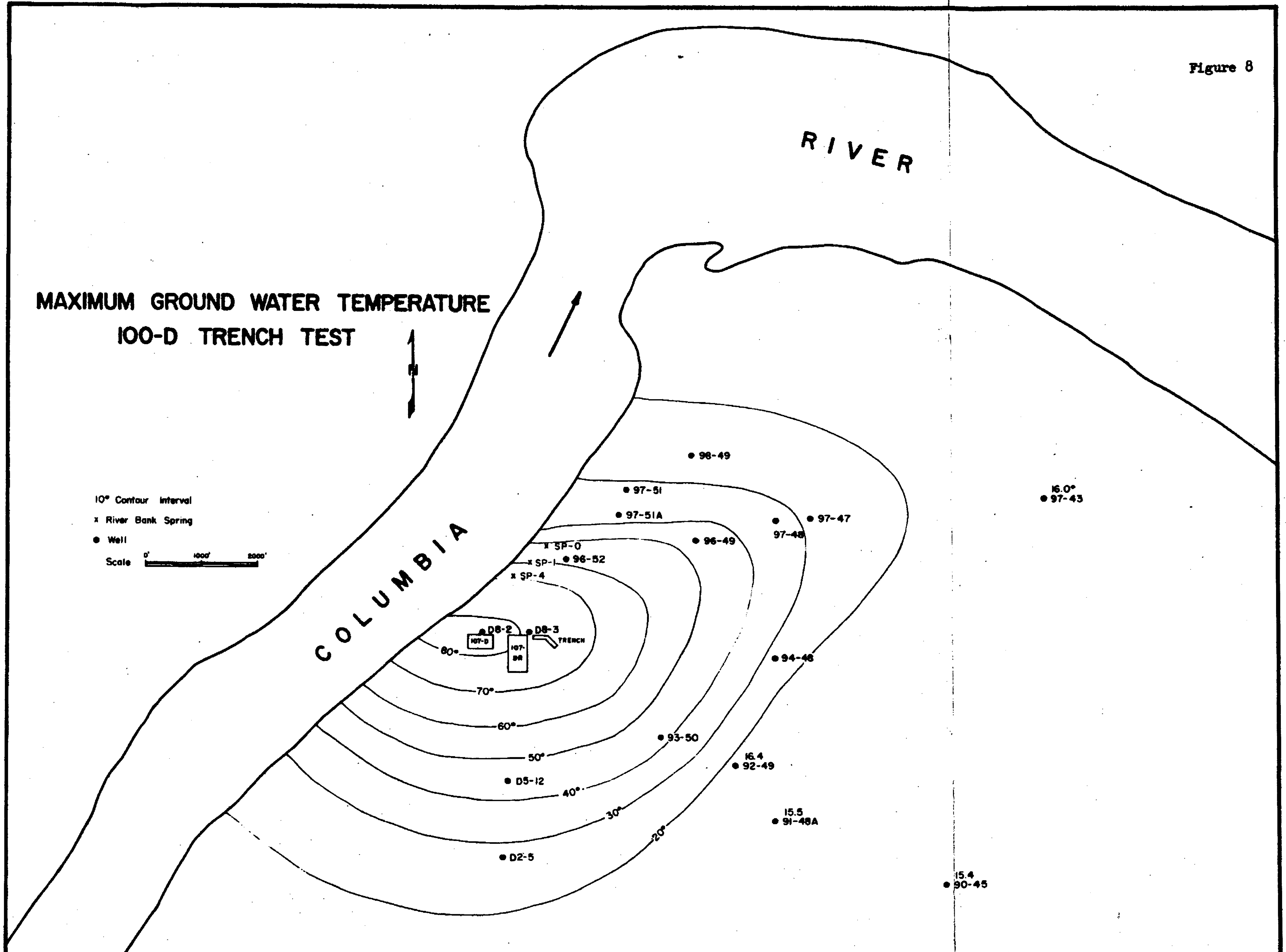

MAXIMUM GROUND WATER TEMPERATURE
100-D TRENCH TEST
N
RIVER
COLUMBIA
10° Contour Interval
x River Bank Spring
● Well
Scale
0'
1000'
2000'
98-49
97-51
97-51A
97-47
97-48
96-49
SP-0
SP-1
96-52
SP-4
D8-2
D8-3
107-D
107-DR
TRENCH
80°
70°
60°
50°
40°
30°
20°
94-48
93-50
16.4
92-49
D5-12
15.5
91-48A
D2-5
15.4
90-45
16.0°
97-43

Figure 9

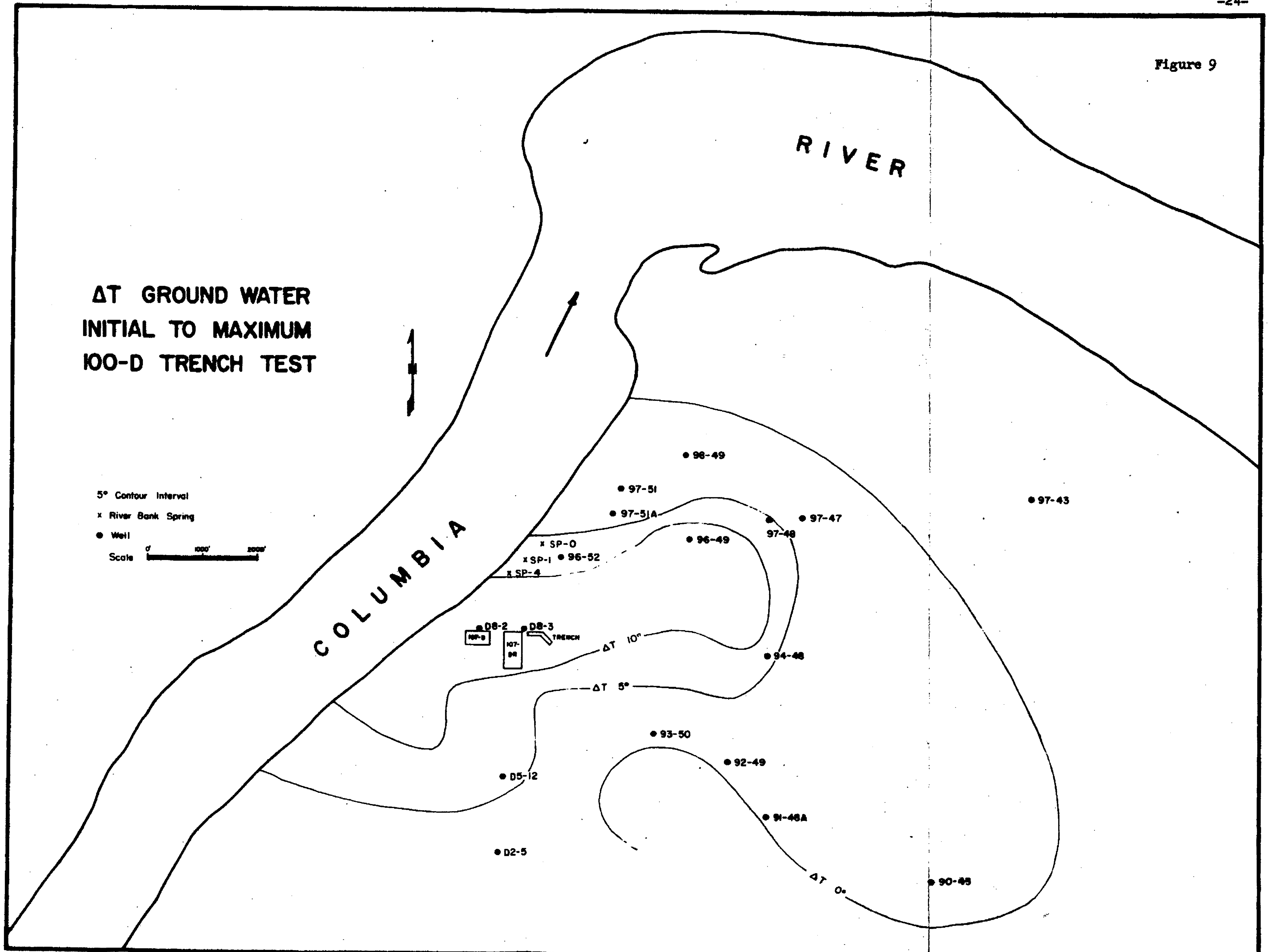

ΔT GROUND WATER
INITIAL TO MAXIMUM
100-D TRENCH TEST
5° Contour Interval
x River Bank Spring
● Well
Scale
0'
1000'
2000'
COLUMBIA
RIVER
98-49
97-51
97-51A
97-47
97-48
97-43
96-49
96-52
SP-0
SP-1
SP-4
D8-2
D8-3
TRENCH
ΔT 10°
ΔT 5°
ΔT 0°
94-46
93-50
92-49
91-46A
90-45
D5-12
D2-5

Figure 10

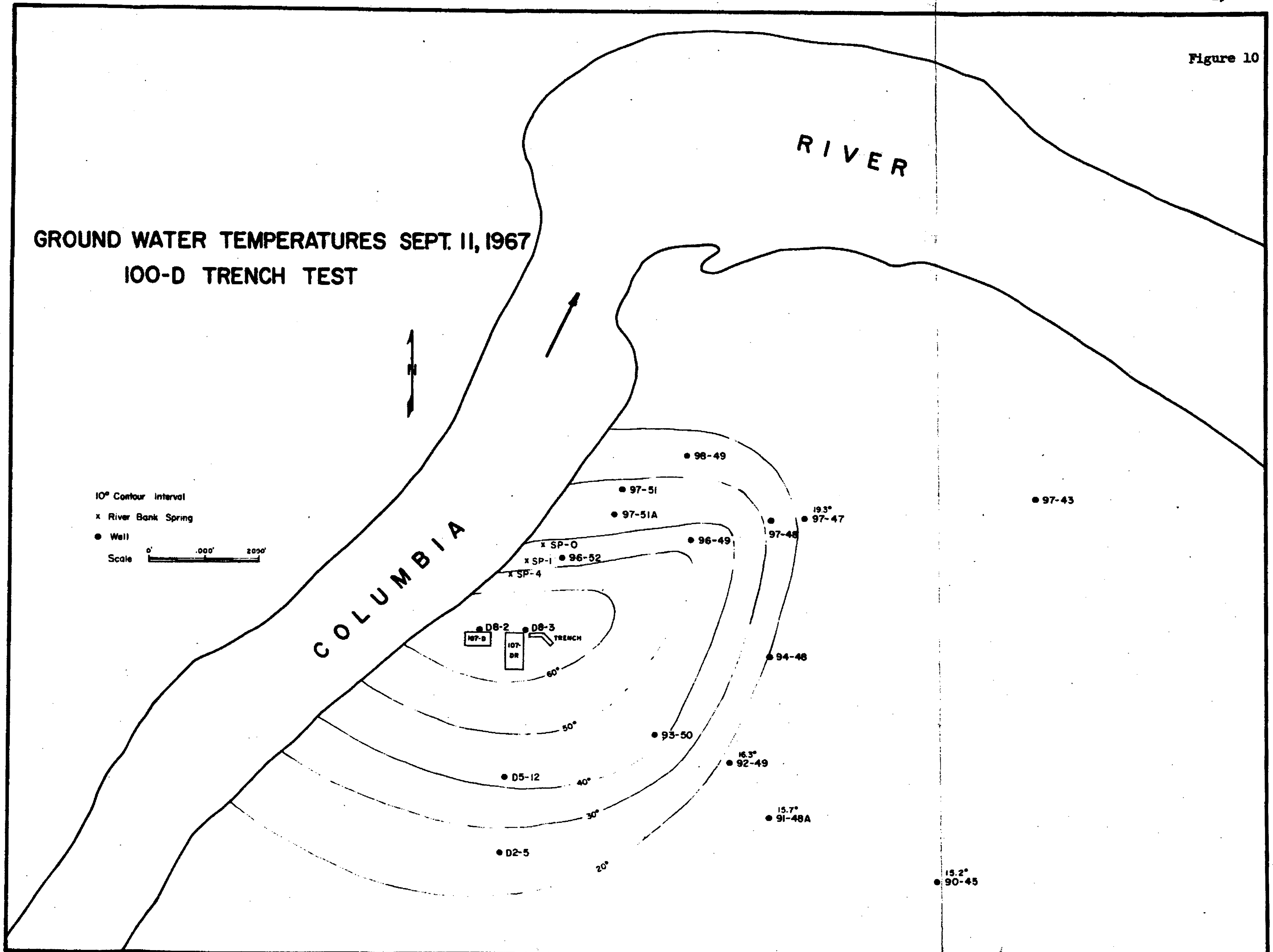
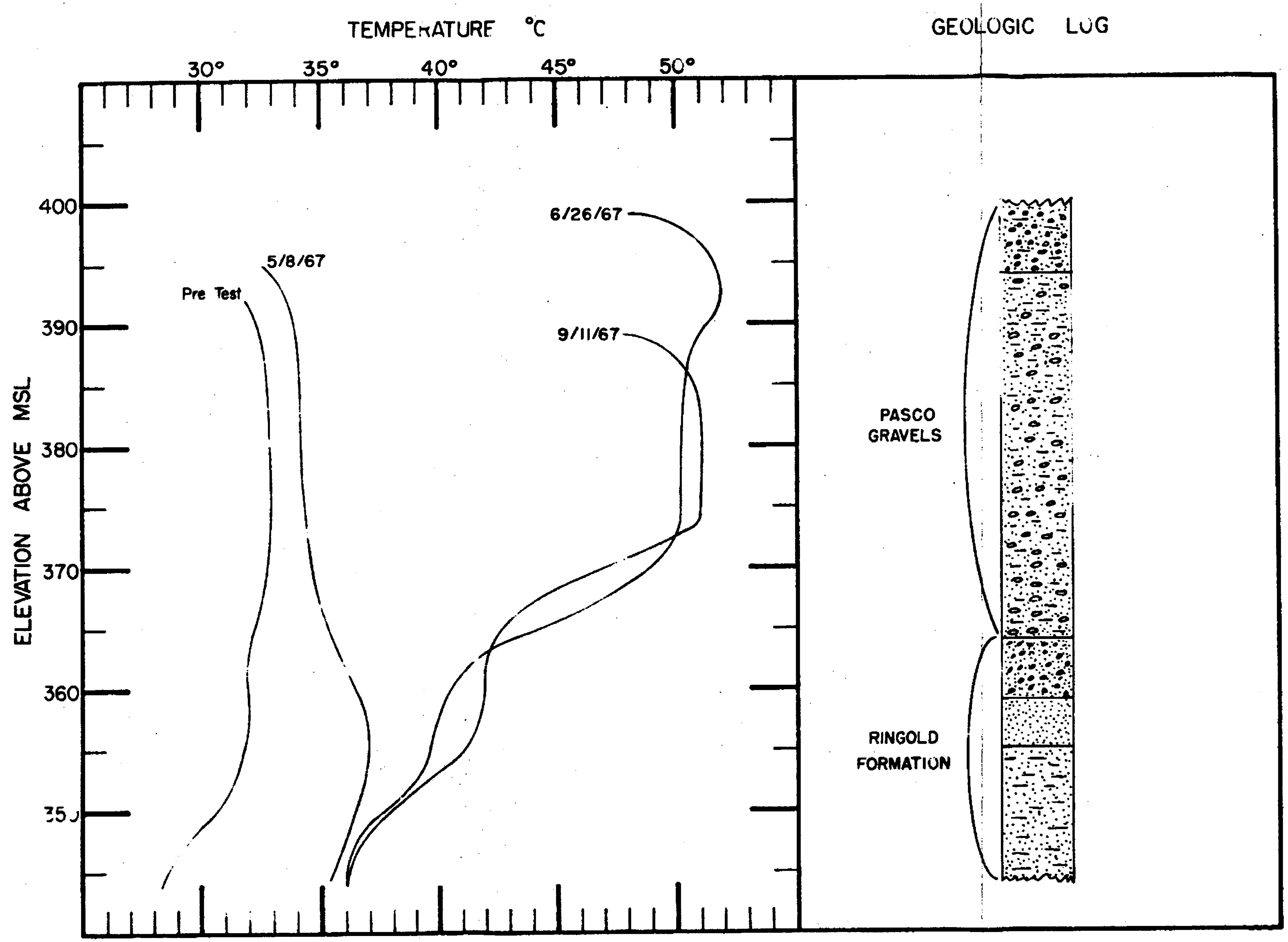

GROUND WATER TEMPERATURES SEPT. 11, 1967
100-D TRENCH TEST
COLUMBIA
RIVER
N
10° Contour Interval
x River Bank Spring
● Well
Scale
98-49
97-51
97-51A
96-49
97-48
19.3°
97-47
97-43
SP-0
SP-1
96-52
SP-4
D8-2
D8-3
TRENCH
107-D
107-DR
60°
50°
40°
30°
20°
94-48
93-50
16.3°
92-49
D5-12
15.7°
91-48A
D2-5
15.2°
90-45

Figure 11



WELL 699-96-49
3200' NE of 100-D TRENCH

Figure 12

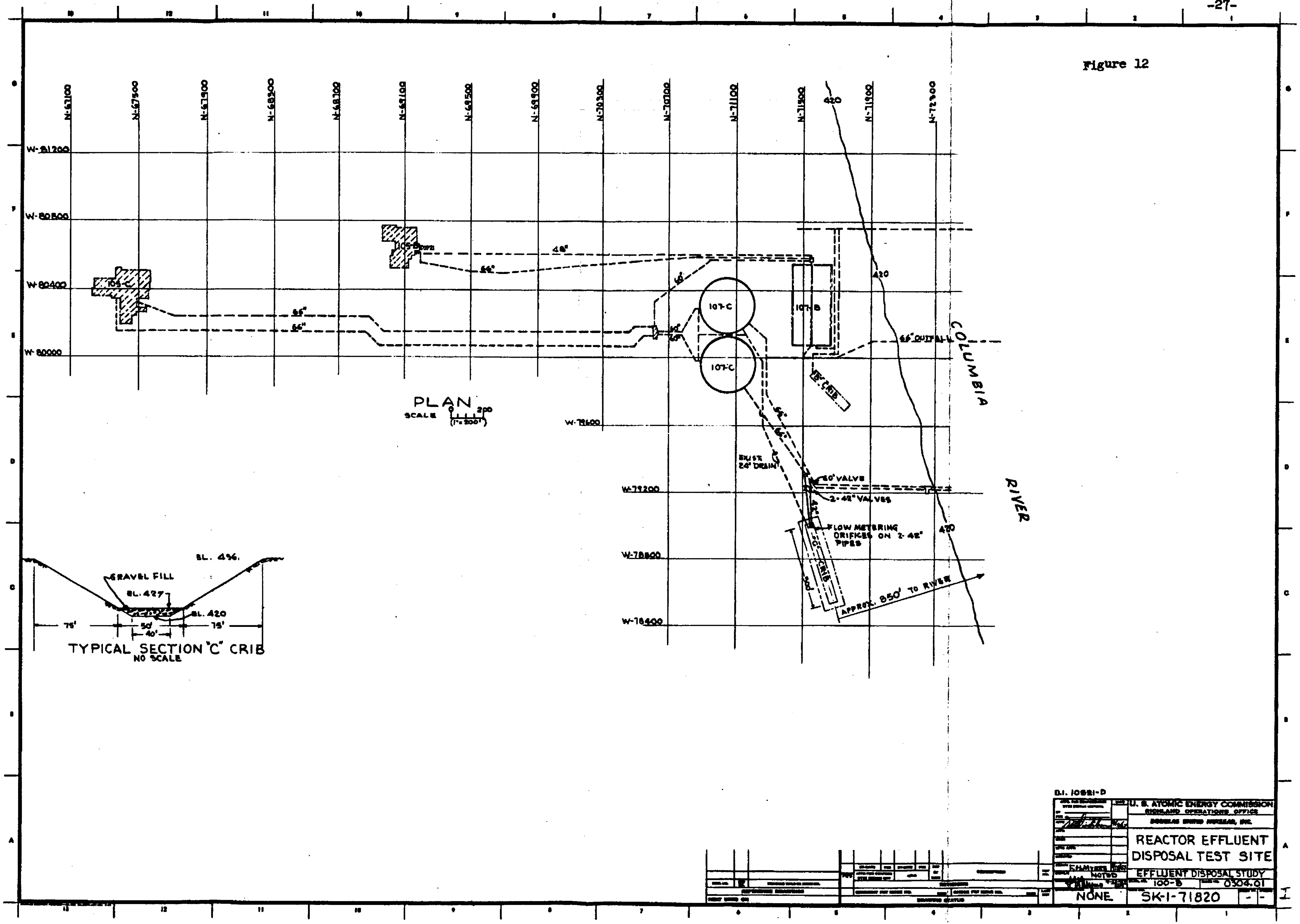

PLAN
SCALE 0 200 (1"=200')
105-C
105-B
107-C
107-C
107-B
66"
54"
42"
60"
54" OUTFALL
"B" CRIB
"C" CRIB
60" VALVE
2-42" VALVES
FLOW METERING ORIFICES ON 2-42" PIPES
24" DRAIN
APPROX. 850' TO RIVER
COLUMBIA
RIVER
420
W-81200
W-80800
W-80400
W-80000
W-79600
W-79200
W-78800
W-78400
N-67100
N-67500
N-67900
N-68300
N-68700
N-69100
N-69500
N-69900
N-70300
N-70700
N-71100
N-71500
N-71900
N-72300
TYPICAL SECTION "C" CRIB
NO SCALE
GRAVEL FILL
EL. 436
EL. 427
EL. 420
75'
50'
40'
75'
D.I. 10681-D
U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
DOUGLAS UNITED NUCLEAR, INC.
REACTOR EFFLUENT
DISPOSAL TEST SITE
EFFLUENT DISPOSAL STUDY
100-B
0304.01
NOTED
NONE
SK-1-71820

Figure 13

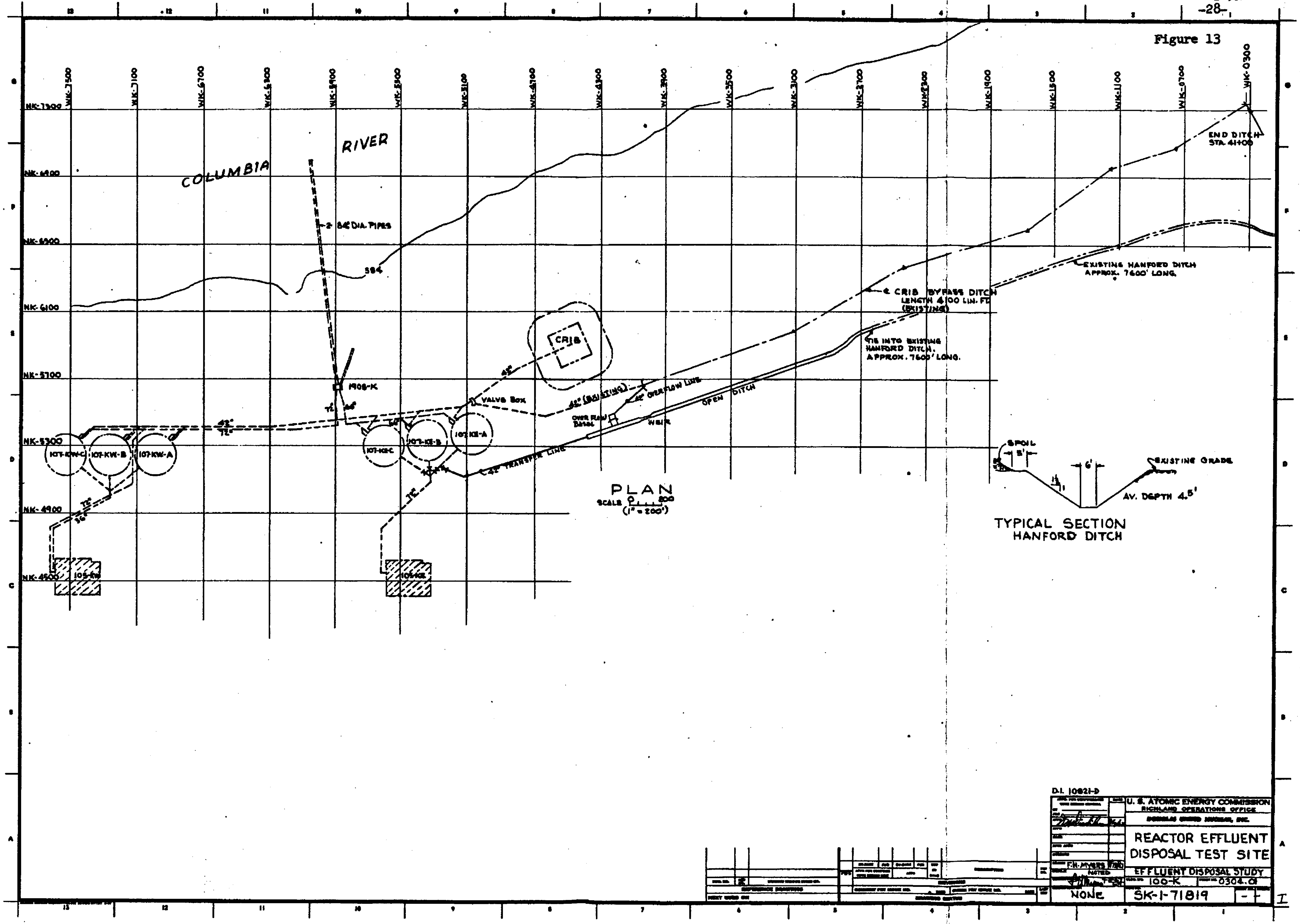
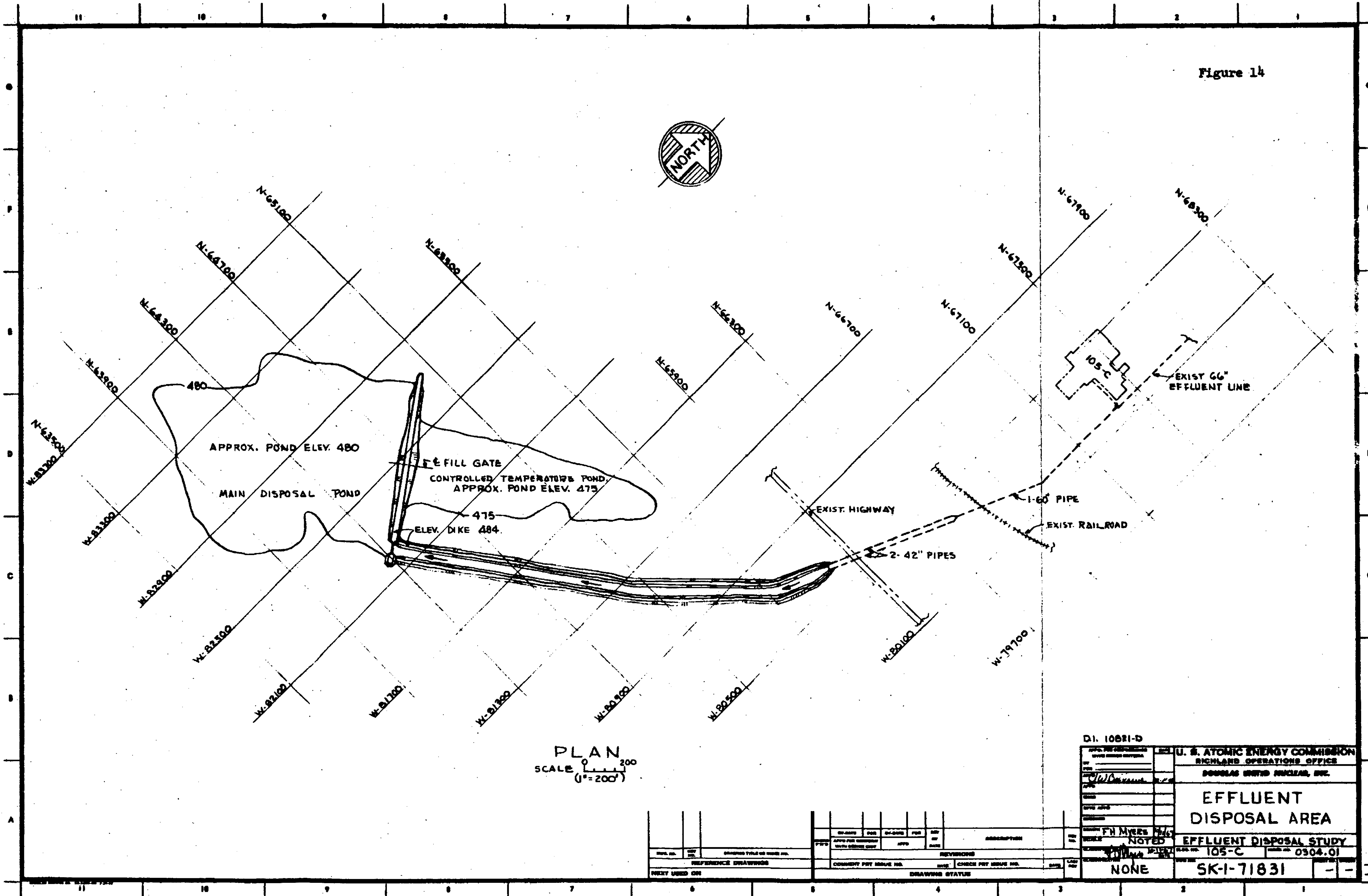

COLUMBIA RIVER
2-84" DIA. PIPES
594
1908-K
CRIB
42"
72"
VALVE BOX
42" (EXISTING)
42" OVERFLOW LINE
OVER FLOW BASIN
WEIR
OPEN DITCH
42" TRANSFER LINE
107-KW-C
107-KW-B
107-KW-A
107-KE-C
107-KE-B
107-KE-A
105-KW
105-KE
NK-7300
NK-6900
NK-6500
NK-6100
NK-5700
NK-5300
NK-4900
NK-4500
WK-7500
WK-7100
WK-6700
WK-6300
WK-5900
WK-5500
WK-5100
WK-4700
WK-4300
WK-3900
WK-3500
WK-3100
WK-2700
WK-2300
WK-1900
WK-1500
WK-1100
WK-0700
WK-0300
END DITCH STA. 41+00
EXISTING HANFORD DITCH APPROX. 7600' LONG
℄ CRIB BYPASS DITCH LENGTH 4100 LIN. FT. (EXISTING)
TIE INTO EXISTING HANFORD DITCH. APPROX. 7600' LONG.
PLAN
SCALE 0 200 (1" = 200')
SPOIL
5'
6'
EXISTING GRADE
AV. DEPTH 4.5'
TYPICAL SECTION HANFORD DITCH
D.I. 10821-D
U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
REACTOR EFFLUENT DISPOSAL TEST SITE
F.H. MYERS
NOTED
EFFLUENT DISPOSAL STUDY
100-K
0304.01
NONE
SK-1-71819

Figure 14


NORTH
APPROX. POND ELEV. 480
MAIN DISPOSAL POND
480
℄ FILL GATE
CONTROLLED TEMPERATURE POND
APPROX. POND ELEV. 475
475
ELEV. DIKE 484
EXIST. HIGHWAY
2- 42" PIPES
1-60" PIPE
EXIST. RAIL ROAD
EXIST 66" EFFLUENT LINE
105-C
N-63500
N-63900
N-64300
N-64700
N-65100
N-65500
N-65900
N-66300
N-66700
N-67100
N-67500
N-67900
N-68300
W-83300
W-83300
W-82900
W-82500
W-82100
W-81700
W-81300
W-80900
W-80500
W-80100
W-79700
PLAN
SCALE 0 200
(1" = 200')
DI. 10821-D
U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
DOUGLAS UNITED NUCLEAR, INC.
EFFLUENT
DISPOSAL AREA
EFFLUENT DISPOSAL STUDY
F H Myers
NOTED
105-C
0304.01
NONE
SK-1-71831