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Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

91-WOB-337

Mr. Paul T. Day
Hanford Project Manager
U. S. Environmental Protection Agency
Region 10
712 Swift Blvd., Suite 5, B5-01
Richland, Washington 99352

Mr. Timothy L. Nord
Hanford Project Manager
State of Washington
Department of Ecology
99 South Sound Building
Lacey, Washington 98503

DEC 1991 RECEIVED EDMC

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Dear Messrs. Day and Nord:

ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS FROM CONTINUED DISCHARGE TO THE 300 AREA PROCESS TRENCHES AT HANFORD

Attached for your review is the final draft of the Golder Associates Inc. report on the assessment of potential environmental impacts from continued discharge to the 300 Area Process Trenches (Trenches) at Hanford. The study was completed on September 13, 1991 and early copies were provided to your staff per DSI. This report concludes that following completion of the Expedited Response Action (ERA) the impact of continued use of the Trenches is expected to be small or indiscernible.

During the May 1991 negotiations the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) indicated that additional information was necessary to support the change request submitted on March 30, 1991 for an extension to Milestone M-17-06. In support of the change request the U.S. Department of Energy (DOE) agreed to the following commitments;

1. Expedited Response Action - The ERA was initiated and the excavation of both Trenches has been completed. Sampling was conducted according to the agreed to protocol and sample data is being transmitted by the labs as it becomes available. The radiochemistry results are anticipated late in October. None of the sample data sets are complete with the exception of the field samples. A contract is being placed to provide for third party review of the sample data packages. This review is anticipated to be completed by November 1991.

2. Waste Water Volume Reductions - Waste minimization activities were initiated which have resulted in a significant reduction of liquid effluent discharges to the Trenches. To date, a reduction of over 500 gpm has been achieved. The target for 12/91 is an average daily flow of 400 gpm. Further reductions will result in an average daily flow of 300 gpm by 12/92 and finally an average daily flow of 200 gpm by 5/93.

3. Waste Water Effluent Sampling and Analysis Plan (SAP) - The SAP was submitted for review and approval on September 18, 1991. We believe this plan incorporates the review comments provided by your staff on the earlier draft submitted on August 9, 1991. In light of the accelerated schedule we would appreciate your review and approval of these documents by September 23, 1991.

4. Acceleration of Construction - The current milestone (M-17-09) for construction of the treatment facility requires completion of construction by 6/95. The DOE has proposed to accelerate construction which will result in operation of the facility by 12/94.

5. Value Engineering Study - A value engineering study was conducted with participation by the EPA and Ecology to determine the feasibility of accelerating the construction and operation of the treatment facility. The study was completed on July 16, 1991 and incorporates review comments from the multi-agency team members. On the basis of the study, there is no appreciable acceleration prior to the proposed date of December 1994.

In recent discussions, requests were made by the EPA and Ecology for additional information beyond the environmental impact report. Specifically, post-excavation sample data obtained as part of the ERA activities. As mentioned earlier, the third party review of the sample data packages is not anticipated to be completed until November 1991. The DOE would propose that the field sampling data obtained during the ERA be used to provide a "heads up" on preliminary sample analysis information. The sample data packages are available for these sample sets and although they have not been subjected to third party interpretation, this information should be adequate for determining the anticipated background levels for the remediated Trenches. The field sampling data can be provided by September 27, 1991.

The DOE believes it has satisfied all reasonable requests for additional information to support the approval of the change package. To defer approval until third party interpretation of all sample data is available is unwarranted.

If you have any questions regarding these commitments, please contact Mr. L. S. Mamiya of the U.S. Department of Energy, Richland Operations Office on (509) 376-1471 or Mr. J. E. Rasmussen on (509) 376-2247.

Sincerely,

J. E. Rasmussen

for Steve H. Wisness
TPA Manager

Attachment

9513388.0821

cc w/o attachment:
B. A. Davis
L. Soler
D. E. McKenney

9513388.0822

ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS FROM CONTINUED DISCHARGE TO THE 300 AREA PROCESS TRENCHES AT HANFORD

Prepared for:

Westinghouse Hanford Company
Richland, Washington

Prepared by:

Golder Associates Inc.
Redmond, Washington

Under contract to:

SAIC
Richland, Washington

September 12, 1991

903-1274

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EXECUTIVE SUMMARY

The 300 Area Process Trenches have received waste effluents since 1974. In 1985, administrative controls were instituted to reduce contaminant discharges to the trenches. The Process Trenches are regulated by the Washington State Department of Ecology under a Resource Conservation and Recovery Act Interim Status Permit; although the current effluent entering the trenches is not a dangerous waste. Milestone N-17-06 of the "Tri-Party Agreement" specifies termination of effluent discharge to the 300 Area Process Trenches by December 1991. An Expedited Response Action (ERA) to reduce the contaminant release and environment threat is currently being implemented. An extension to this milestone date was requested, which motivated the initiation of this study to assess environmental impacts of continued discharge.

The ERA is being implemented to remove contaminated sediments that have accumulated in the bottom of the trenches from historic discharges. These sediments contain elevated concentrations of aluminum, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium and uranium. These sediments are perceived to be a continued source of contaminant loading to the underlying aquifer. The removal of these contaminated sediments will reduce the ultimate quantity of contaminant releases to the environment.

At the present time, the groundwater contaminants of concern associated with the Process Trenches are uranium, copper, and chloroform. Chloroform concentrations are below drinking water standards and appear to be due to pre-treatment of the process water. Elevated copper and uranium groundwater concentrations are evidently due to leaching of these constituents from sediments and soils near the bottom of the Process Trenches. Other constituents that are present in Process Trench sediments appear to be retained within these sediments and are not found at elevated concentrations in groundwater.

It is anticipated that following completion of the ERA, groundwater concentrations of copper and uranium will decrease with time. Further discharge to the Process Trenches will likely transport remnant copper and uranium in the vadose zone to the saturated zone. However, the impact on groundwater concentrations is expected to be small, or indiscernible, because the uranium and copper that remain in the vadose zone beneath the trenches are predicted to contribute only an additional 3-percent uranium and 6-percent copper to the quantities that are already in the aquifer. These estimates do not account for small amounts of soluble particulate uranium and copper that may remain in the bottom of the trenches following ERA excavations. The potential impacts from residual particulates will be further evaluated upon receipt of analytical results from soil sampling in the trench bottoms following the ERA.

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1.0 INTRODUCTION

This report summarizes the results of an assessment of the potential environmental impacts from continued use of the 300 Area Process Trenches following completion of an Expedited Response Action (ERA). This assessment was performed by a panel of technical specialists and is based upon an evaluation of existing information.

1.1 BACKGROUND

The 300 Area Process Trenches have been used for soil column disposal of process water from facilities at the 300 Area since 1974. The 300 Area is located on the west bank of the Columbia River at the south end of the Hanford Site in southeastern Washington State. As shown in Figure 1-1, the trenches are located in the north end of the 300 Area and are designated as the 316-5 Process Trenches. They consist of two separate trenches, approximately 1500 feet long, that are aligned parallel to each other in a north-south direction. The trenches are approximately 11 feet deep, 10 feet wide at the bottom, and 30 to 35 feet wide at the top (DOE 1991b). The berm separating the trenches is approximately 15 to 20 feet wide (Tyler 1991). The depth to groundwater from the bottom of the trenches is approximately 20 feet. The west trench has a southwest trending lobe at its northern end that is approximately 150 feet long. The lobe was an active portion of the west trench until 1990 (DOE 1991b). Effluent is discharged from outlet structures in the southern end of the trenches and the trench floors slope slightly to the north to allow water to drain the entire length of the trenches. The trenches are used alternately for periods of up to eight months. The flow rate presently averages 900 gallons per minute (gpm), although it has peaked at approximately 3 million gallons per day (2,100 gpm) in the past (DOE 1991b).

The Process Trenches are regulated by the Washington State Department of Ecology under a Resource Conservation and Recovery Act (RCRA) Interim Status Permit. Administrative controls to reduce discharges of contaminants to the process sewer were instituted in 1985. Estimated quantities of hazardous and radioactive chemicals discharged to the trenches before 1985 are provided in Table 1-1. Chemical analyses of the current process sewer effluent were provided in a recent report (WHC 1990). The current effluent is not designated as a dangerous waste (WHC 1990) and consists of: 1) purified or potable water, 2) equipment cooling water, 3) laboratory and research facility wastewater, and 4) direct precipitation. Fuel fabrication facilities were probably the most significant source of contaminants in the past, but have not been operated since 1987 (DOE 1991b).

The Process Trenches are included within CERCLA cleanup activities being conducted for operable units 300-FF-1 and 300-FF-5. Operable unit 300-FF-1 includes source regions and soil contamination within the boundary shown in Figure 1-1. Operable unit 300-FF-5 includes all groundwater within and near the 300 Area. An Expedited Response Action (ERA) to reduce the contaminate release and environmental threat associated with the Process Trenches is currently underway. The proposed plan for the ERA is summarized in Section 2.2. In addition, a waste minimization program is currently being implemented to decrease the flowrate and contaminant loading of the process sewer.

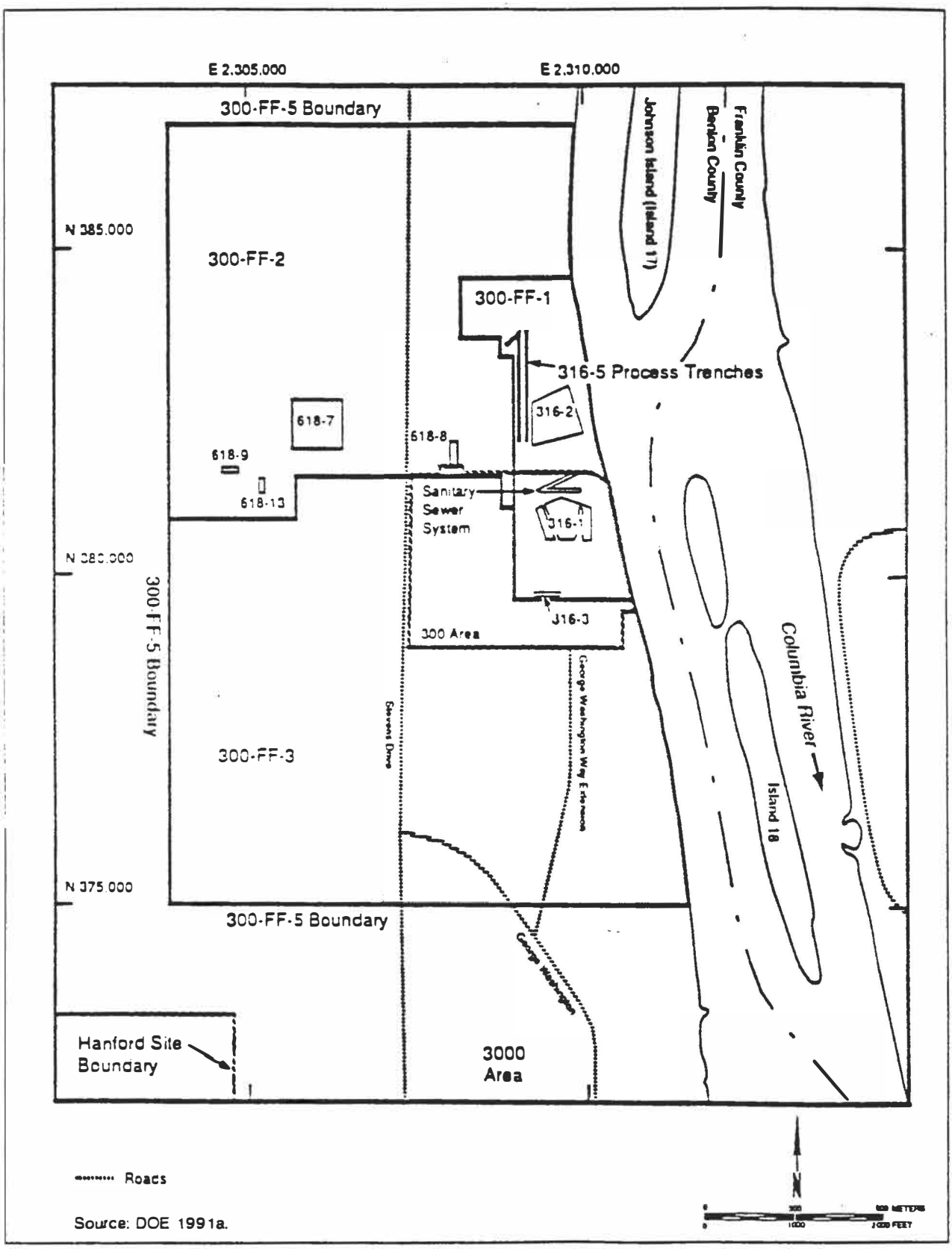

Figure 1-1. Location of the 316-5 Process Trenches in the 300-FF-1 Operable Unit, Hanford Site, Richland, Washiungton.

Table 1-1. Estimated Nonradiological Chemical Waste Inventory for the Process Trenches (before implementation of administrative controls on February 1, 1985).

Intermittant discharges		Larger discharges[a]	
<gm	<kg		
Ammonium biofluoride	Benzene	Copper	~30 kg/month
Antimony	Carbon tetrachloride	Detergents	≤30 kg/month
Arsenic	Chromium	Ethylene glycol	≤200 L/month
Barium	Chlorinated benzenes	Heating oil	~300 L[b]
Cadmium	Degreasing solvents	Hydrofluoric acid	~100 kg/month
Dioxine	Formaldehyde	Nitrates	≤2,000 kg/month
Dioxin[c]	Formic acid	Nitric acid	≤300 L/month
Hydrocyanic acid	Hexachlorophene	Paint solvents	≤100 L/month
Pyridine	Kerosene	Tetrachloroethylene	~450 L[b]
Selenium and Selenium compounds	Lead	Photo chemicals	≤700 L/month
Thiourea	Methyl ethyl ketone	Sodium chloride	~75 ton/yr
Miscellaneous laboratory chemicals	Mercury	Sodium hydroxide	≤300 L/month
	Naphthalene	Uranium	~20 kg/month
	Nickel		
	Phenol		
	Silver		
	Sulfuric acid		
	Tetrachloroethylene		
	Toluene		
	Tributylphosphate (paraffin hydrocarbon solvents)		
	1,1,1-trichloroethane		
	Trichloroethylene		
	Xylenes		

Source: DOE (1985)

[a]These discharges, except for the spills, were relatively continuous.
[b]Known spills.
[c]Included only because of the potential for dioxin to exist as trace impurity in chlorinated benzenes.

Milestone N-17-06 of the Hanford Federal Facility and Agreement Consent Order (Tri-Party Agreement) specifies termination of effluent discharge to the 300 Area Process Trenches by December 1991 (Ecology et al. 1989). Because of delays in design of a wastewater treatment facility to treat the process sewer discharge, it has become necessary to request an extension of the December 1991 deadline. This extension request motivated initiation of this study to assess the environmental impacts of continued discharge.

1.2 SCOPE

The principal objective of this study is to assess the likely environmental impacts to underlying soil and groundwater due to continued discharge to the 300 Area Process Trenches, given:

(a) the effects of the planned Expedited Response Action, and
(b) the effects of the ongoing waste minimization effort.

Secondary objectives of the task are: 1) evaluate the effectiveness of the existing groundwater monitoring system to detect changes in contaminant concentrations, and 2) provide recommendations for the collection of additional data and/or operational improvements. Additional field work and development of a numerical model are beyond the scope of this task. The analysis is intended to be semi-quantitative and conclusions are based upon scientific principles and professional judgement.

1.3 APPROACH

Given that a quantitative analysis of trench performance was beyond the scope of this study, the approach consisted of data review and assessment by a panel of technical specialists. The panel consisted of two hydrogeologists (Charlie Wilson and Scott Kindred) and one geochemist (Douglas Morell) from Golder Associates Inc., and a chemical engineer (Peter Keenan) from Engineering Science, Inc. Two representatives from Westinghouse Hanford Company (Anthony Knepp and Daniel Tyler) were present at the panel meeting to answer questions that arose during the discussion. In addition, the Westinghouse Hanford Company Project Manager for the ERA, George Henckel, was contacted by phone during the panel meeting to provide up-to-date information regarding implementation of the ERA. Following the panel discussion, the results were summarized in a report and circulated among the panel members for their review and approval. This report is the final product of the panel discussion and review.

The technical basis for determining the impacts of continued discharge to the Process Trenches rested upon the following information:

1) observed concentrations of contaminants in soil and groundwater beneath the trenches,

2) estimated quantities of chemicals discharged to the trenches,

3) observed groundwater flow patterns beneath and surrounding the trenches, and,

4) knowledge of the geochemical behavior of the contaminants associated with the trenches.

Given this information and the general knowledge of the panel members, it was possible to assess the environmental conditions that would result from continued discharge to the Process Trenches after implementation of the ERA. Since contamination would remain in the groundwater even if effluent discharge were discontinued, the impact of continued discharge was assumed to be the difference between environmental conditions with and without effluent discharge. In general, environmental conditions that were considered included contaminant concentrations in soil and groundwater, and the total mass of contaminants in the system.

2.0 EXISTING ENVIRONMENTAL CONDITIONS

2.1 HYDROGEOLOGY

The 300 Area is located one mile north of Richland on the west bank of the Columbia River. The geology underlying the 300 Area is dominated by the glaciofluvial sediments of the Hanford and Ringold Formations. Stratigraphic cross-sections of the 300 Area are provided in Figure 2-1. Cross-section B-B' is located just south of the Process Trenches. The Pasco Gravels that directly underlie the trenches are characterized as basaltic sandy gravel, with some silt and local sand stringers (Schalla et al. 1988). The Middle Ringold sediments beneath the Pasco Gravels consist of sandy gravels with local silt and sand lenses (Schalla et al. 1988) and are similar in nature to the Pasco Gravels. These stratigraphic units are distinguished from each other by the lower percentage of basaltic clasts in the Middle Ringold.

Near the process trenches, the water table is located within the coarse Pasco gravels approximately 35 feet below the ground surface. The saturated thickness of the underlying aquifer in the vicinity of the trenches, including both the Pasco Gravels and the Middle Ringold, is approximately 100 feet. Based upon aquifer tests, transmissivity ranges from 10,000 to 1,000,000 ft^2/day (Schalla et al. 1988). Groundwater flow patterns near the 300 Area are controlled by the stage of the Columbia River and the presence of a transmissive channel separated from the river by a levee of less permeable Ringold sediments. As shown in Figures 2-2 (low groundwater levels) and 2-3 (high groundwater levels), groundwater generally flows to the southeast beneath the Process Trenches. However, flow directions appear to shift more to the south during periods of high river stage, and more to the east during periods of low river stage (Lindberg and Bond 1979). As shown by the shape of the 343- and 344-foot contours, a groundwater mound is present beneath the Process Trenches and upgradient groundwater appears to be diverted around the trenches.

2.2 VADOSE ZONE CONTAMINATION

An investigation of contaminant concentrations in sediments and soils within and beneath the Process Trenches was conducted by Zimmerman and Kossik (1987). The investigation included two phases: 1) shallow sampling of sediments and underlying soils at 16 locations within each trench to a maximum depth of 18 inches, and 2) borehole drilling and soil sampling of vadose zone soils beneath the berm separating the two trenches. Twenty percent of the samples were analyzed for the full list of parameters included in the groundwater monitoring program, while the remaining 80 percent were analyzed for a reduced list of screening parameters. In the first phase, samples were collected from up to three depths at 100-foot intervals along each trench. At each sampling location, samples were collected of the loose surficial sediments, and at depths of 4 inches and 18 inches below the trench bottom. Loose sediment samples were not collected at 16 sampling locations where no loose sediments were present. In addition, 15 samples were not collected because of water covering the trench bottom. In the second phase, boreholes were drilled to a final depth of 40 feet at six locations in the berm separating the two trenches. Samples were collected at five-foot intervals in each borehole.

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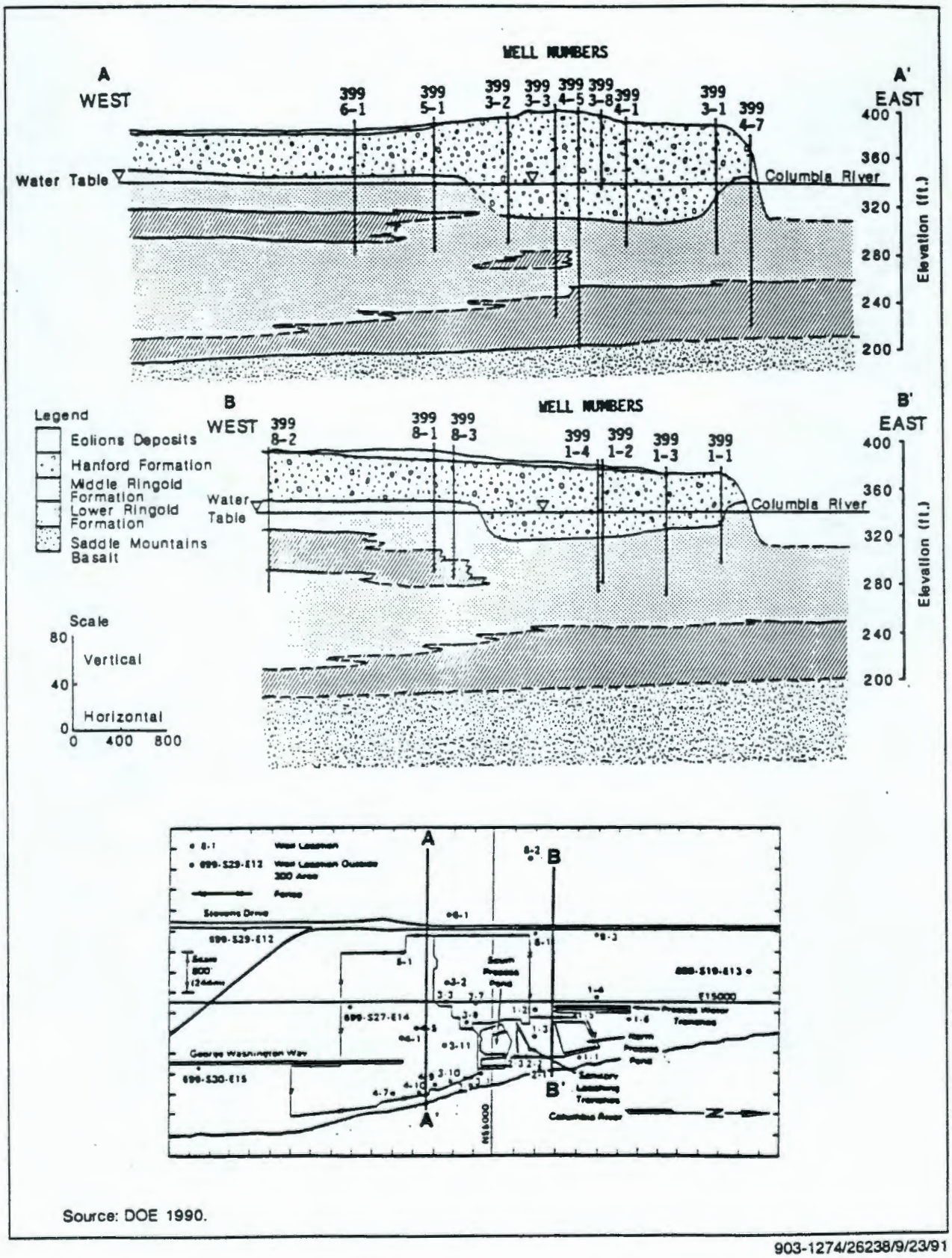

Source: DOE 1990.

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Figure 2-1. Geologic Cross-Sections of the 300 Area.

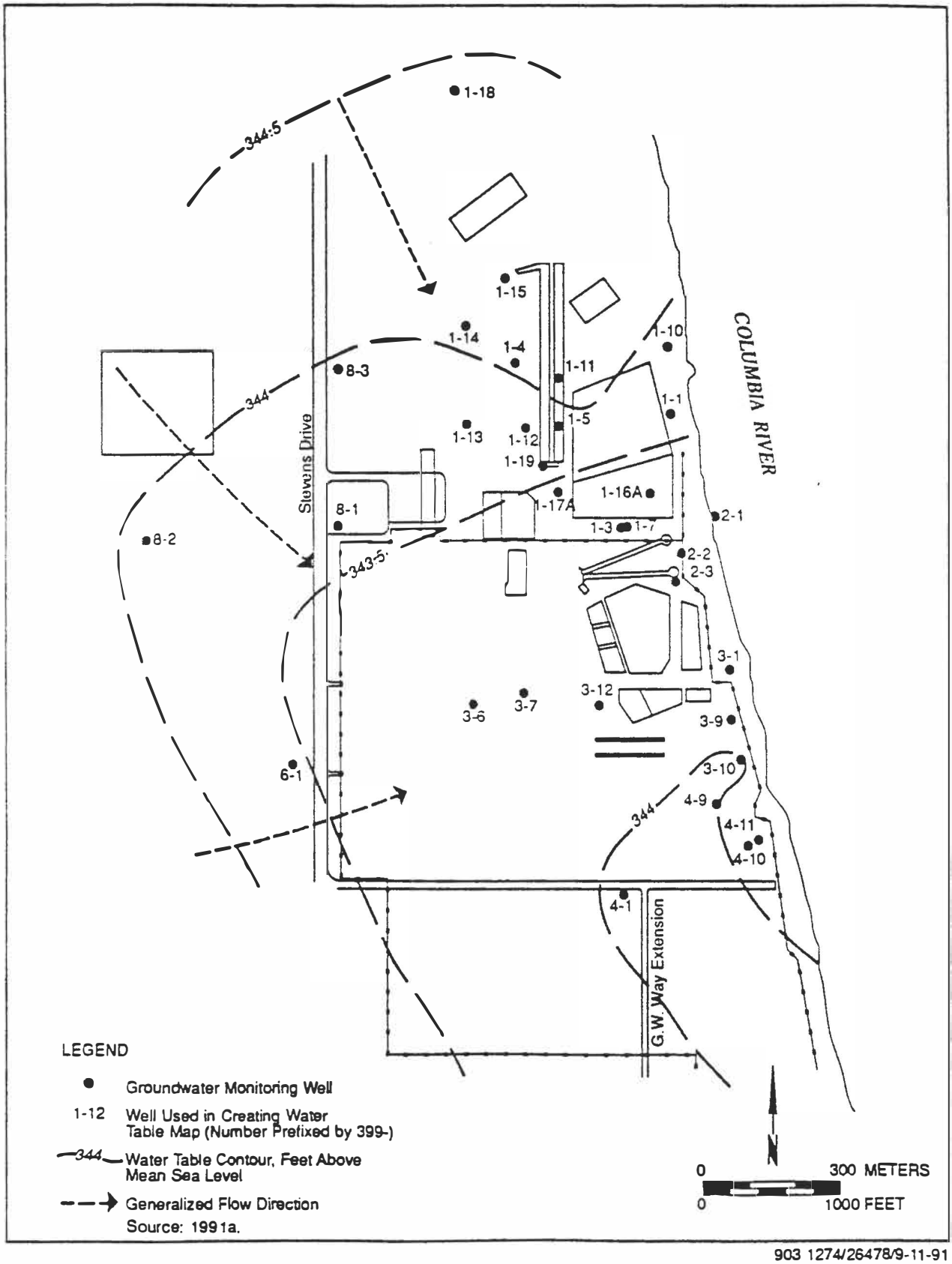

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Figure 2-2. Water Level Contour Map of the Unconfined Aquifer, January 29, 1990.

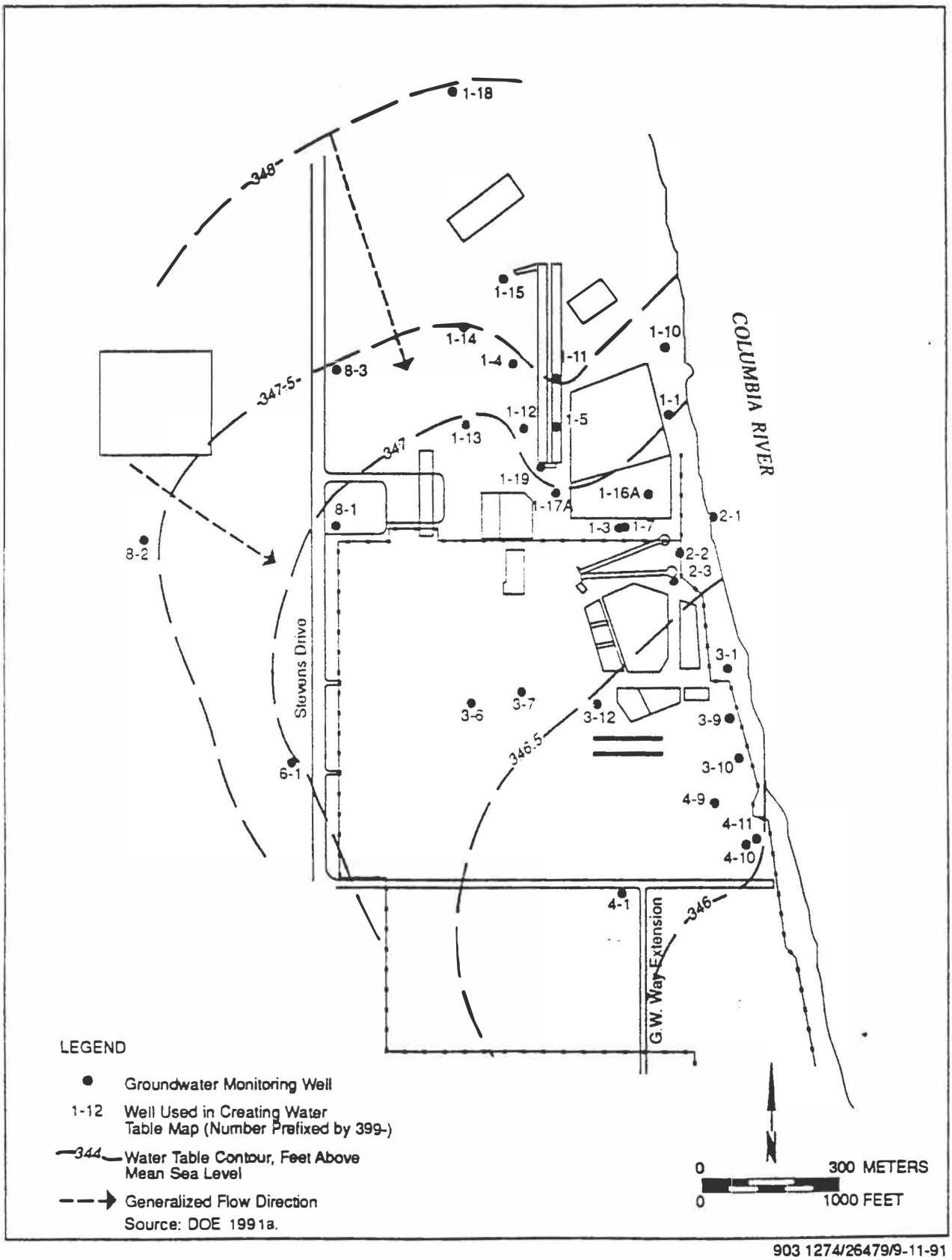

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Figure 2-3. Water Level Contour Map of the Unconfined Aquifer, June 25, 1990.

The constituents in the shallow trench samples that had concentrations appearing to be elevated above background levels include aluminum, antimony, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium, and uranium (likely due to alpha radioactivity). The concentrations of these constituents are summarized in Table 2-1. In general, these metals appeared to be concentrated in the loose sediments (Zimmerman and Kossik 1987). An estimate of the mass of some of these constituents contained within the bottom of the trench is provided in Table 2-2. From this table, it is evident that chromium, copper, nickel, silver and uranium appear to be most elevated above background concentrations. EP toxic leach tests on sediment samples from the trench indicated that the sediments were not a dangerous waste according to Washington State regulations (Zimmerman and Kossik 1987).

The deep soil samples obtained from the berm between the trenches contained constituent concentrations near background levels. A summary of the sampling results is provided in Table 2-1. The absence of elevated contaminant concentrations in the vadose zone beneath the trenches, even for those constituents with elevated concentrations within trench sediments, indicates that mobile contaminants have already migrated through the system, and strongly sorbed contaminants have been retained near the trench bottom. As discussed below, only uranium and copper remain in the groundwater system at elevated concentrations.

2.3 GROUNDWATER CONTAMINATION

The only inorganic chemical constituents in groundwater that appear to consistently exceed background concentrations include gross alpha, gross beta, copper, fluoride, and nitrate (Schalla et al. 1988). The gross alpha and gross beta are likely associated with elevated uranium concentrations. Elevated fluoride concentrations tend to be associated with the deeper portions of the aquifer, and probably reflect the influence of groundwater from the basalt aquifer that is naturally elevated in fluoride (Schalla et al. 1988). Nitrate concentrations downgradient of the process trenches are actually lower than surrounding areas suggesting that elevated nitrate concentrations are due to upgradient sources. As suggested by concentration contours shown in Figures 2-4 and 2-5, the elevated copper and uranium concentrations appear to be associated with the Process Trenches. As shown in Figure 2-4, copper concentrations were as high as 48 ppb, compared to a drinking water standard of 1,000 ppb, and a chronic aquatic standard of 12 ppb. The highest uranium concentration in November 1987 was 90 pCi/L (~131 ppb) in Well 1-19 (Schalla et al. 1988). As shown in Figure 2-6, uranium concentrations in Well 1-17A have ranged from 50 to 340 pCi/L (~70 to ~490 ppb) in recent years.

A variety of chlorinated organic compounds have been detected in groundwater, including chloroform, methylene chloride, PCE, TCE, 1,1,1-trichlorethane, and trans-1,2-dichloroethylene. A map of chloroform concentrations provided in Figure 2-7 indicates that the chloroform is associated with the process trenches. Concentrations have been as high

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Table 2-1. Summary of Sediment Analyses for the 300 Area Process Trenches and the Berm Separating the Trenches

Constituent[a]	Background[b]	Trenches			Berm		
		Range	Mean	s[c]	Range	Mean	s
Ag	<1.0	2-405	66.7	86.0	nd[d]	–	–
Ba	96.6 ± 26.0	53-491	138.1	98.2	57-110	85.7	13.3
Cd	0.5 ± 0.3	4-28	9.5[f]	3.6	0.5-9	5.5[f]	1.1
Cr	9.8 ± 1.2	5-551	92.8	129.7	4-10	6.5	1.5
Cu	18.4 ± 4.9	104-8470	1390	1804	8-42	18.1	6.8
Hg	<0.1	0.2-69	6.6	13.3	0.11	0.11	–
Mn	396.2 ± 63.5	121-6740	457.7	874.6	167-346	277.6	35.3
Ni	7.6 ± 1.0	15-4700	280.3	667.2	2-11	5.1	1.7
Pb	5.1 ± 0.88	2-486	63.2	102.7	2-6	3.3	1.0
Sb	<10.0	13-128	55.2	40.3	n.d.	–	–
V	60 ± 7.0	1-207	52.1	34.5	46-83	60.5	8.1
Zn	50.2 ± 8.2	49-1160	203.8	205.7	29-50	39.9	5.0
gross alpha[e]	6.4 ± 2.1	16-18700	1740	3440	<1-11	5.0	2.7
gross beta[e]	21.4 ± 2.4	75-20800	3280	5690	11-25	15.4	2.7

Source: Schalla et al. (1988)

[a]Units are mg/kg except for gross alpha and gross beta, which are in pCi/g.
[b]Average, plus or minus one standard deviation, of concentrations in five samples from a location outside the South Process Pond.
[c]s is one standard deviation.
[d]Not detected.
[e]Alpha and beta are likely due to uranium.
[f]Zimmerman and Kossik (1987) report mean cadmium concentrations of approximately 1.8 mg/kg for the trenches and 0.5 mg/kg for the berm.

Table 2-2. Estimated Total Amount of Constituents in the Sediment (kg)

Constituent	Shallow Sediments	Estimated Amount from Background
As[a]	2	8
Cd	3	3
Cr	341	19
Cu	2261	30
Pb[b]	108	33
Hg[b]	12.8	3
Ni	578	17
Ag	74	3
U	720	9

Source: Zimmerman and Kossik (1987)

[a]The arsenic is always within background range.
[b]The lead and mercury are within the range of background values except in some of the loose and shallow sediments.

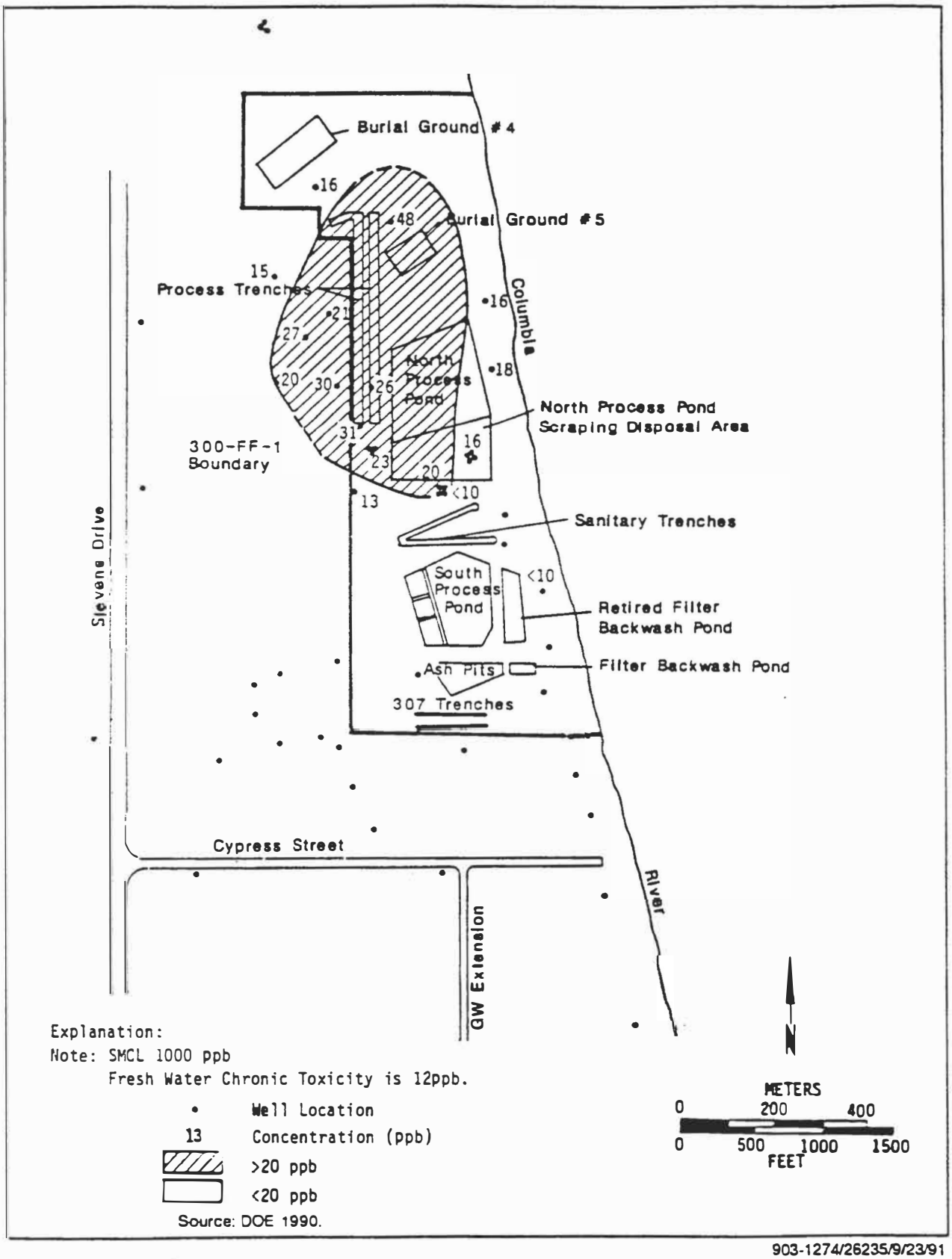
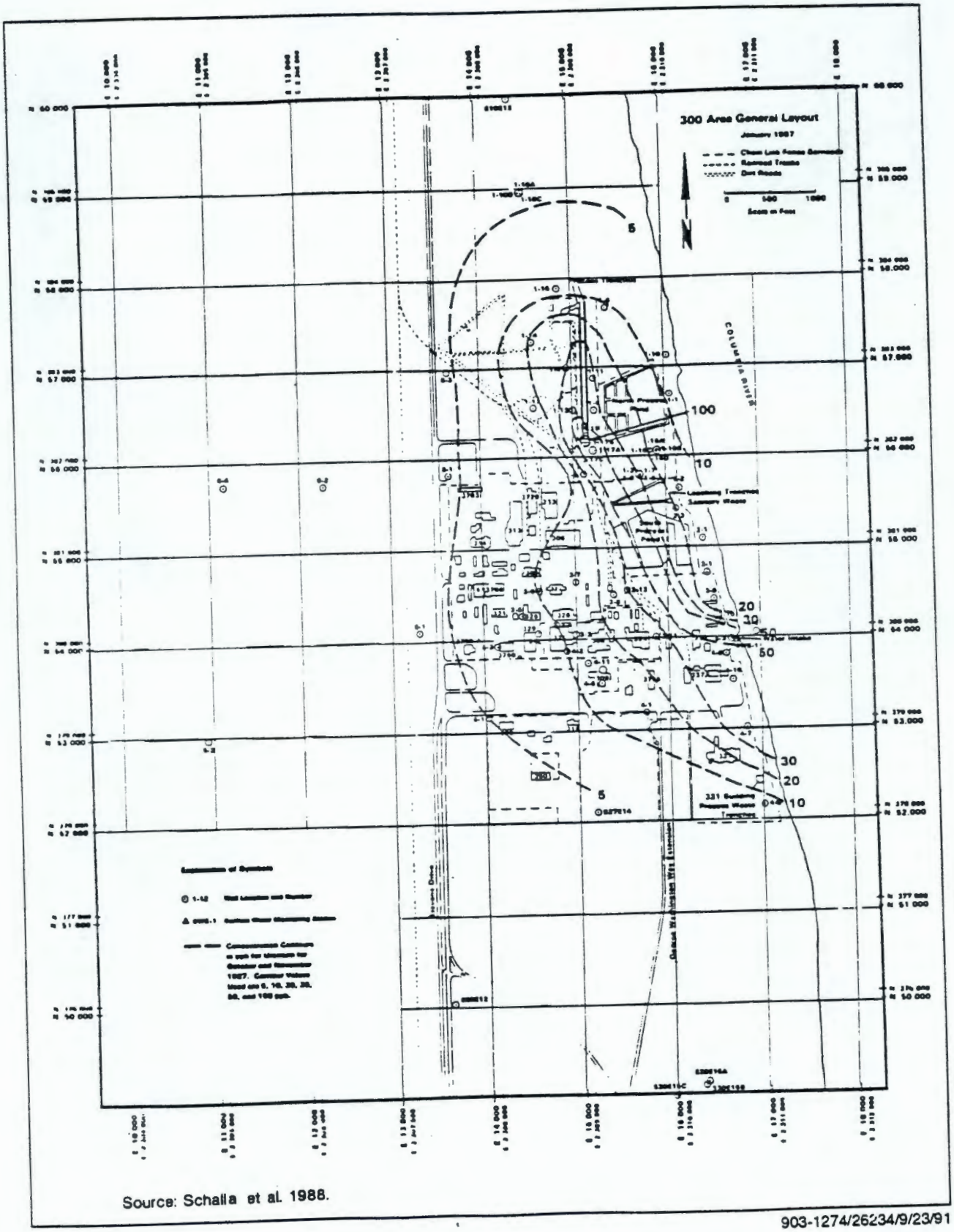


Figure 2-4. Maximum Filtered Copper Concentrations in Shallow Groundwater (1985-1987).



Source: Schalla et al. 1988.

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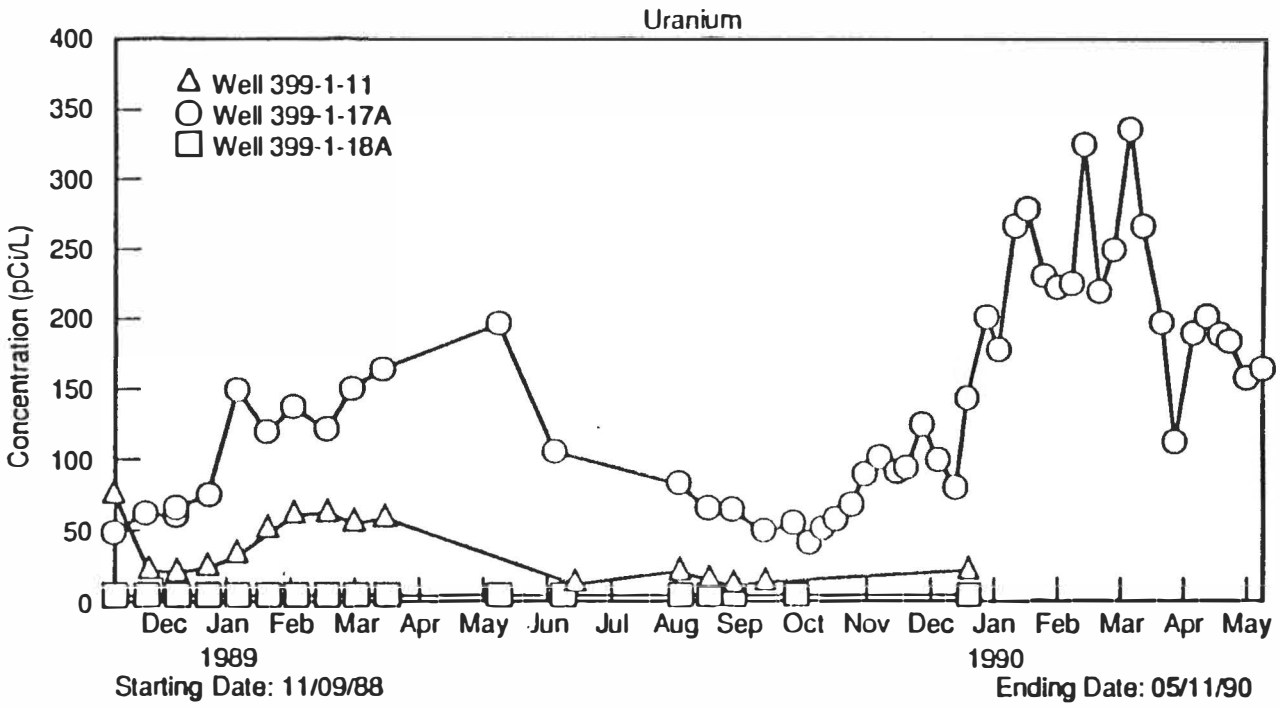
Figure 2-5. Uranium Distribution in the Shallow Portion of the Unconfined Aquifer in the 300 Area, October Through November 1987.



Source: DOE 1991a.

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Figure 2-6. Concentrations of Uranium in Selected Wells.

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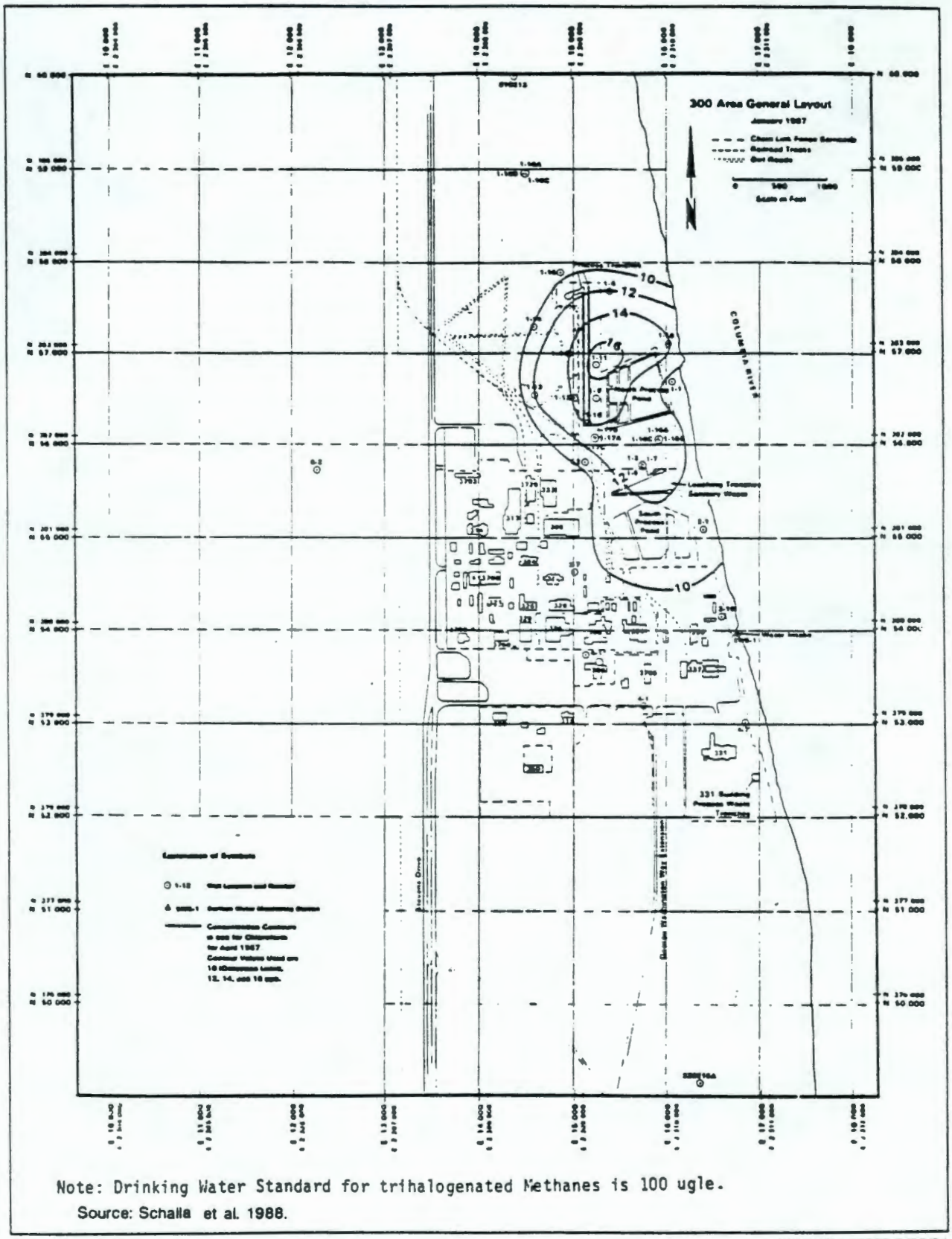

Note: Drinking Water Standard for trihalogenated Methanes is 100 ugle.

Source: Schalla et al. 1988.

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Figure 2-7. Concentration Contours for Chloroform in Shallow Groundwater for April 1987.

as 42 ppb (Schalla, et al. 1988), compared to the drinking water standard of 100 ppb (total trihalogenated methanes). The elevated chloroform concentrations are likely due to disposal of chlorinated water used in 300 Area facilities. The remaining organic compounds have been sporadically detected, and although some of these compounds have been discharged to the process sewer, the concentrations do not directly implicate the Process Trenches as a significant source (Schalla et al. 1988).

2.4 PROPOSED EXPEDITED RESPONSE ACTION

A description of the proposed Expedited Response Action (ERA) for the 300 Area Process Trenches was provided by the Department of Energy (DOE 1991b). The ERA was being implemented while this study was ongoing and partial results were available. Before excavation, the radiation readings were 2000 to 3000 counts per minute (c/m) using a beta/gamma detector with a hand-held pancake probe. In contrast, background radiation readings averaged approximately 50 counts per minute with an upper tolerance limit of 108 c/m. The ERA involved excavating sediments and shallow soils from the bottom of the trenches until radiation levels measured with hand-held field monitors were less than three times the upper tolerance limit (324 c/m). The excavated soils were to be placed in the northern ends of the trenches and isolated from the active portions of the trenches with a berm of clean soil. According to reports from personnel in the field, the depth of excavation for the east trench ranged from about 48 inches in the south end to 18 inches in the north end (Henckel, 1991). Radiation readings within the east trench after excavation were less than 200 c/m. An x-ray spectrometer was used to screen soil samples from the trench for metals. Although no metals were detected in samples from the bottom of the trench, the detection levels were generally above background concentrations (100 to 500 ppm).

Based upon limited field data, it appears the ERA will result in removal of the highly contaminated sediments from the bottom of the trenches. However, due to minor spillage and presumed migration of low concentrations of uranium and copper, it is likely that low concentrations of contaminants remain in the soils beneath the trenches. To confirm field screening procedures, soil samples were collected from the bottom of the excavation and shipped to a laboratory for analysis. More definitive information regarding concentrations of uranium and metals remaining in the trench will be available when analytical testing is completed.

3.0 ASSESSMENT OF IMPACTS

3.1 CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT

The information presented in the previous section forms the basis for the conceptual model of contaminant transport beneath the Process Trenches. One of the most important observations (illustrated in Figure 2-6) was that copper and uranium groundwater concentrations have not abated since administrative controls were instituted in 1985. Because elevated concentration of uranium and copper have not been present during the past six years in the process sewer effluent before entering the trench, it appears that the source of dissolved uranium and copper in the groundwater has been the copper and uranium-enriched sediments in the bottom of the trenches. Either solubility factors or kinetic limitations have determined the groundwater concentrations resulting from contact with the sediments. Solubility or kinetic factors are also likely reasons why concentrations of some metals are elevated in trench sediments but not in groundwater. Implementation of the ERA should remove most of the particulate uranium and copper contained within the trench sediments, and should result in an ultimate reduction of groundwater concentrations. The time necessary to observe significant reductions in groundwater concentrations will depend on the remaining mass of contaminants in the system, and whether equilibrium conditions predominate between the aqueous and solid phases.

The analysis that is described below for estimating the impact of continued discharge to the Process Trenches relies upon comparison of contaminant mass remaining in the vadose zone with the mass remaining in the saturated zone after implementation of the ERA. If the mass remaining in the vadose zone is very small compared with that in the saturated zone, it may be concluded that any continued leaching of vadose zone sediments would have a negligible incremental impact on groundwater contamination. It is likely that uranium and copper will remain present in the vadose zone after the ERA in a variety of different forms, including: 1) dissolved, 2) reversibly sorbed, 3) irreversibly sorbed, 4) particulates from the waste water, and 5) naturally bound within existing soil minerals. Naturally occurring uranium and copper that are bound up in the soil matrix and irreversibly sorbed uranium and copper should not contribute to elevated concentrations in groundwater. The fine grained sediment that accumulated at the bottom of the trenches contained high concentrations of particulate uranium and copper. The ERA was initiated to remove most of the contamination by removing the sediments and shallow soils from the trenches. Although some particulate uranium and copper may remain present in the bottom of the trench due to spillage during excavation, the amount of spillage is not expected to be significant. This assumption will be confirmed when the analytical results for the trench bottom soil samples are available. Assuming insignificant amounts of spillage, it is likely that the dissolved and reversibly-sorbed fractions in the vadose zone will be the only important remaining contributors to elevated groundwater concentrations.

The concentrations of reversibly-sorbed uranium and copper should be directly related to the dissolved concentrations by a distribution coefficient (K_d). Therefore, the total amount of reversibly sorbed uranium and copper in a soil mass should be approximately proportional to the dissolved mass in the groundwater associated with that soil. This relationship is utilized below to compare the relative amount of uranium and copper remaining in the vadose zone to the amount in the saturated zone.

3.2 CONTAMINANT MASS IN THE SATURATED ZONE

Even if discharges to the trenches were discontinued, the environment would continue to be affected by the elevated concentrations of uranium and copper that remain in the saturated zone. An estimate of the mass of dissolved uranium remaining in the groundwater can be obtained using the contour map provided in Figure 2-5. The uranium mass represented by each contour was calculated by multiplying the mass of water between plume contours by the average concentration. The water mass was approximated by estimating the area between each contour interval, and multiplying by a plume thickness of 20 feet, a porosity of 0.3, and a water density of 28 kg/ft^3. As shown in Table 3-1, the total mass of dissolved uranium in the groundwater plume is estimated to equal 47 kg. Additional mass probably is associated with the plume due to uranium that is sorbed on sediments. Serne and Wood (1990) have estimated that the uranium partitioning coefficient for coarse Hanford sediments ranges from 0 to 3 mL/gm. Assuming equilibrium partitioning with a linear isotherm, a porosity of 0.3, and a bulk density of 1.6 g/cm^3 for the sediments, the sorbed mass may be from 0 to 16 times greater than the dissolved mass.

Table 3-1. Calculation of Dissolved Uranium Mass in Saturated Zone.[d]

Outer Contour (ppb)	Area[a] (ft^{3}x10^6)	Water Mass[b] (kgx10^9)	Average Conc.[c] (ppb)	Uranium Mass (kg)
50	0.6	0.10	75	7.5
30	1.4	0.24	40	9.6
20	2.5	0.42	25	10.5
10	4.5	0.77	15	11.2
5	6.5	1.1	7.5	8.3
Total	15.5	2.6	-	47

[a]Estimated by subtracting the area within the inner contour from the area within the outer contour.
[b]Assumes plume depth of 20 feet, porosity of 0.3, and water density of 28 kg/ft^3.
[c]Average of the inner and outer contour value for each contoured region.
[d]Figure 2-5 used for the calculations in this table.

The other contaminant plume associated with the trenches is the copper plume, which is considerably smaller than the uranium plume. The mass of copper can be estimated by multiplying the average detected copper concentration by the volume of the plume of detected copper concentrations. Assuming a plume area of 4.5x10^6 ft^3, a plume thickness of 20 feet, a porosity of 0.3, water density of 28 kg/ft^3, and an average concentration of 23 ppb, the total mass of dissolved copper is approximately 16 kg. Again, there probably is an additional mass of copper sorbed onto aquifer sediments that is proportional to the mass of dissolved copper in the aqueous phase.

3.3 CONTAMINANT MASS IN THE VADOSE ZONE BENEATH THE TRENCHES

Given the high flow rate into the trenches, it is likely that upgradient groundwater is diverted around the trenches (see discussion in Section 2.1.1) and does not appreciably mix with the infiltrating process water. Therefore, the dissolved mass of a constituent within the vadose zone can be estimated assuming that infiltrating process water concentrations in the vadose zone are similar to groundwater concentrations in the underlying saturated zone. Groundwater concentrations of uranium beneath the trenches were shown in Figure 2-5. Using an approach similar to that used for the saturated zone, the total mass of dissolved uranium in the vadose zone was calculated to equal 1.2 kg. This is less than 3 percent of the mass of dissolved uranium in the groundwater. The calculations and assumptions used to arrive at this estimate are summarized in Table 3-2. The estimate was calculated assuming that the soil beneath the trenches was saturated with infiltrating process water. If incomplete saturation was assumed, the mass estimate would be reduced. Similar to the mass estimate for the saturated zone, it is likely that additional mass is sorbed on the aquifer sediments, but this mass should be proportional to the dissolved concentration in the same ratio as the saturated zone. The ratios of reversibly sorbed contaminated mass in the vadose and saturated zones should therefore be similar to the ratios of dissolved contaminant mass in those zones.

Table 3-2. Calculation of Dissolved Uranium Mass in Vadose Zone.

Outer Contour (ppb)	Length of Trench (ft)	Water Mass[a] ($kg x 10^6$)	Average Conc.[b] (ppb)	Uranium Mass (kg)
100	100	1.7	150	0.25
50	200	3.4	75	0.25
30	700	12	40	0.48
20	300	5.0	25	0.14
10	200	3.4	15	0.12
Total	1500	25	-	1.2

[a]Assumes an affected width of 100 feet, an affected depth of 20 feet, porosity of 0.3, and water density of 28 kg/ft^3.
[b]Average of the inner and outer contour for each region.

The mass of dissolved copper in the vadose zone can be estimated using a trench length of 1500 feet, a plume width of 100 feet, a plume depth of 20 feet, a porosity of 0.3, a water density of 28 kg/ft^3, and an average concentration of 35 ppb. Given these assumptions, the estimated total mass of dissolved copper in the vadose zone is approximately 0.9 kg. This is less than 6 percent of the mass of dissolved copper in the groundwater. Again, there is probably additional copper sorbed onto aquifer sediments in approximately the same ratio as in the saturated zone.

3.4 IMPACT OF CONTINUED DISCHARGE

Implementation of the ERA should ultimately result in a significant reduction of uranium and copper concentration in groundwater beneath the trenches whether or not discharge is continued. The additional environmental impact of continuing discharge to the Process Trenches is related to the contaminant mass remaining in the vadose zone. As shown in the previous sections, the total mass of mobile (reversibly sorbed and dissolved) uranium in the vadose zone is estimated to be less than 3 percent of the estimated mobile mass already in the saturated zone. Similarly, the mass of mobile copper in the vadose zone is estimated to be less than 6 percent of the estimated mobile mass in the saturated zone. Although these estimates were based on 1987 groundwater concentrations that vary with time, the relative percentage of total contaminants contained in the vadose zone soils and contained in the saturated zone soils is expected to remain similar. Both of these percentages are quite low, suggesting that continued use of the trenches would not significantly impact groundwater contamination beneath them. The change in contaminant concentration within the aquifer due to the additional contaminant mass loading is not expected to be discernible. This analysis does not account for small amounts of soluble particulate uranium and copper that may remain in the trench bottoms. The potential impacts from residual particulates will be further evaluated upon receipt of analytical results from soil sampling in the trench bottoms following the ERA.

3.5 POSSIBLE MITIGATION MEASURES

A number of mitigating measures could be implemented if the additional environmental impact due to continued operation of the trench was considered unacceptable. These are listed and briefly discussed below:

1) Discontinue effluent discharge to the Process Trenches:

   Elimination of effluent discharge to the Process Trenches would reduce the mass of uranium and copper released to the accessible environment by up to 3 percent and 6 percent, respectively. As discussed above, it is expected that the associated reduction in groundwater concentrations would be practically indiscernible.

2) Remove all vadose zone soils beneath the trenches:

   The additional environmental impact of vadose zone contamination could be minimized by removing all vadose zone soils beneath the trenches to the water table. The volume of waste soils generated by such activity would be approximately 150,000 to 200,000 cubic yards, and would likely require washing or off-site disposal. As discussed above, it is expected that the associated reduction in groundwater concentrations would be practically indiscernible.

3) In-situ fixation of remaining vadose zone contaminants:

   In-situ fixation offers theoretical potential for elimination of soluble contaminants, thereby reducing releases to the accessible environment. However, such technology is not yet available and would require research and development. The benefits of in-situ fixation would be similar to those of the other alternative mitigating measures.

4.0 GROUNDWATER MONITORING SYSTEM EVALUATION

A brief overview of the 300 Area monitoring well network was conducted to assess the effectiveness of groundwater monitoring for the Process Trenches. An effective monitoring well network should have several up-gradient wells and enough down-gradient wells to allow delineation of a plume. In addition, to allow collection of representative samples, the wells should be constructed with less that twenty feet of stainless-steel screen placed across the water table.

According to recent work plans (e.g., PNL 1989), approximately 50 monitoring wells are located within the 300 Area. Only 18 wells satisfy the criteria listed above. The locations of these wells, shown in Figure 4-1, appear to provide a reasonable coverage that allows delineation of groundwater plumes emanating from the Process Trenches. Wells 1-19 and 1-17A are located near the southern end of the trenches and should reflect the highest contaminant concentrations in groundwater due to releases from the trenches. Cluster wells at the 1-17 location are expected to be adequate to assess the potential vertical extent of contamination that results from groundwater mounding due to effluent discharges to the trench. Additional wells are planned for installation in the 300 Area during the remedial investigations for the 300-FF-5 Operable Unit (PNL 1989).

As discussed in Sections 2.1.2 and 2.1.3, the primary contaminants of concern are aluminum, antimony, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium, and uranium, and chloroform. Analysis for all of these constituents is planned during the Phase I sampling for Operable Unit 300-FF-5. It is recommended that these constituents continue to be analyzed in the future. Particular emphasis should be given to those constituents that currently are of most concern, including copper and uranium.

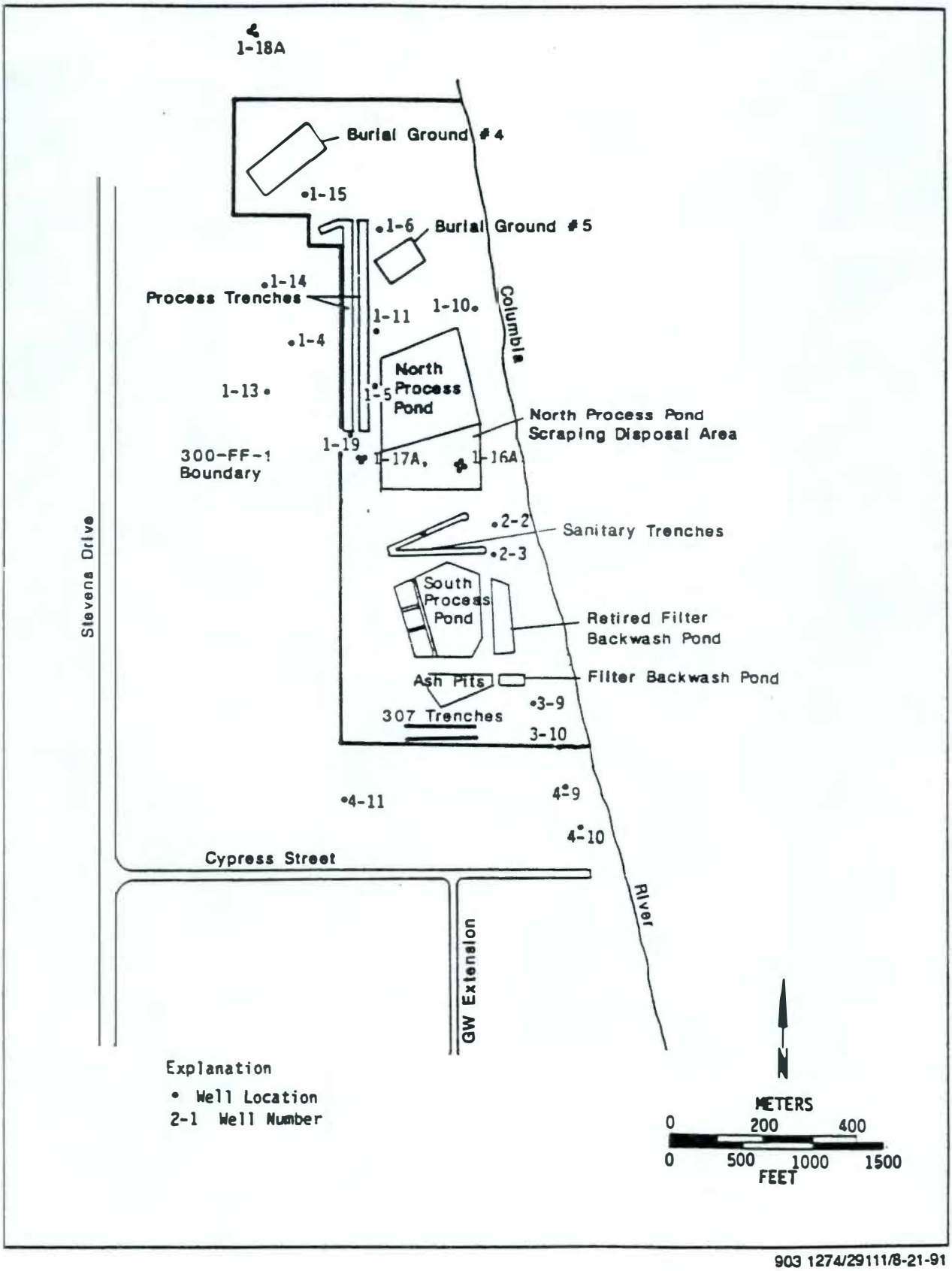

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Figure 4-1. Suitable Groundwater Monitoring Wells for the Process Trenches.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Elevated concentrations of aluminum, antimony, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium, and uranium have been detected in sediments and near-surface soils in the 300 Area Process Trenches. At the present time, it appears that the only groundwater contaminants of concern associated with the Process Trenches are uranium, copper, and chloroform. Chloroform concentrations are below drinking water standards and appear to be due to pre-treatment of the process water. Elevated copper and uranium groundwater concentrations are evidently due to leaching of these constituents from sediments and soils near the bottom of the Process Trenches. Other constituents that are present in Process Trench sediments appear to be retained within these sediments and are not found at elevated concentrations in groundwater. An ERA is currently being implemented to remove the majority of the contaminated sediments and soils in the bottom of the trenches.

It is anticipated that following completion of the ERA, groundwater concentrations of copper and uranium will decrease with time. Further discharge to the Process Trenches will likely transport remnant copper and uranium in the vadose zone to the saturated zone. However, the impact on groundwater concentrations is expected to be small, or indiscernible, because the uranium and copper that remain in the vadose zone beneath the trenches are predicted to contribute only an additional 3-percent uranium and 6-percent copper to the quantities that are already in the unconfined aquifer. These estimates do not account for small amounts of soluble particulate uranium and copper that may remain in the bottom of the trenches. The potential impacts from residual particulates will be further evaluated upon receipt of analytical results from soil sampling in the trench bottoms following the ERA.

5.2 RECOMMENDATIONS

The following recommendations are intended to allow continued assessment of the environmental impact of effluent discharge to the Process Trenches, should such discharge be continued.

1) Sample influent for chloroform:

   Chloroform appears to be the only contaminant remaining in the process sewer effluent that may be affecting groundwater, although concentrations are below water quality standards. It is recommended that periodic samples of the process sewer be obtained and analyzed for chloroform to ensure that concentrations do not rise above water quality standards.

2) Monitor uranium concentrations in down-gradient wells:

   It is expected that uranium concentrations in groundwater will decrease due to implementation of the ERA. In order to confirm this prediction, routine sampling of

several wells near the south end of the Process Trenches is recommended. Wells 1-19 and 1-17A are best suited for such monitoring.

3) Conduct leaching tests of soils in the trench bottoms:

As discussed above, soluble uranium and copper in particulate form may remain in the bottom of the trenches, and could provide a source of additional mass not accounted for in this study. Leaching tests on soil samples from the trench bottoms could provide an estimate of the additional impact of particulate copper and uranium. The need for such testing should be evaluated after analytical results are available for soil samples from the trench bottoms.

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7. Abstract

This document summarizes the results of the radiological surveys conducted over the entire surface of the 316-5 Process Trench Site. In addition, this document explains the survey methodology using the Ultrasonic Ranging and Data System (USRADS) automatic data recording equipment to monitor the gross gamma radiation levels of the surface soil.

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316-5 PROCESS TRENCH SITE

USRADS SURVEYS

Pre and Post Remediation

Author
MARC WENDLING
Occupational Health and Safety
Site Investigative Surveys

Reviewed by
C.D. WADE
Occupational Health and Safety
Site Investigative Surveys

316-5 PROCESS TRENCH USRADS SURVEYS

SCOPE

This report summarizes the results of the radiological surveys conducted over the entire surface of the 316-5 Process Trench Site,300 Area, Hanford Site, Richland, Washington. In addition, this report explains the survey methodology using the Ultrasonic Ranging and Data System (USRADS) automatic data recording equipment.

The radiological surveys of the 316-5 PT Site, along with the background study, were conducted by Site Investigative Surveys, Occupational Health and Safety organization of the Westinghouse Hanford Company. The survey methodology was based on utilization of the Ultrasonic Ranging and Data System (USRADS) for automated recording of the gross gamma radiation levels of the surface soil.

INSTRUMENTATION

Two surveys were conducted at the PT site. The first survey was conducted in February, 1991 prior to remediation activities. The Pre-Remediation survey was performed using a Ludlum Model 2221 count rate meter with a 1" X 1" NaI Ludlum Model 44-2 radiation detector. A post remediation survey was conducted in late October, early November, 1991 utilizing both the 2221/44-2 NaI count rate meter and a Ludlum Model 19 uR meter.

The radiological surveys were conducted by interfacing the contamination/radiation detection instrument(s) with a CHEMRAD Tennessee Corp. Series 2000 USRADS. The count rate meter was set for gross counting, i.e., window "out". The window setting allows detection of low, intermediate and high energy photons. The USRADS equipment is used to record the detector readings verses the location of the readings, generate a map of the survey area and save the data on computer storage mediums.

One of the features of the USRADS is the ability to enter a "Threshold" setting upon initiating a survey. The threshold setting is a value that when exceeded, will highlight the data point plotted on the CPU monitor. This feature alerts the CPU operator that the cpm data has exceeded the threshold, or preset value. For the purpose of conducting the 316-5 PT surveys, it was desired to establish a value for the threshold where readings above the setting could be considered surface contamination. The threshold value established for the entire 316-5 Process Trench Site survey was twice the background count rate determined at the Low Background Test Site (Appendix) or 3,900 cpm. This value is valid based on the premise that too low a setting would highlight normal fluctuations above the calculated mean, and too high a setting would cut off the low end of surface contamination that might be present.

METHODOLOGY

Prior to performing the surveys, a grid block system was utilized at the site in order to establish horizontal control and tie the individual surveys together. Each survey of the area entailed setting up the USRADS equipment in a grid block; connecting the radiation survey meter(s) to the USRADS Data Pack; calibrating the USRADS equipment and performing the survey. Calibration of the USRADS is performed prior to starting a survey. The purpose to the calibration sequence is to reestablish the positioning of instrumentation after the equipment is moved to a new location.

Each grid block was traversed in a cross hatched pattern on approximately ten foot centers.The gamma detector was maintained 6 inches from the soil surface by suspending the detector from a boom attached to the surveyors backpack. For the post remediation survey a uR detector was also mounted approximately three feet above the soil surface. Detector geometry remained relatively constant throughout the entire survey. Survey speed was approximately one meter/sec.

As the surveyor traverses the survey area, the USRADS records the output data from the radiation detector verses the location of where in the survey area the data was detected - each second. Therefore, while the survey is in progress, a real-time map of the survey area is generated. When the survey is completed, the survey data set is saved on a computer disk.

Radiation survey instruments were checked at the beginning of each day for the proper instrument response. This was accomplished by placing a Uranium Check Source next to the detector and observing the instrument's response to the source. Local background radiation checks were also performed. This involved taking three-one minute counts and calculating the average of the three counts.

RESULTS

For both surveys the entire fenced area at the Process Trench Site was surveyed, with the exception of the steep embankments and the covered trenches themselves. This fenced area encompasses approximately 423,200 sq. feet or 9.7 acres.

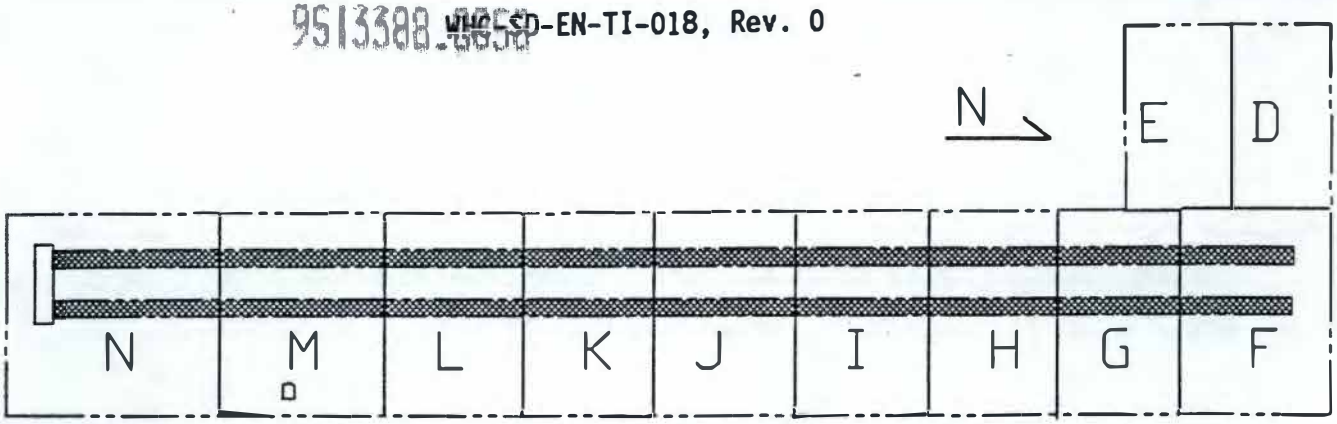
The pre-remediation survey consisted of eleven individual USRADS surveys collecting 30,453 data points. Page 3 shows the grid block layout for the site and the table summarizes the individual survey statistics.

The post-remediation survey also consisted of eleven surveys totaling 29,356 data points. It is summarized on page 4.

Page 5 is a composite survey track map of both pre and post-remediation surveys. Data points greater than 3900 CPM with the NaI detector (>MDC) are highlighted in red (boldface if black and white report copy).

On pages 6 and 7 are 3-D graphic maps of the site with the Z axis representing the NaI detectors count rates.

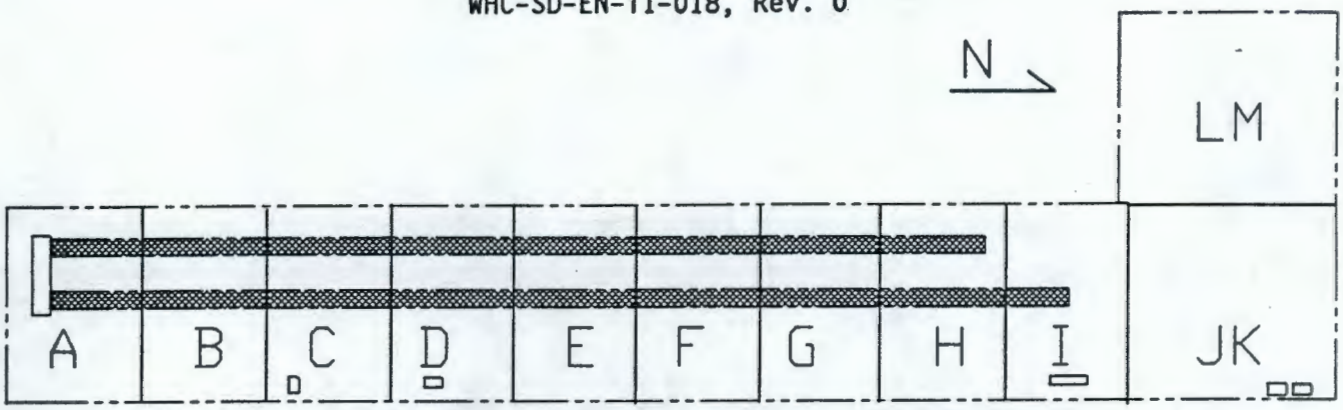
Appendixes A and B are USRADS software generated track maps of the individual pre and post-remediation surveys respectively. Appendix C is a summary of the Low Background Site survey where background levels were determined.



PRE-REMEDIATION USRADS SURVEYS GRID LAYOUT FEB 1991

NaI COUNT RATE METER SURVEY STATISTICS

SURVEY	DATE	GRID	DATA PTS	MAX CPM	MEAN CPM	SD CPM
316-5D	02/12/91	D	3006	14940	3560.94	2473.91
316-5E	02/13/91	E	3209	13260	3592.22	2039.94
316-5F	02/14/91	F	2516	6380	2099.63	609.67
316-5G	02/15/91	G	2646	3580	2070.43	299.04
316-5H	02/17/91	H	2514	3500	1867.43	291.25
316-5I	02/20/91	I	2695	3800	2004.36	311.07
316-5J	02/22/91	J	2410	3400	2079.57	273.62
316-5K	02/23/91	K	2332	4680	2402.67	492.15
316-5L	02/25/91	L	2438	6300	2566.42	570.27
316-5M	02/26/91	M	2713	7580	3029.97	864.57
316-5N	02/27/91	N	3974	10840	3468.03	1219.84



POST-REMEDIATION USRADS SURVEYS GRID LAYOUT OCT/NOV 1991

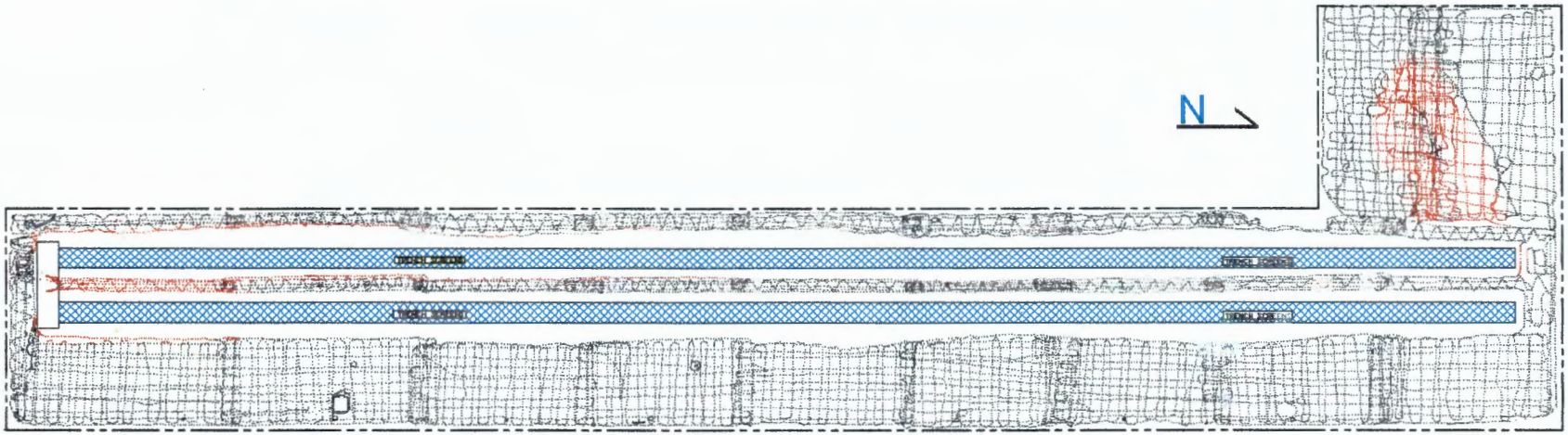
NaI COUNT RATE METER SURVEY STATISTICS

SURVEY	DATE	GRID	DATA PTS	MAX CPM	MEAN CPM	SD CPM
316-5A	10/26/91	A	2154	2740	2000.5	233.95
316-5B	10/26/91	B	1989	2780	1935.14	235.5
316-5C	10/27/91	C	1812	2660	1852.43	210.38
316-5D	10/27/91	D	1931	2500	1772.44	188.46
316-5E	10/27/91	E	1996	2740	1725.95	205.47
316-5F	10/27/91	F	1875	2340	1687.3	191.36
316-5GA	11/02/91	G	1968	2320	1691.19	182.41
316-5HA	11/02/91	H	1997	2320	1683.55	197.49
316-5IA	11/02/91	I	3031	2220	1614.6	176.59
316-5JKA	11/03/91	J+K	4721	2400	1656.82	187.24
316-5LMA	11/03/91	L+M	5882	2620	1666.92	194.62

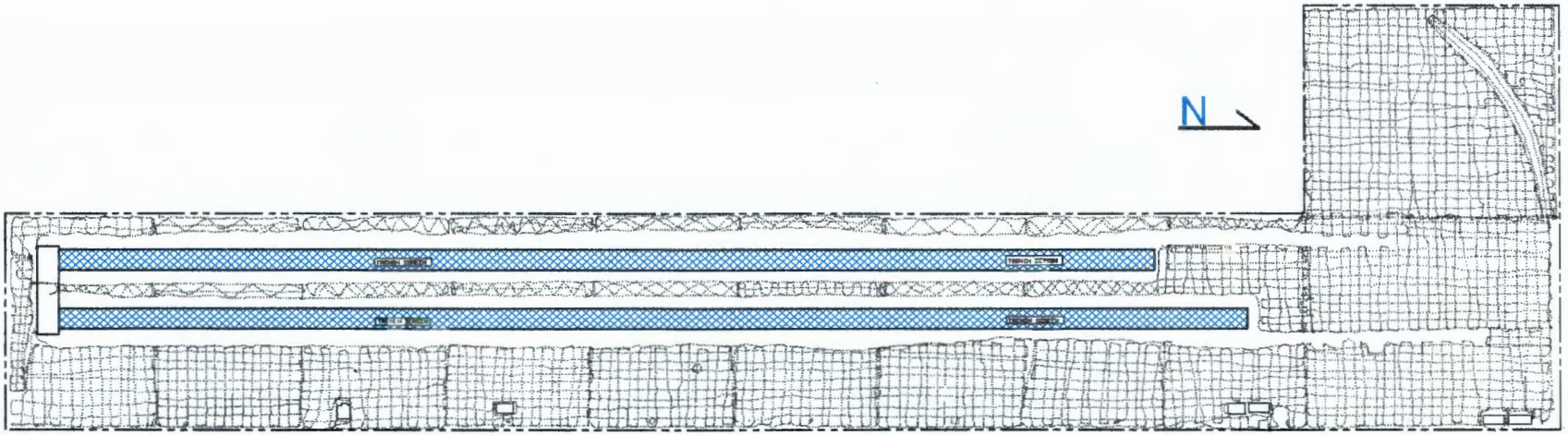
uR METER SURVEY STATISTICS

SURVEY	DATE	GRID	DATA PTS	MAX uR	MEAN uR	SD uR
316-5A	10/26/91	A	2154	17.52	11.75	1.48
316-5B	10/26/91	B	1989	16.22	11.13	1.45
316-5C	10/27/91	C	1812	15.22	10.54	1.22
316-5D	10/27/91	D	1931	14.02	10.1	1.15
316-5E	10/27/91	E	1996	14.82	9.75	1.22
316-5F	10/27/91	F	1875	13.32	9.25	1.08
316-5GA	11/02/91	G	1968	22.02	10.79	2.12
316-5HA	11/02/91	H	1997	23.52	10.95	2.66
316-5IA	11/02/91	I	3031	24.42	10.69	2.45
316-5JKA	11/03/91	J+K	4721	27.82	11.15	2.65
316-5LMA	11/03/91	L+M	5882	22.62	10.55	2.09

316-5 PROCESS TRENCHES USRADS SURVEYS



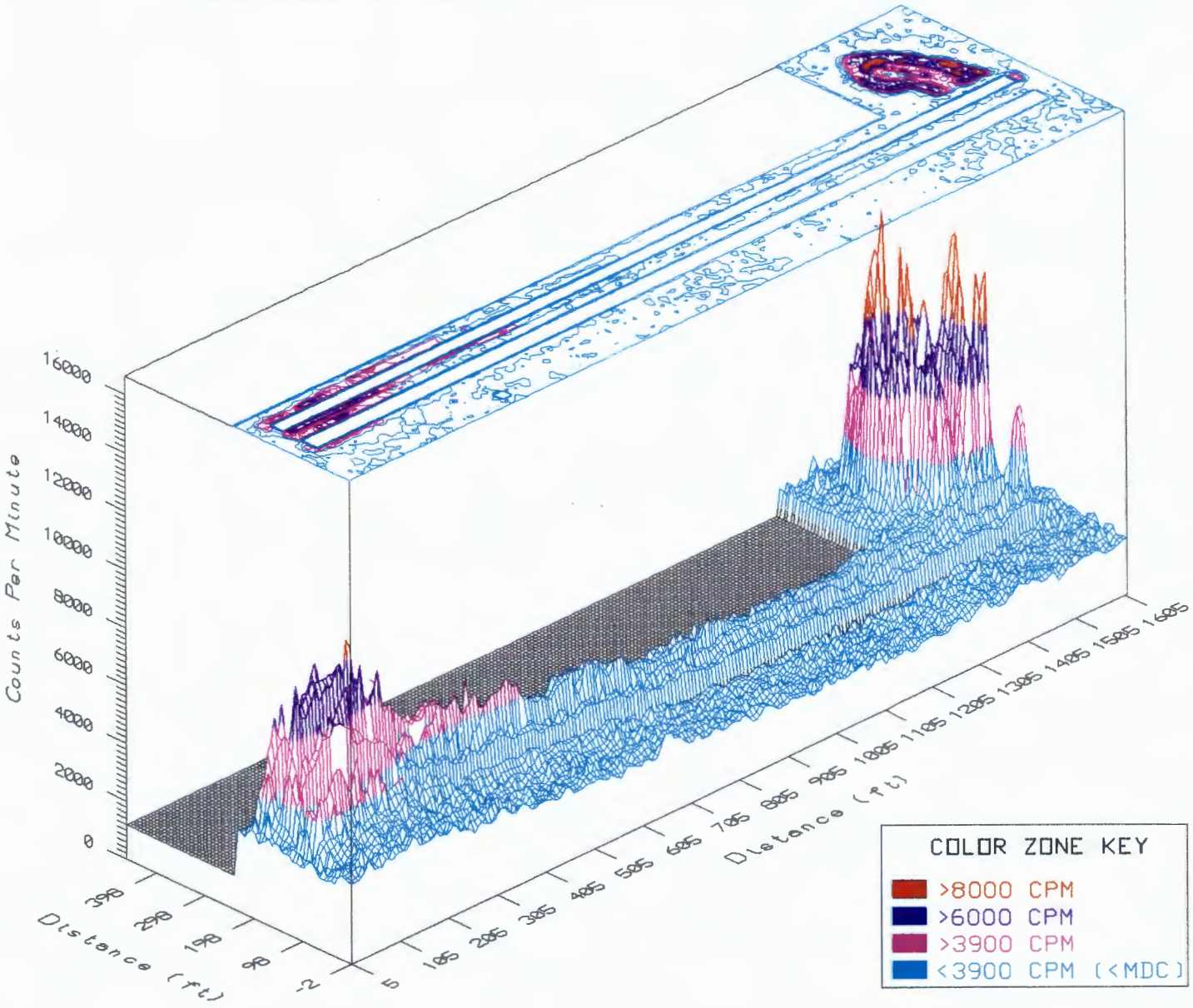
PRE-REMEDIATION USRADS SURVEY- COMPOSITE TRACK MAP FEB. 1991 (RED DENOTES >3900 CPM W/NaI)



POST-REMEDIATION USRADS SURVEY- COMPOSITE TRACK MAP OCT/NOV 1991

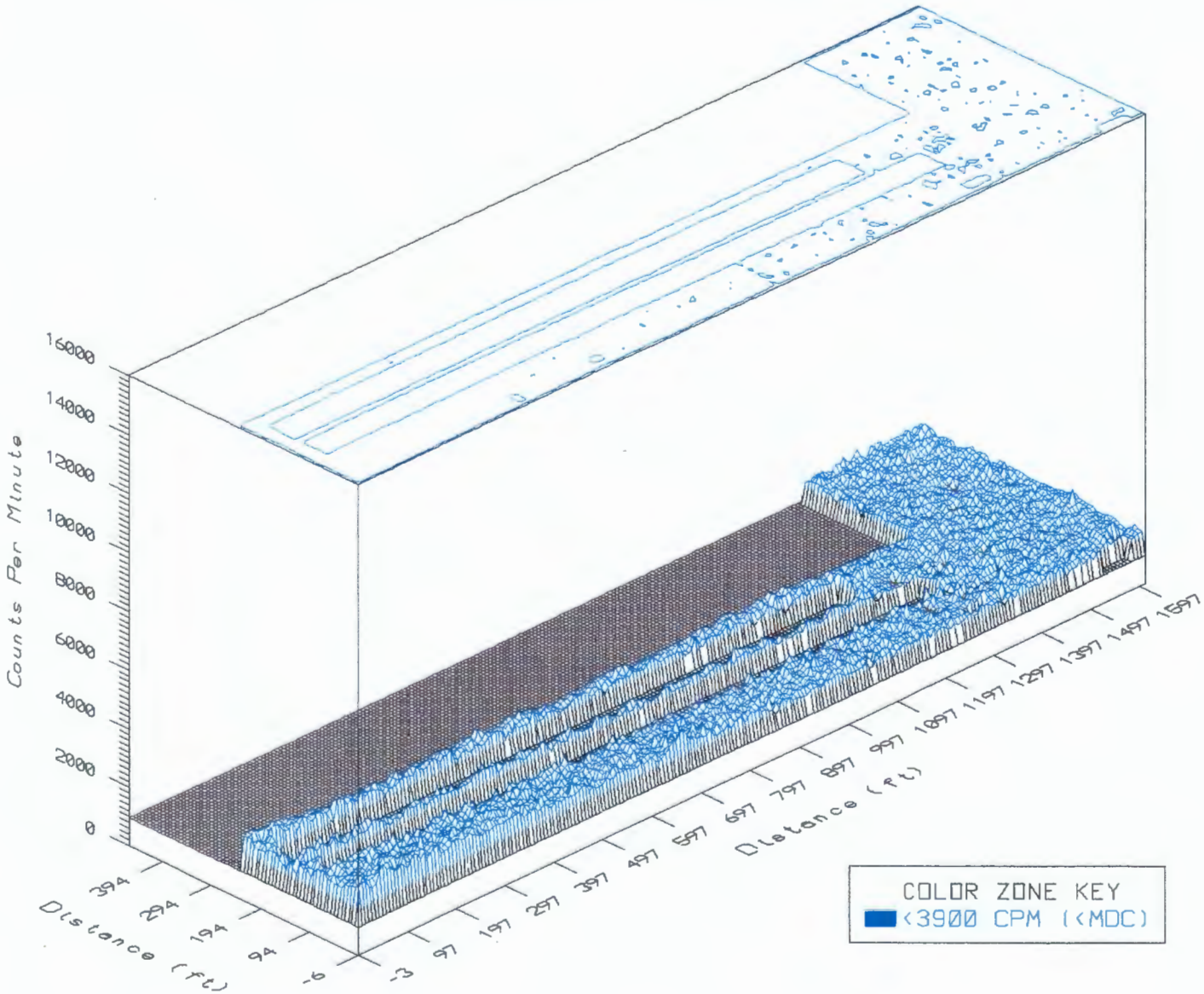
9513388.0859

Pre-Remediation Radiological Profile of 316-5 Process Trench Site



9513388.0861

Post-Remediation Radiological Profile of 316-5 Process Trench Site



316-5 PROCESS TRENCH SITE

USRADS SURVEYS

Pre and Post Remediation

APPENDIX A

Pre-Remediation Surveys

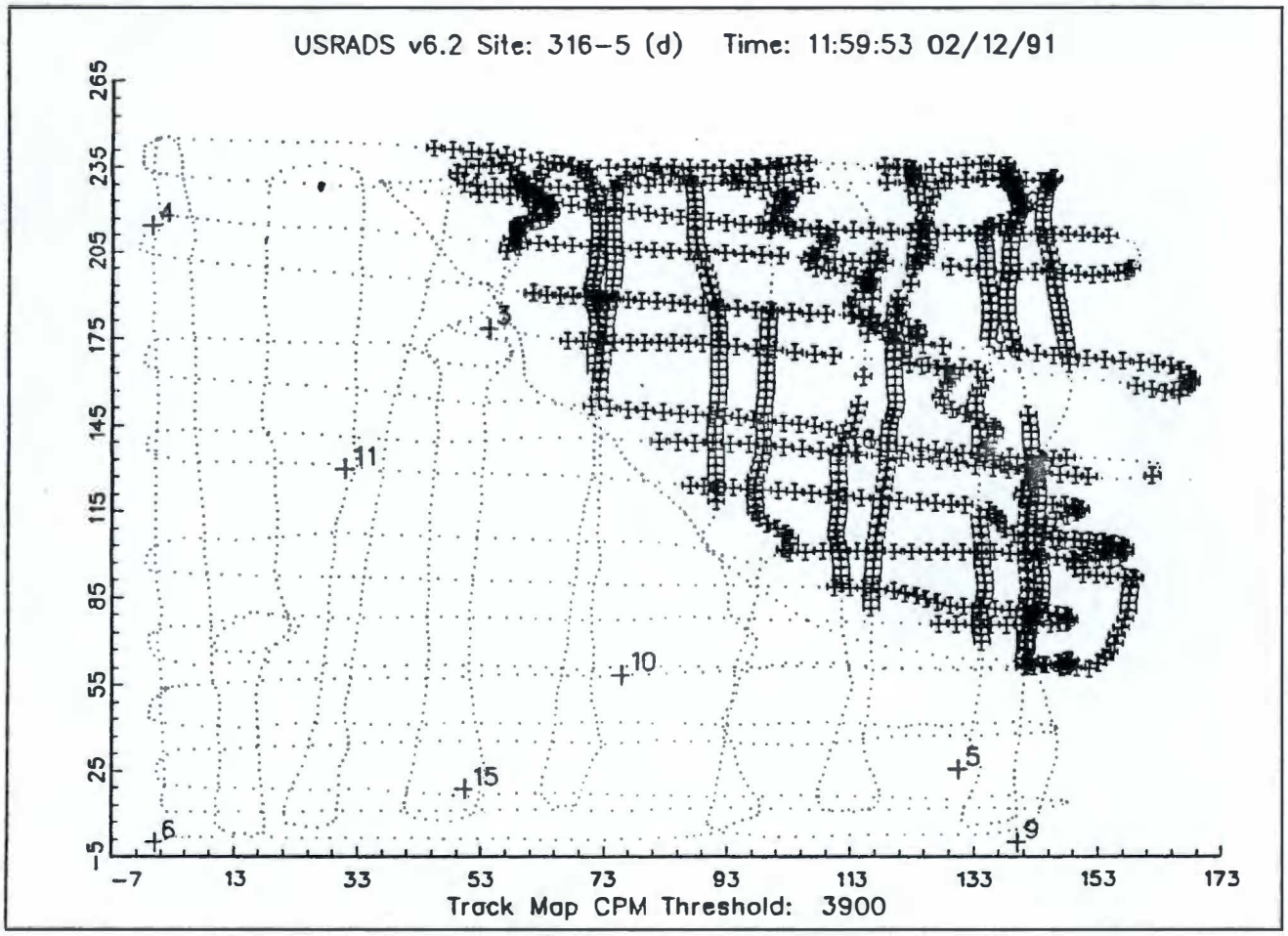
USRADS Software Generated Track Maps

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 3006 data points

The Statistics for the selected data signal are
min = 0.00 max = 14940.00 mean = 3560.94 stddev = 2473.91

Enter CPM display threshold : 3900

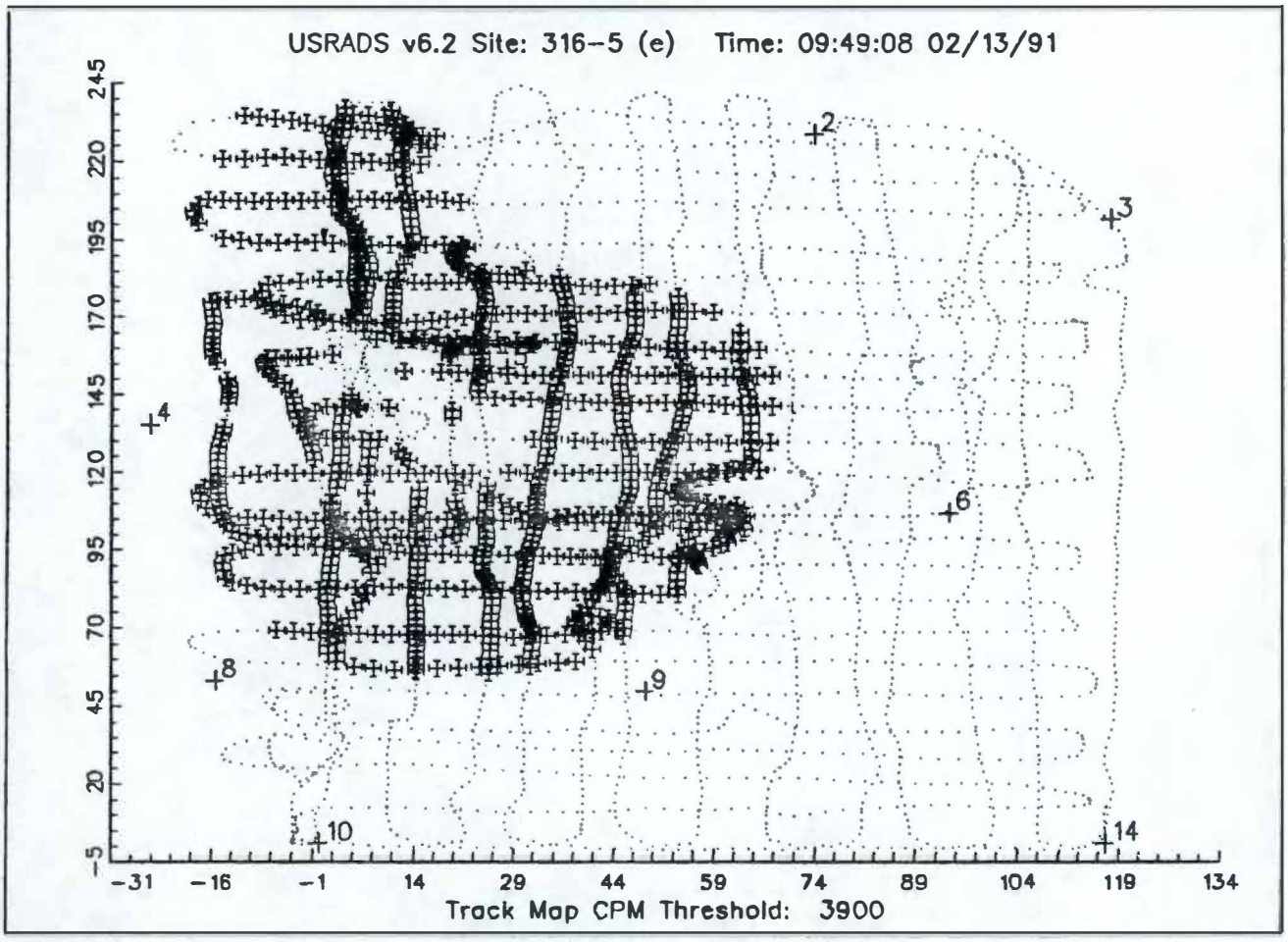


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 3209 data points

The Statistics for the selected data signal are
min = 1480.00 max = 13260.00 mean = 3592.22 stddev = 2039.94

Enter CPM display threshold : 3900

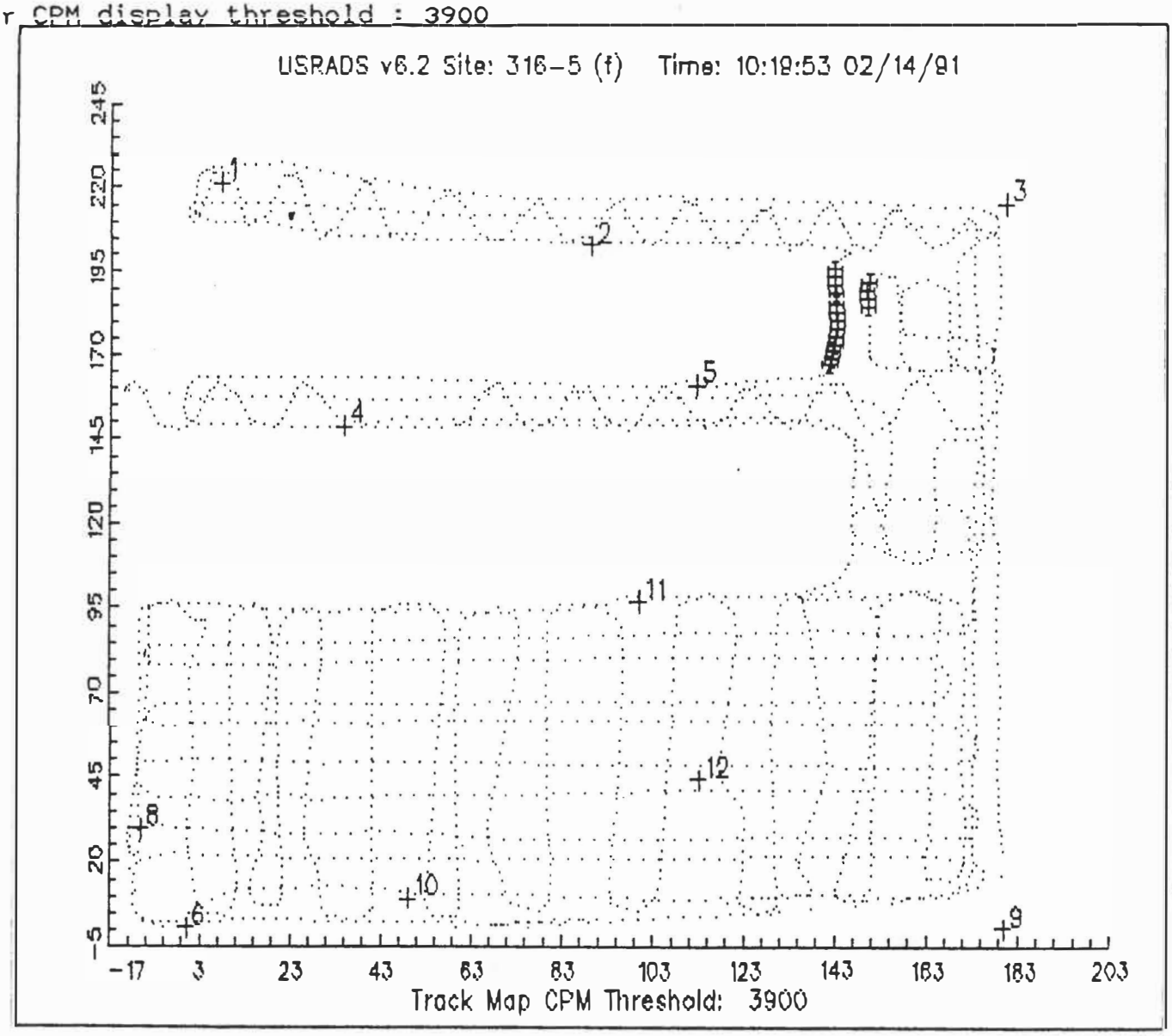


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2516 data points

The Statistics for the selected data signal are
min = 0.00 max = 6380.00 mean = 2099.63 stddev = 609.67

Enter CPM display threshold : 3900

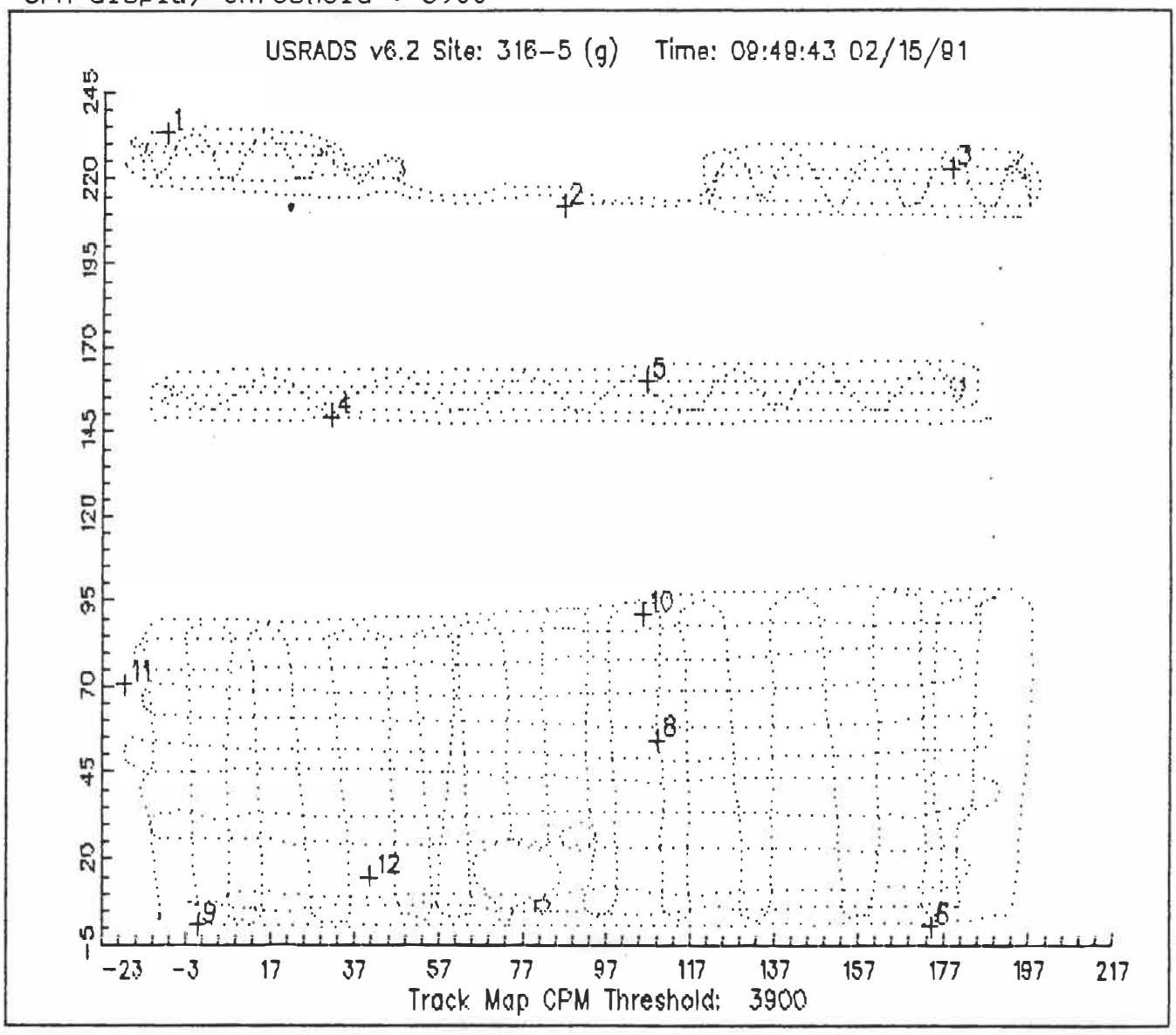


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2646 data points

The Statistics for the selected data signal are
min = 1160.00 max = 3580.00 mean = 2070.43 stddev = 299.04

Enter CPM display threshold : 3900

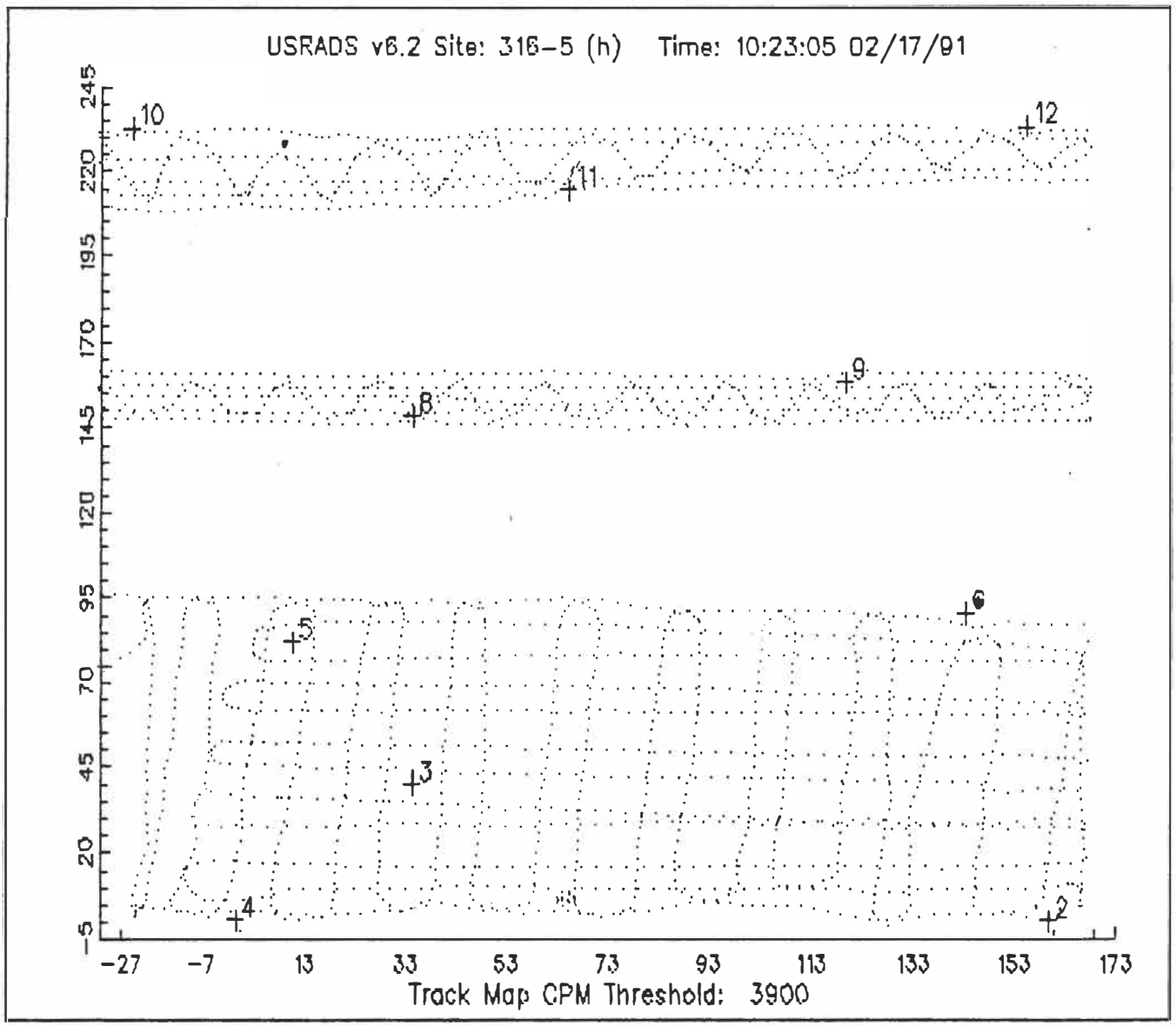


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2514 data points

The Statistics for the selected data signal are
min = 1180.00 max = 3500.00 mean = 1867.43 stddev = 291.25

Enter CPM display threshold : 3900

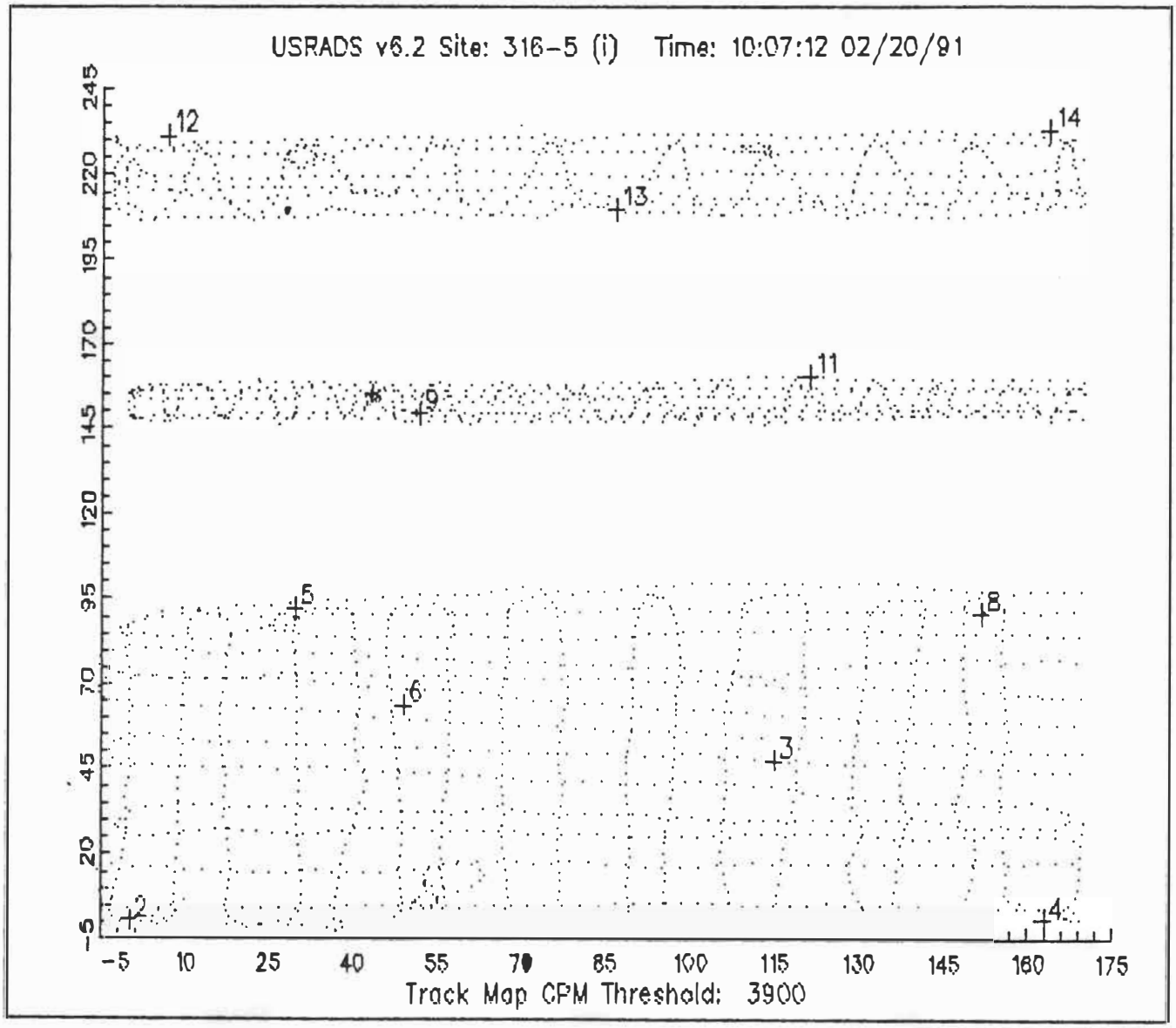


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2695 data points

The Statistics for the selected data signal are
min = 1280.00 max = 3800.00 mean = 2004.36 stddev = 311.07

Enter CPM display threshold : 3900

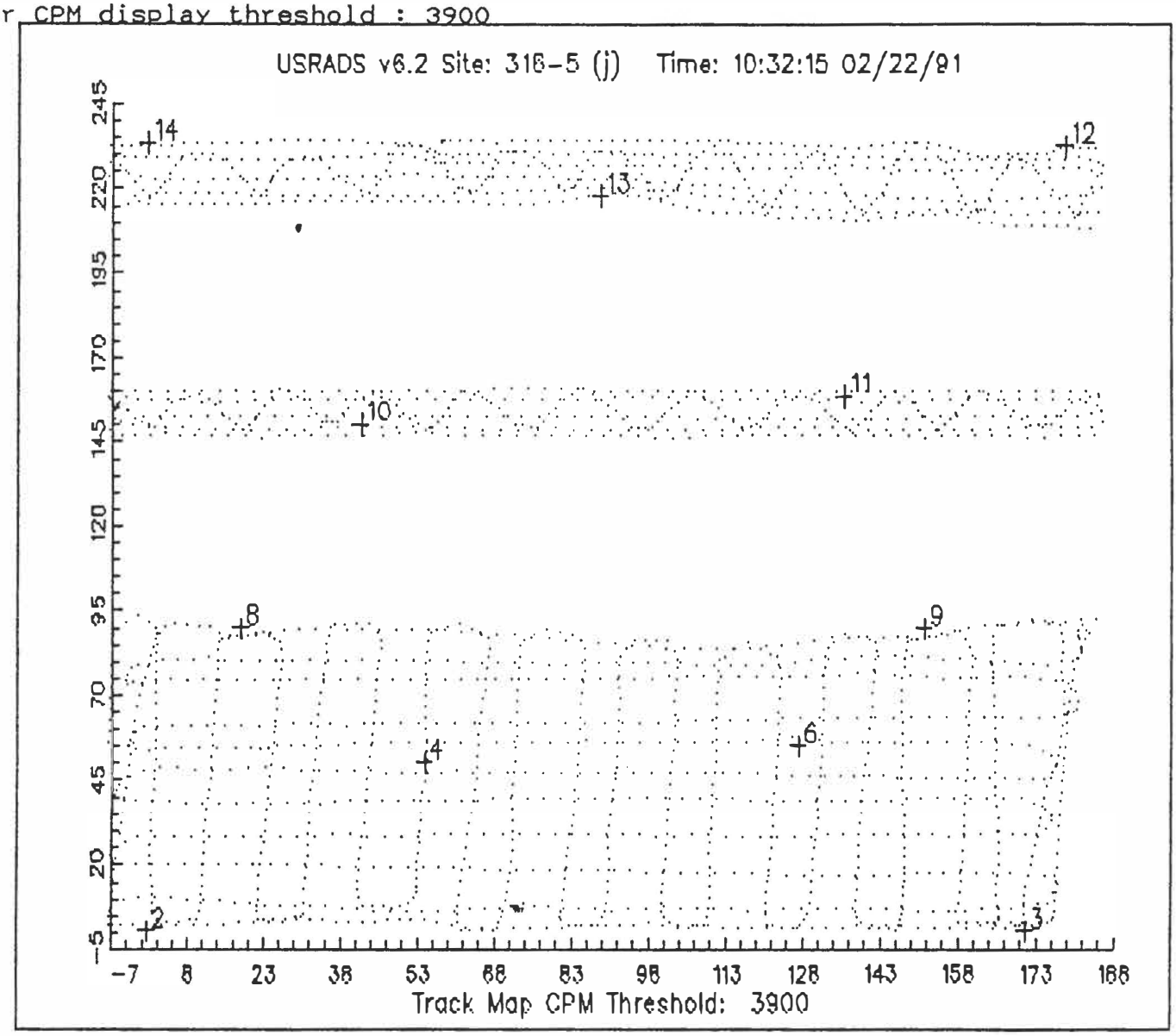


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2410 data points

The Statistics for the selected data signal are
min = 1320.00 max = 3400.00 mean = 2079.57 stddev = 273.62

Enter CPM display threshold : 3900

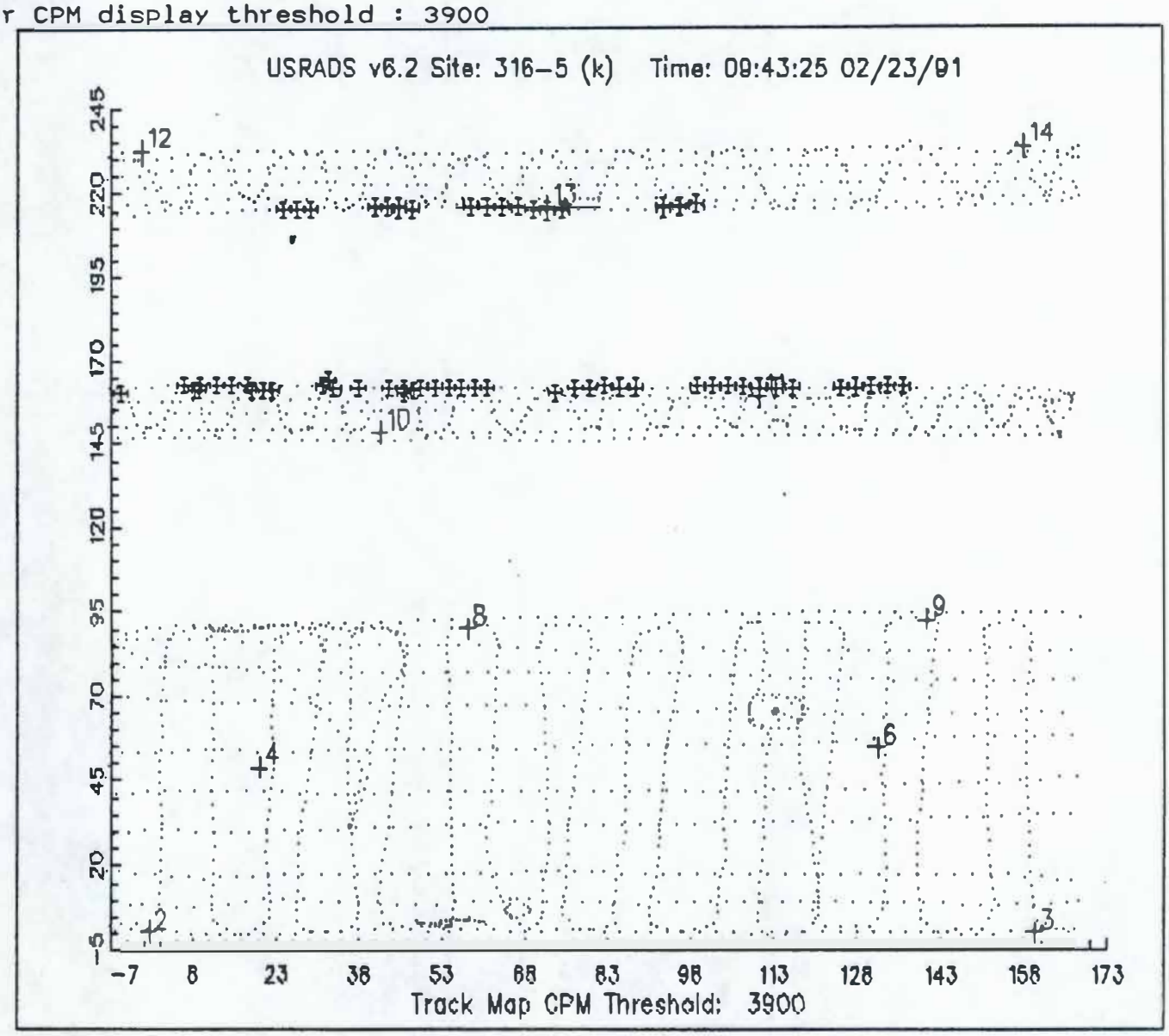


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2332 data points

The Statistics for the selected data signal are
min = 1500.00 max = 4680.00 mean = 2402.67 stddev = 492.15

Enter CPM display threshold : 3900

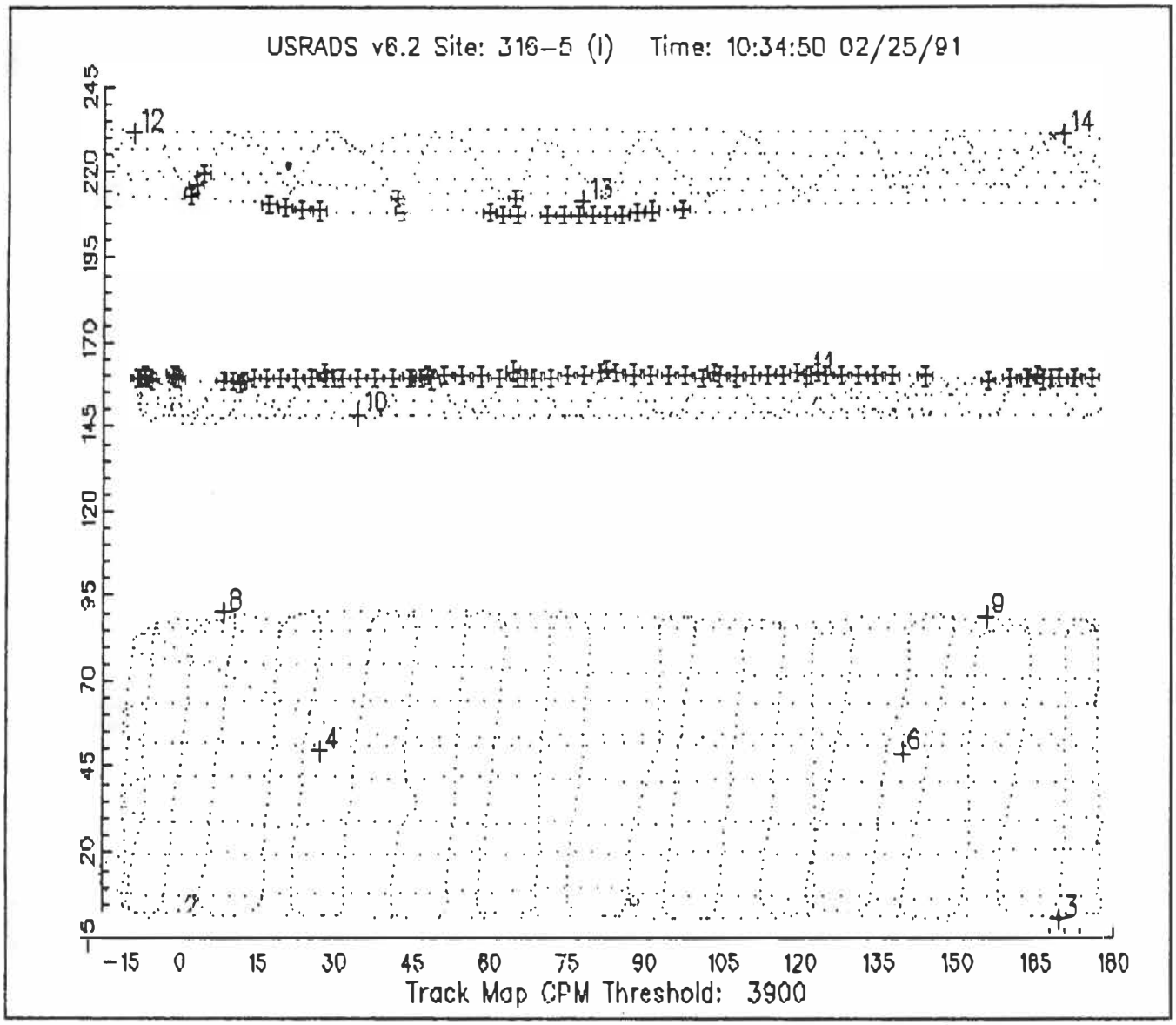


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2438 data points

The Statistics for the selected data signal are
min = 1580.00 max = 6300.00 mean = 2566.42 stddev = 570.27

Enter CPM display threshold : 3900

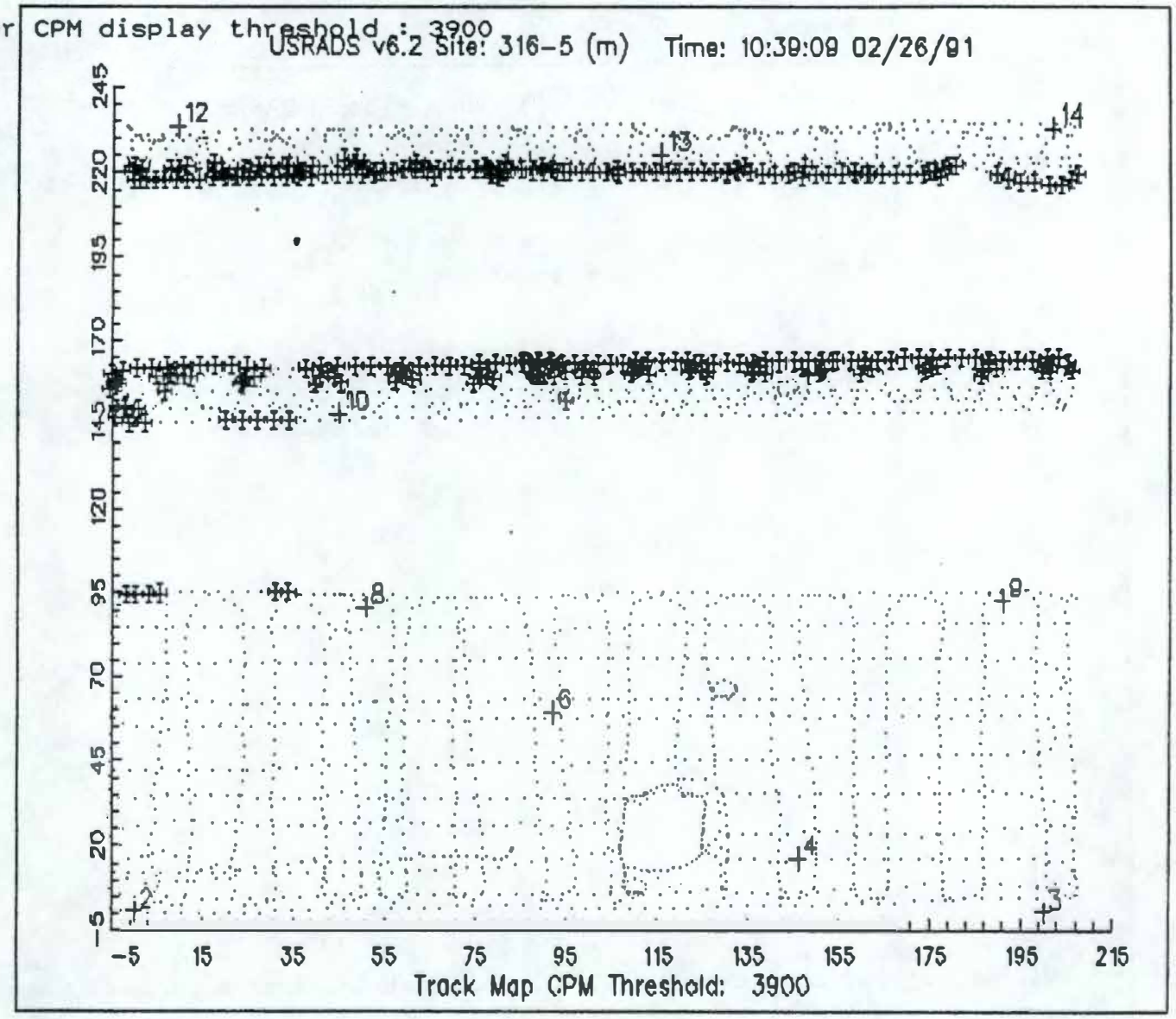


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2713 data points

The Statistics for the selected data signal are
min = 0.00 max = 7580.00 mean = 3029.97 stddev = 864.57

Enter CPM display threshold : 3900

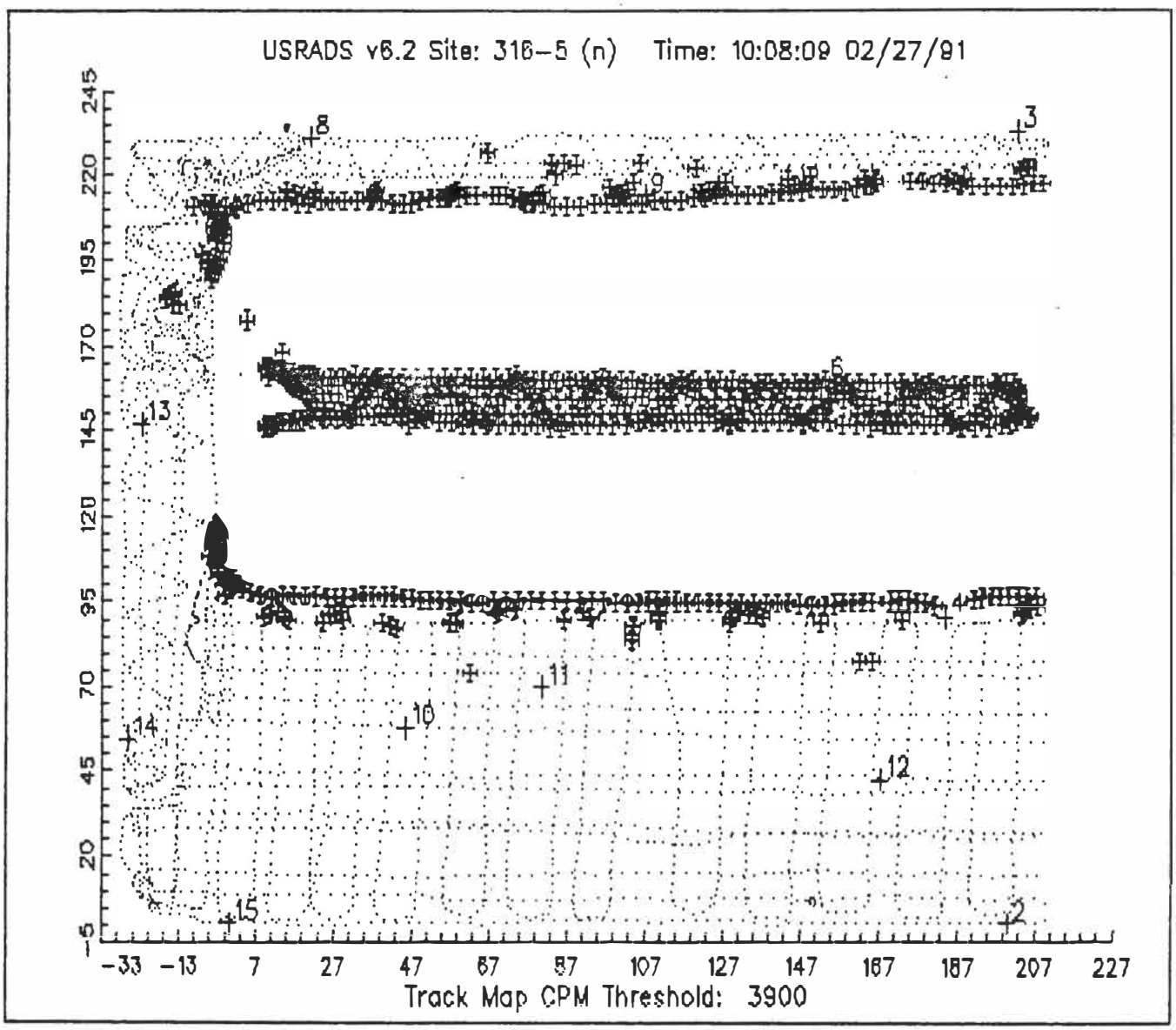


Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 3974 data points

The Statistics for the selected data signal are
min = 1880.00 max = 10840.00 mean = 3468.03 stddev = 1219.84

Enter CPM display threshold : 3900



316-5 PROCESS TRENCH SITE

USRADS SURVEYS

Pre and Post Remediation

APPENDIX B

Post-Remediation Surveys

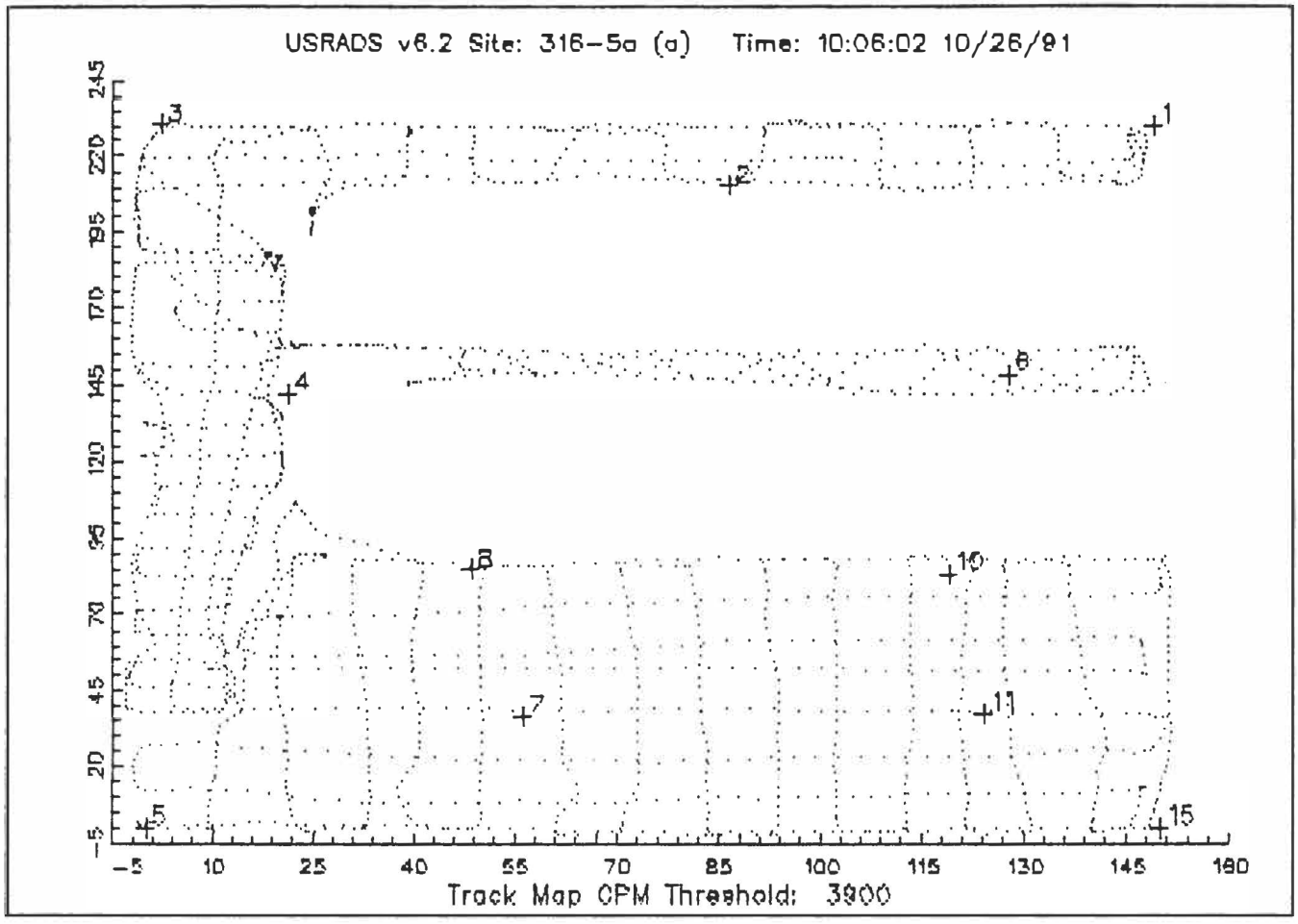
USRADS Software Generated Track Maps

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2154 data points

The Statistics for the selected data signal are
min = 1080.00 max = 2740.00 mean = 2000.50 stddev = 233.95

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 2154 data points

The Statistics for the selected data signal are
min = 6.52 max = 17.52 mean = 11.75 stddev = 1.48

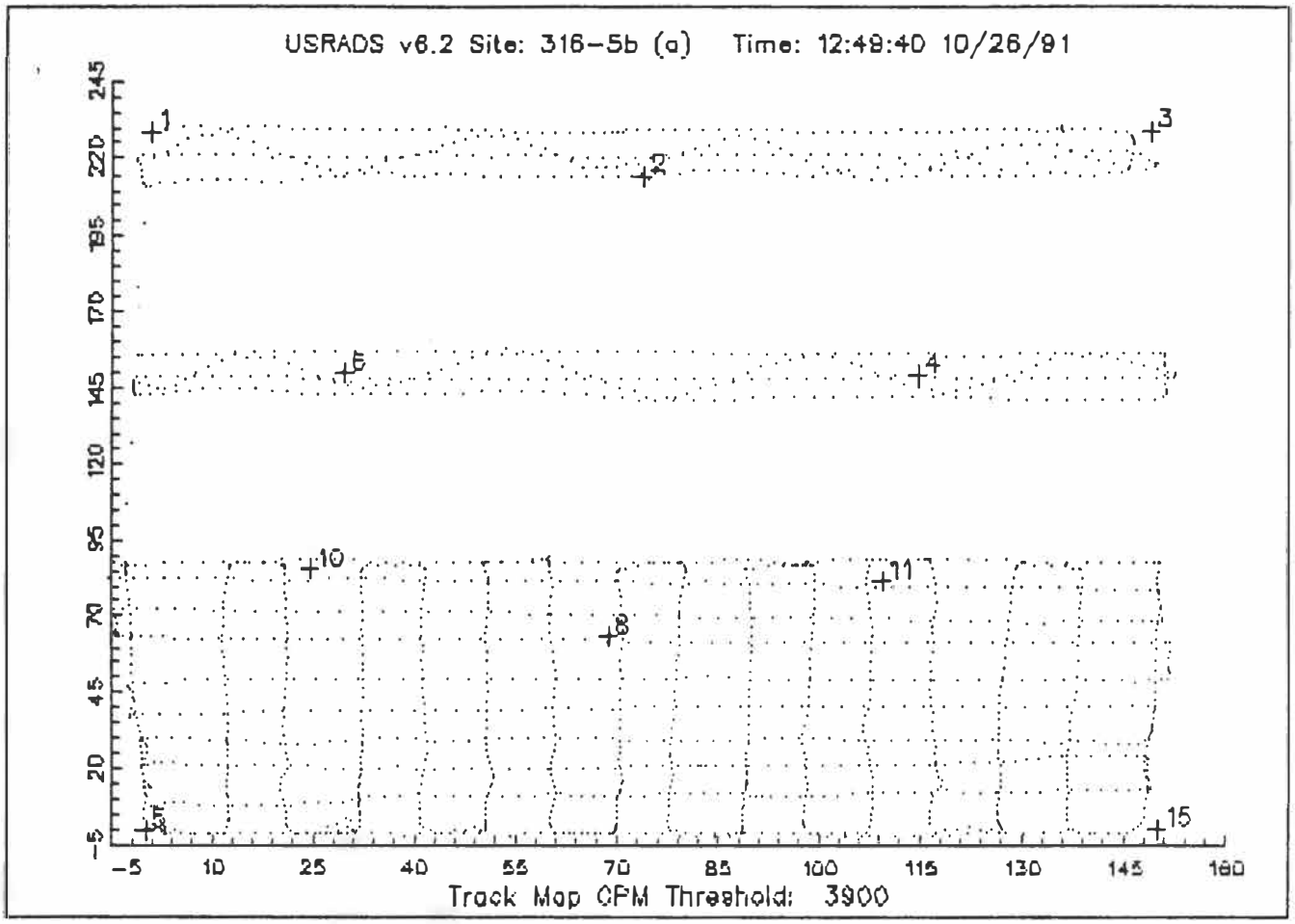
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1989 data points

The Statistics for the selected data signal are
min = 1120.00 max = 2780.00 mean = 1935.14 stddev = 235.50

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1989 data points

The Statistics for the selected data signal are
min = 6.92 max = 16.22 mean = 11.13 stddev = 1.45

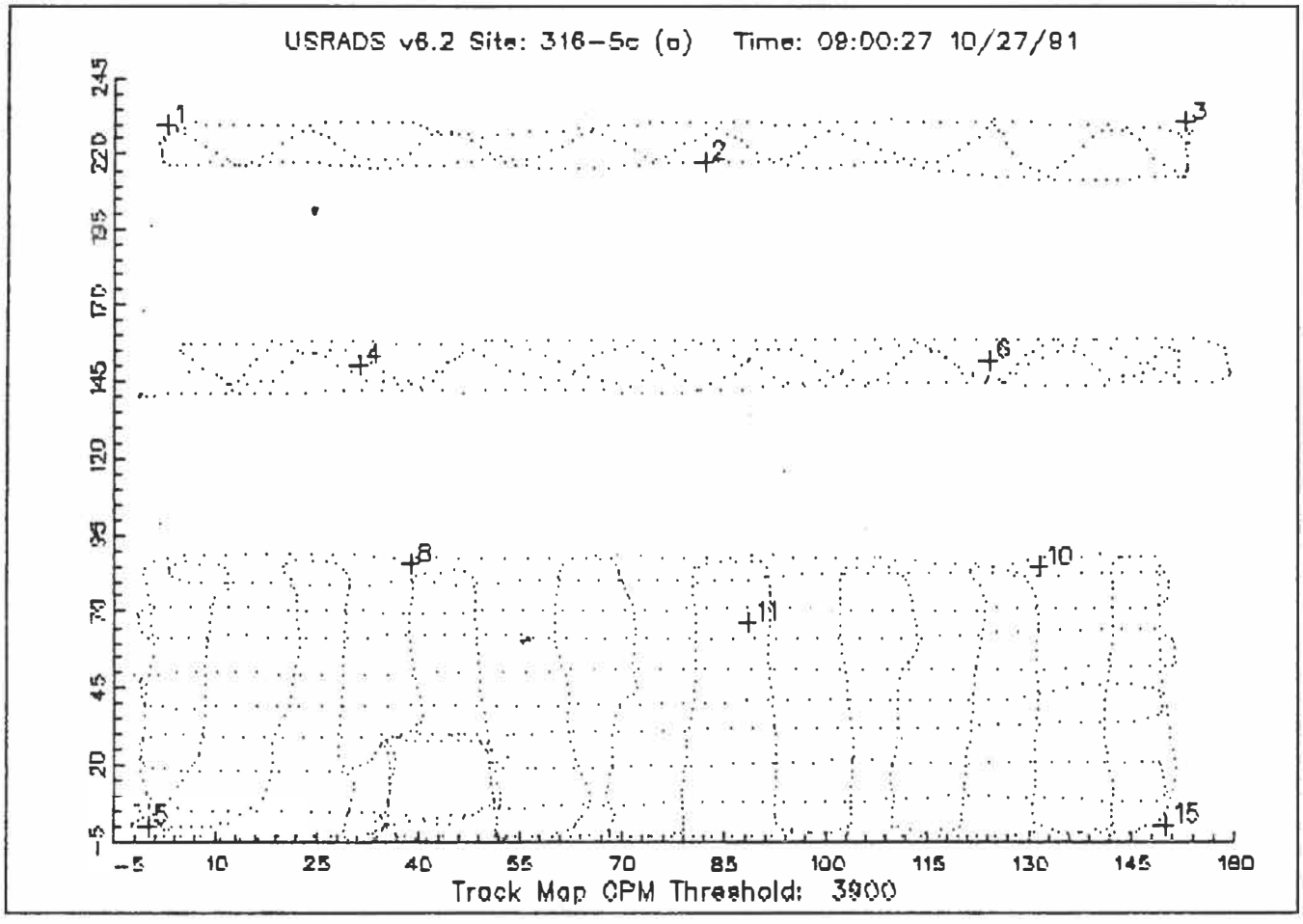
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1812 data points

The Statistics for the selected data signal are
min = 1120.00 max = 2660.00 mean = 1852.43 stddev = 210.38

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1810 data points

The Statistics for the selected data signal are
min = 7.22 max = 15.22 mean = 10.54 stddev = 1.22

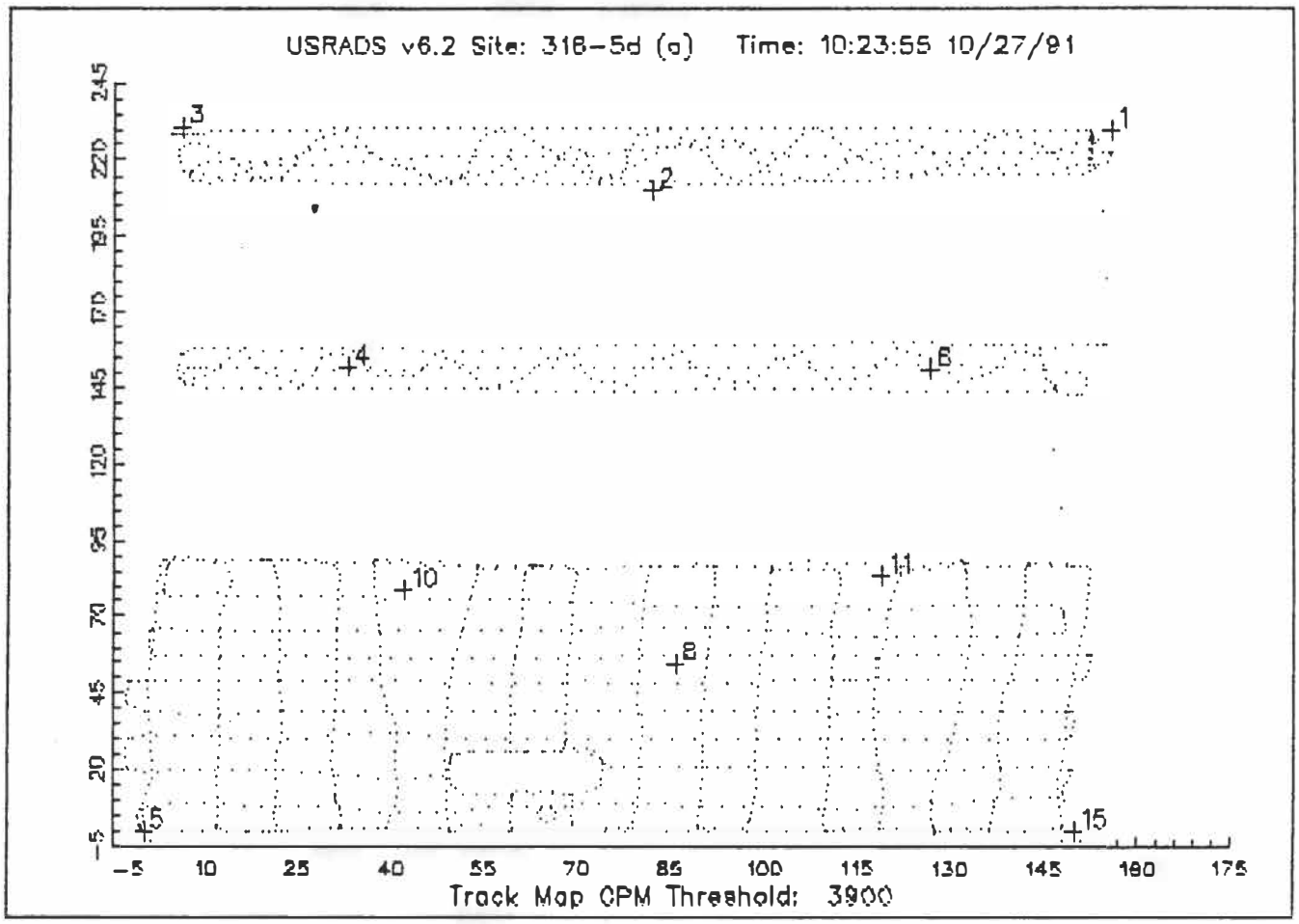
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1931 data points

The Statistics for the selected data signal are
min = 700.00 max = 2500.00 mean = 1772.44 stddev = 188.46

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1931 data points

The Statistics for the selected data signal are
min = 6.52 max = 14.02 mean = 10.10 stddev = 1.15

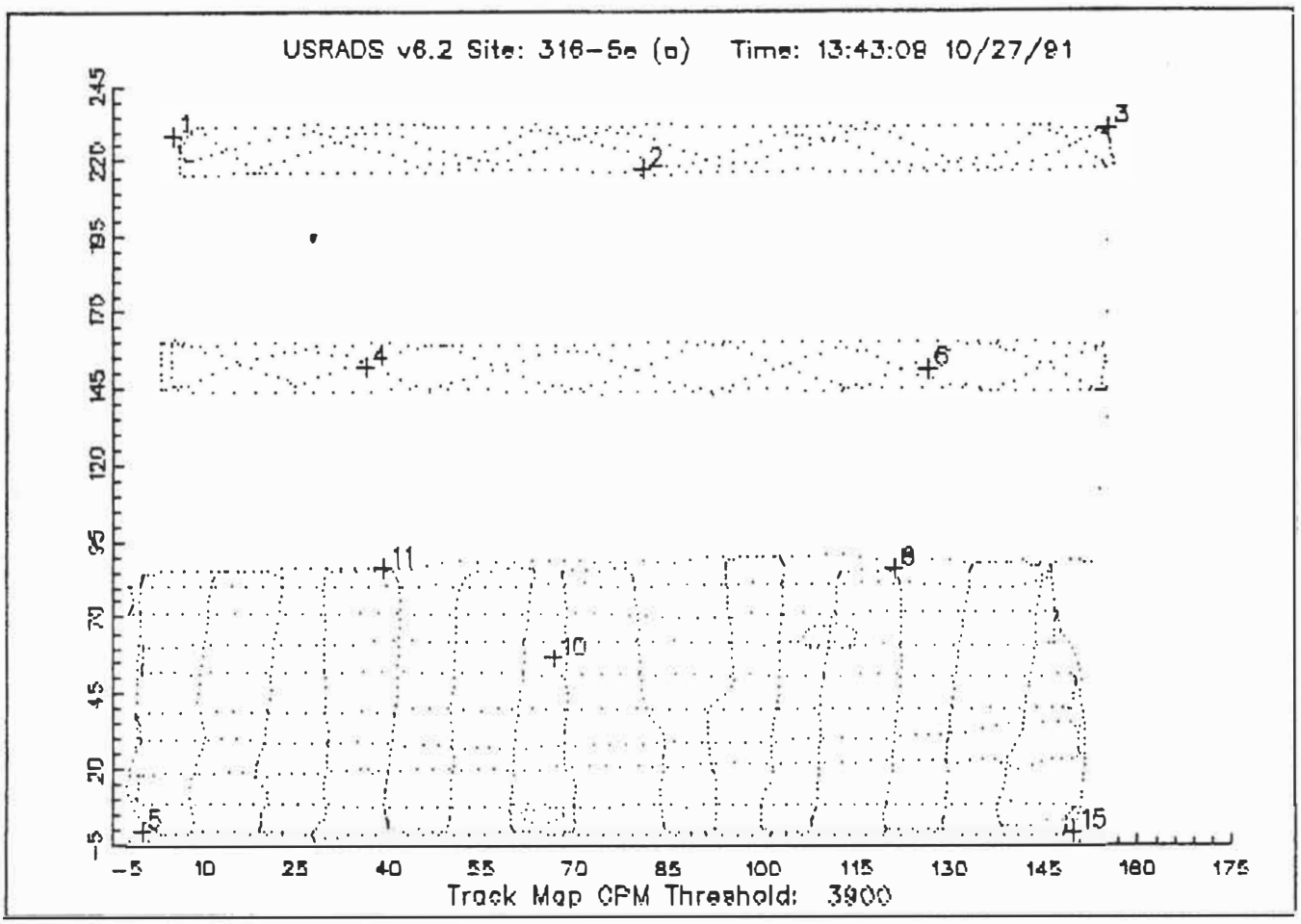
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1996 data points

The Statistics for the selected data signal are
min = 1200.00 max = 2740.00 mean = 1725.95 stddev = 205.47

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1996 data points

The Statistics for the selected data signal are
min = 6.12 max = 14.82 mean = 9.75 stddev = 1.22

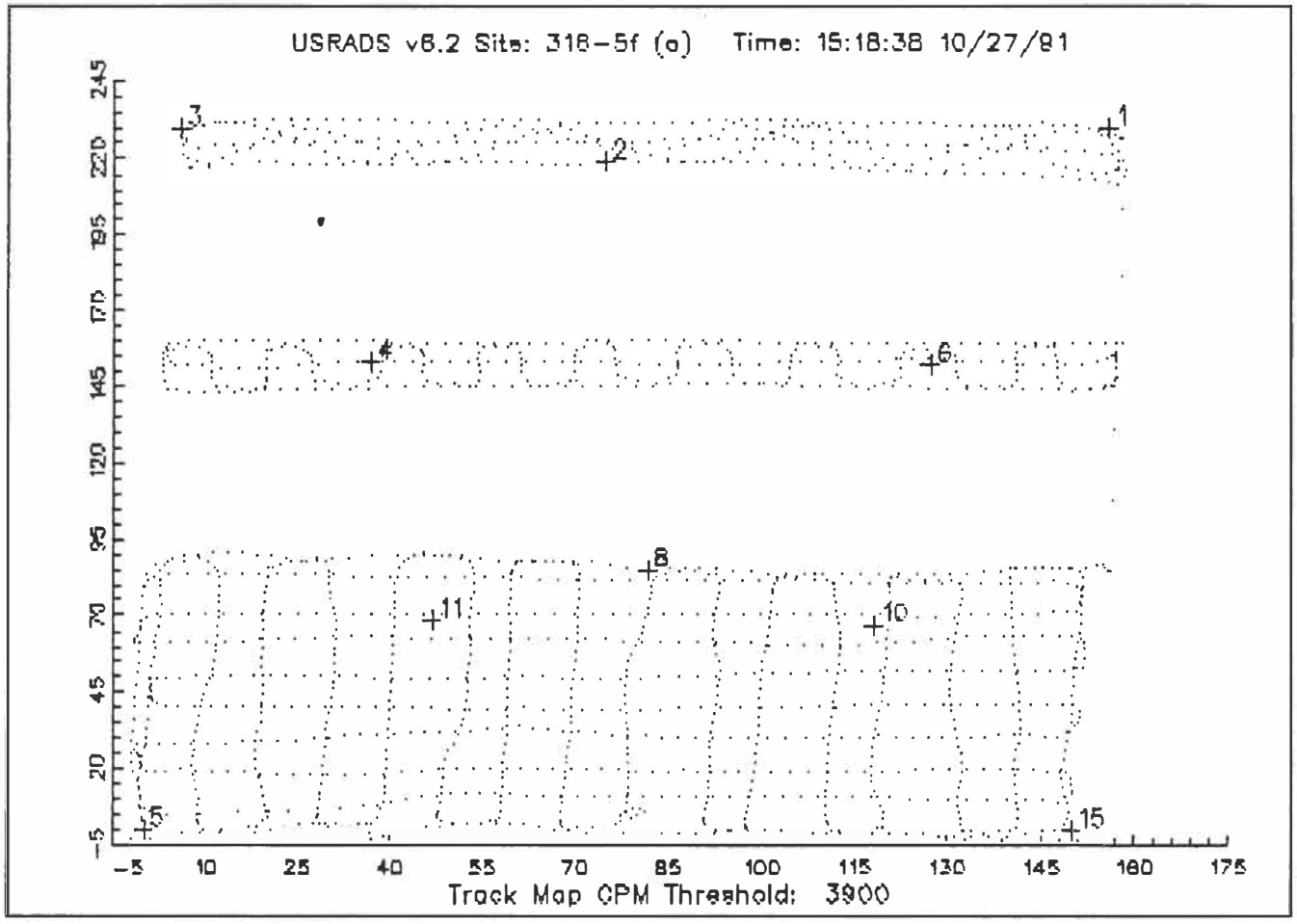
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1875 data points

The Statistics for the selected data signal are
min = 1140.00 max = 2340.00 mean = 1687.30 stddev = 191.36

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1875 data points

The Statistics for the selected data signal are
min = 5.82 max = 13.32 mean = 9.25 stddev = 1.08

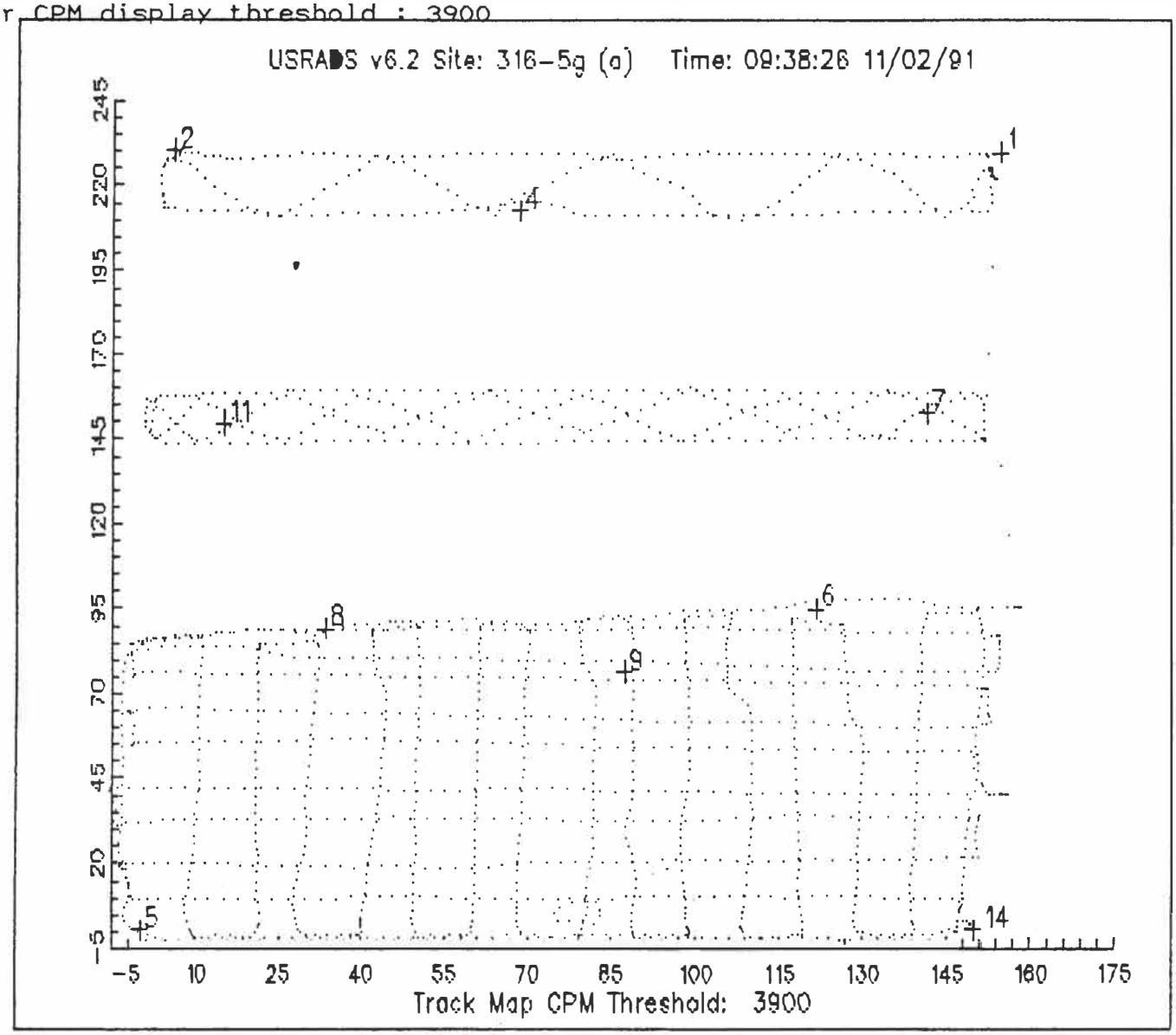
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1968 data points

The Statistics for the selected data signal are
min = 1040.00 max = 2320.00 mean = 1691.19 stddev = 182.41

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1968 data points

The Statistics for the selected data signal are
min = 6.72 max = 22.02 mean = 10.79 stddev = 2.12

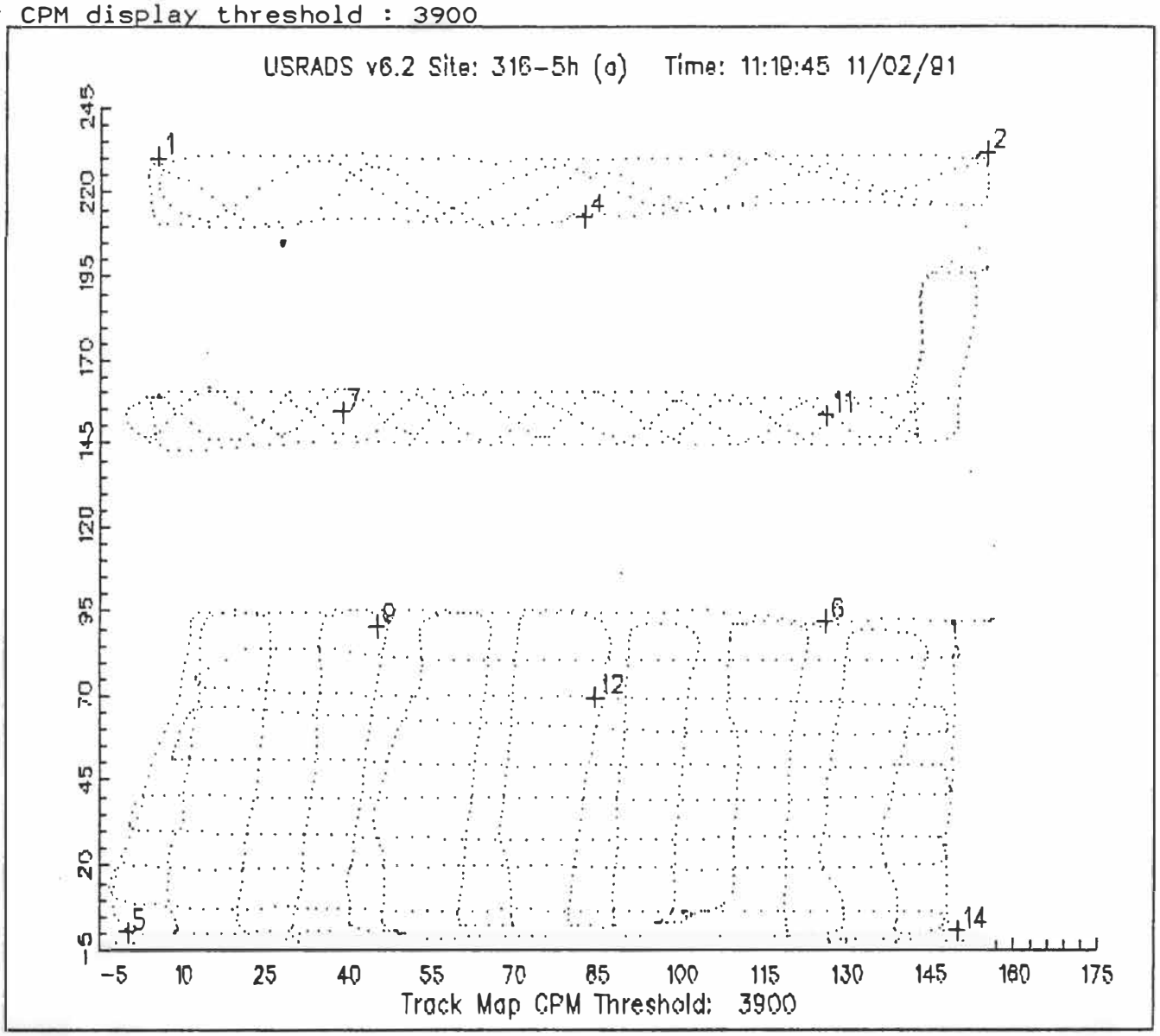
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1997 data points

The Statistics for the selected data signal are
min = 440.00 max = 2320.00 mean = 1683.55 stddev = 197.49

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 1997 data points

The Statistics for the selected data signal are
min = 6.12 max = 23.52 mean = 10.95 stddev = 2.66

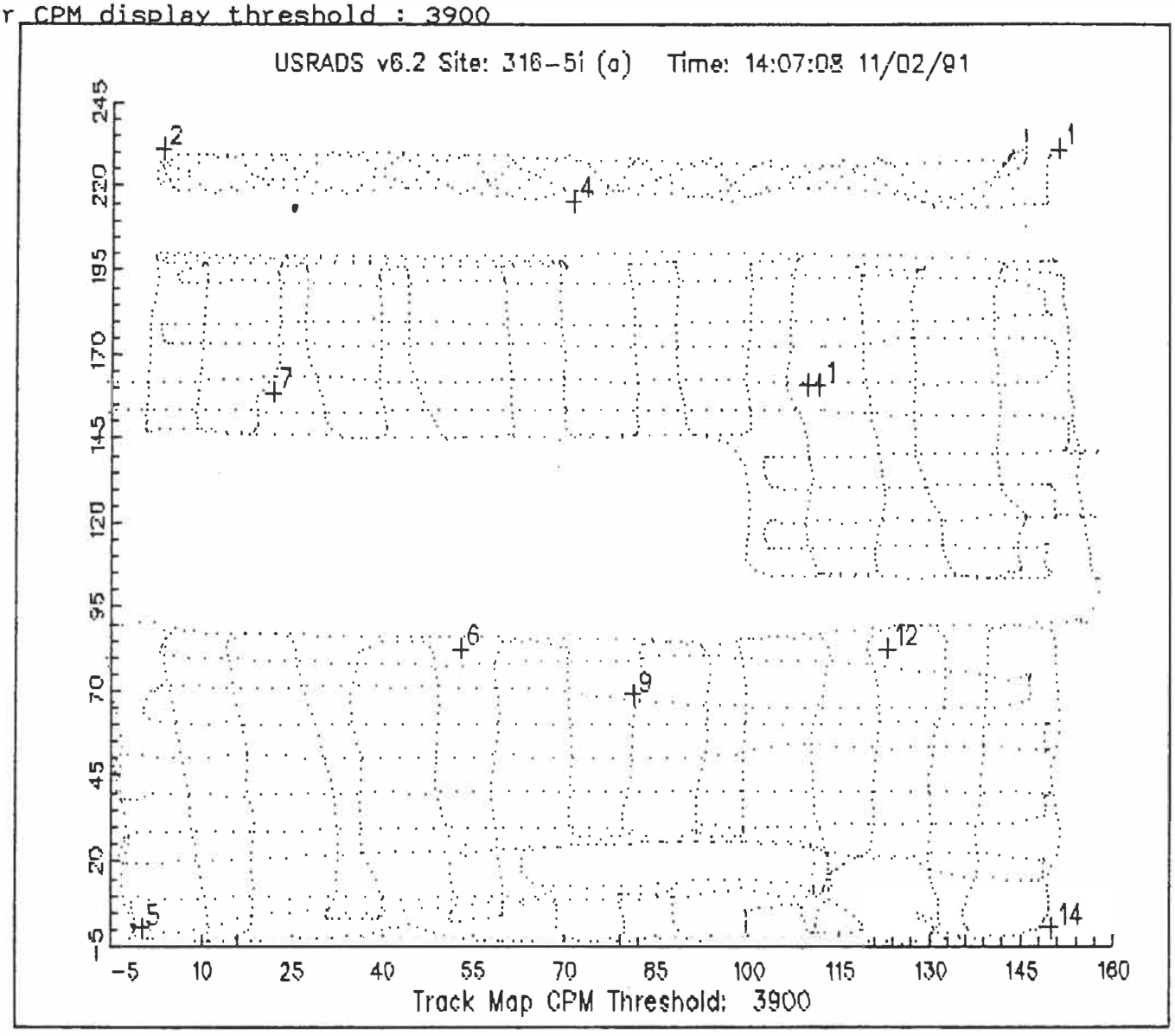
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 3031 data points

The Statistics for the selected data signal are
min = 1100.00 max = 2220.00 mean = 1614.60 stddev = 176.59

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 3030 data points

The Statistics for the selected data signal are
min = 5.42 max = 24.42 mean = 10.69 stddev = 2.45

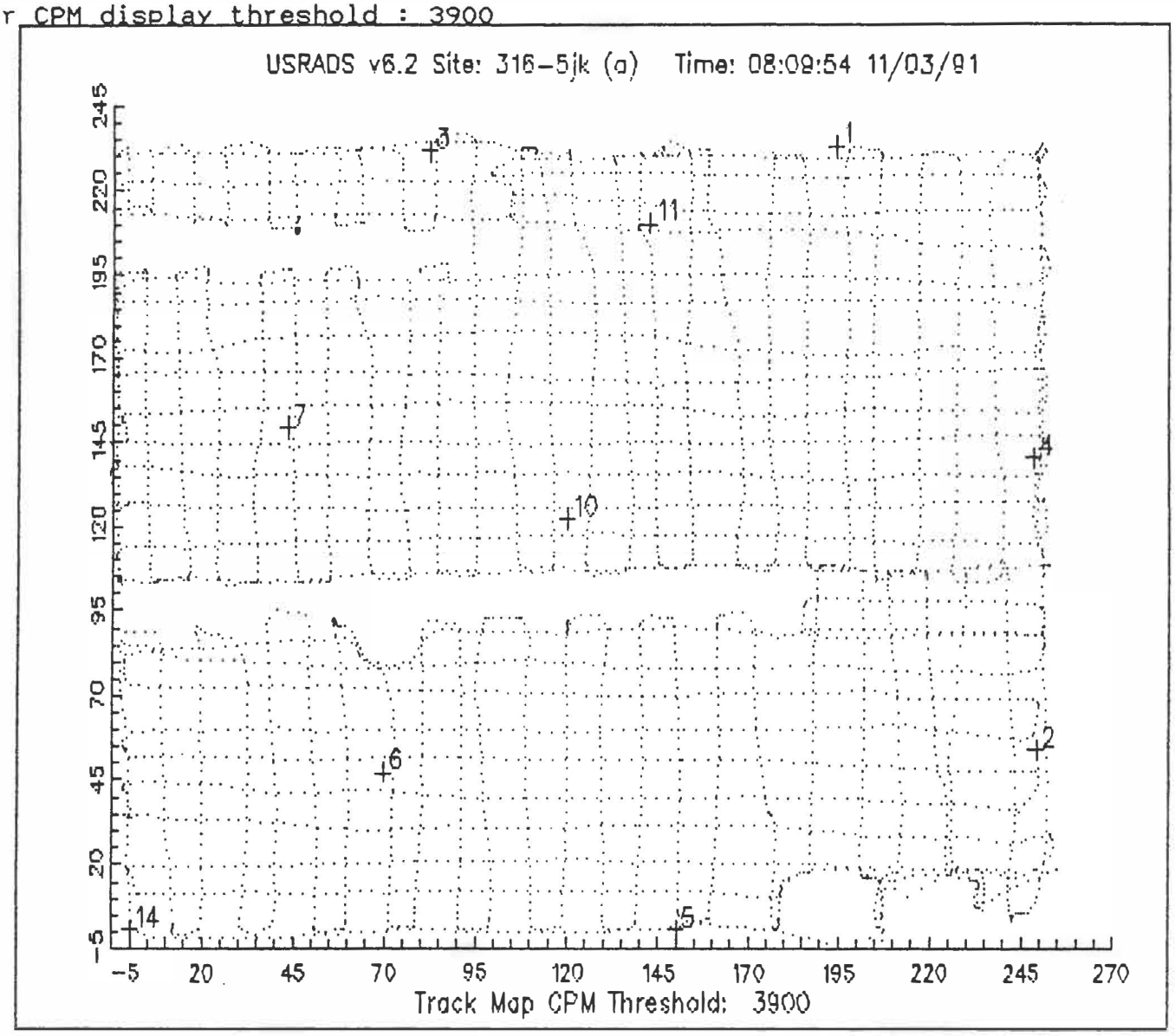
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 4721 data points

The Statistics for the selected data signal are
min = 880.00 max = 2400.00 mean = 1656.82 stddev = 187.24

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 4722 data points

The Statistics for the selected data signal are
min = 5.92 max = 27.82 mean = 11.15 stddev = 2.65

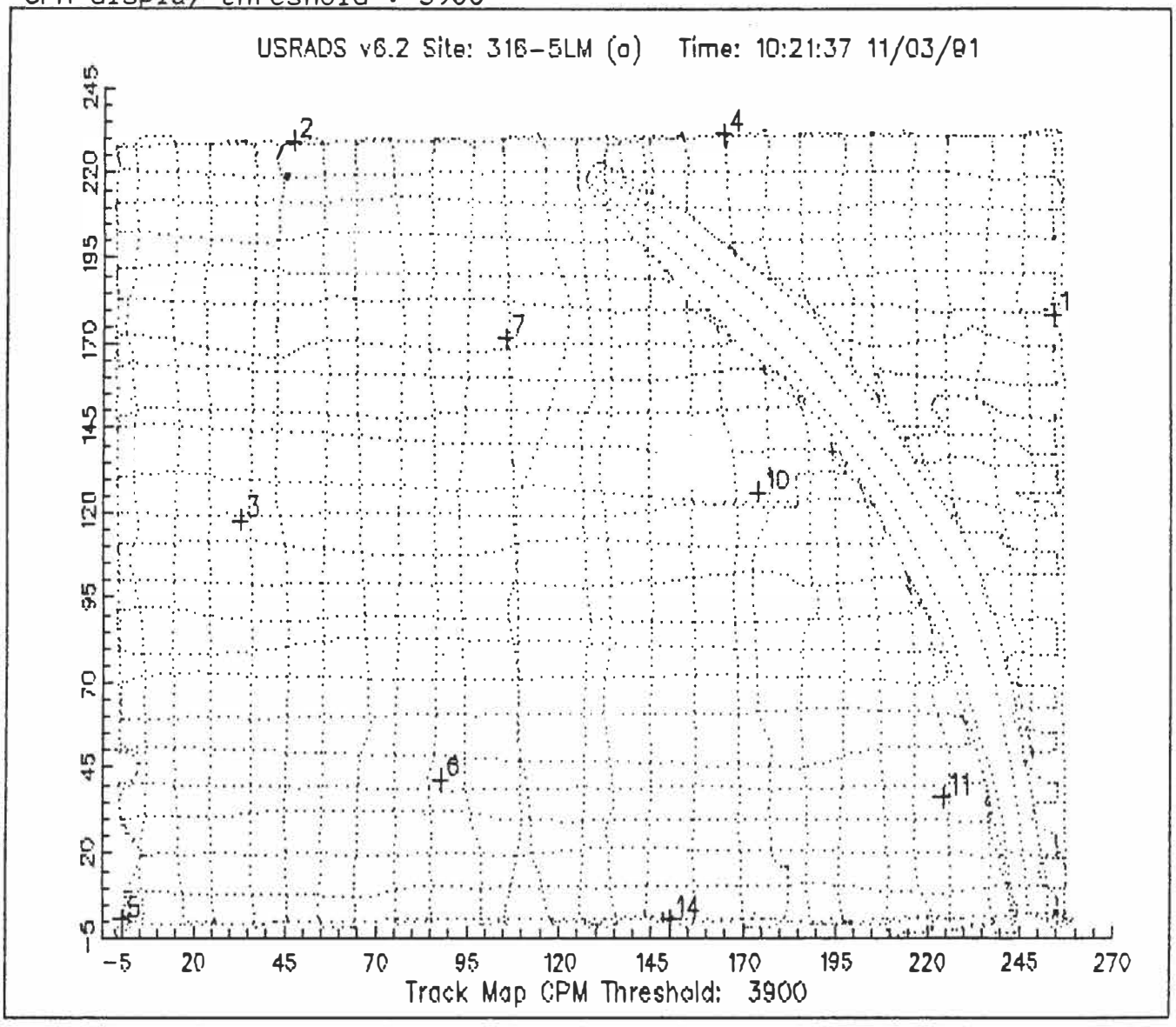
Enter uR/H display threshold : 25

Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 5882 data points

The Statistics for the selected data signal are
min = 0.00 max = 2620.00 mean = 1666.92 stddev = 194.62

Enter CPM display threshold : 3900



Calculating the stats for the selected data channel and analysis region.

For the selected Analysis Limits there are 5882 data points

The Statistics for the selected data signal are
min = 5.92 max = 22.62 mean = 10.55 stddev = 2.09

Enter uR/H display threshold : 25

316-5 PROCESS TRENCH SITE

USRADS SURVEYS

Pre and Post Remediation

APPENDIX C

Low Background Test Site Survey

LOW BACKGROUND SITE SURVEY

Introduction

The Low Background survey was conducted to establish baseline radiological background conditions. The radiological data collected during this survey is considered representative of the undestrubed soil surfaces of the Hanford Site. The survey was conducted on April 10, 15 and 16, 1991.

Location

The Low Background test plot is located in the 600 Area, between the 100-D/DR and 100-H Areas, approximately 2,000 feet from the Columbia River. The site had been previously staked on 100 foot intersects oriented along a north-south axis. The total size of the background plot is 500 by 500 feet. Figure 2 illustrates the layout of the low background survey site.

Discussion

The survey was conducted using a Ludlum Model 2221 digital rate meter with a Ludlum Model 44-2, 1 by 1 inch sodium iodide detector. The Ludlum meter was coupled to the USRADS for the purpose of recording the data from the output of the detector verses the location of the data within the survey area.

A total of six individual surveys were performed to completely cover the 250,000 square foot site. A total of 4,924 data point were collected within the survey site. A summary of the survey results can be found in Table 1. Except for survey LBSa, each survey was traversed on approximately 25 foot transects.

Table 1. Summary Radiological Data for Low Background Site.

SURVEY	AREA (SQ.FT)	DATA POINTS	MEAN (CPM)	SIGMA (CPM)
LBSa	40,000	635	1,477	210
LBSc	40,000	829	1,932	310
LBSd	60,000	1,055	2,203	209
LBSi	60,000	1,146	2,192	212
LBSj	20,000	656	2,085	218
LBSk	30,000	603	1,828	213
TOTAL	250,000	4,924		

The background count rate was established by averaging the mean count rate for each survey. Using the formula: $BKGD=\sum\bar{X}\div 6$, the average background count rate for the Low Background Site was calculated to be 1,951 cpm, say 1,950 cpm. The standard deviation for the average is calculated using the formula:

$$s_{\bar{x}}=\frac{\sqrt{(s_a^2+s_b^2+\ldots s_z^2)}}{n}$$

Based on the formula above, the standard deviation is +/- 95 cpm.

One of the features of USRADS is the ability to enter a "Threshold". The threshold setting is a value that when exceeded, the data point plotted on the CPU monitor is highlighted. This feature alerts the CPU operator that the cpm data has exceeded the threshold, or preset value. For the purpose of conducting the 316-5 Process Trench Site survey, it was desired to establish a value for the threshold, where readings above the setting could be considered surface contamination. The threshold value established for the entire 316-5 survey was twice the background count rate determined above, or 3,900 cpm. This value is practical base on the premiss that too low a setting would highlight normal fluctuations above the calculated mean, and too high a setting would cut off the low end of surface contamination that might be present.