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2101-M Pond Closure Plan

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2101-M POND CLOSURE PLAN

FOREWORD

The Hanford Site is owned and operated by the U.S. Department of Energy, Richland Operations Office. The Hanford Site manages and produces radioactive, dangerous and mixed waste (containing both radioactive and dangerous components). The radioactive waste and radioactive component of mixed waste is interpreted by the U.S. Department of Energy to be regulated under the *Atomic Energy Act of 1954*; dangerous waste and the nonradioactive dangerous waste components of mixed waste are interpreted to be regulated under the *Resource Conservation and Recovery Act of 1976* and the Washington State Department of Ecology, *Dangerous Waste Regulations*, WAC 173-303.

For the purposes of the *Resource Conservation and Recovery Act of 1976*, the Hanford Site is considered to be a single facility. A single dangerous waste permit identification number issued to the Hanford Site by the U.S. Environmental Protection Agency and the Washington State is Environmental Protection Agency/State Identification Number WA890008967. This identification number encompasses a number of waste management units within the Hanford Facility. Waste management units that are no longer operating will be closed under interim status (using final status standards in WAC 173-303-610).

Since 1987, Westinghouse Hanford Company has been a major contractor to the U.S. Department of Energy, Richland Operations Office and has served as co-operator of the 2101-M Pond, the waste management unit addressed in this closure plan. For the purposes of the *Resource Conservation and Recovery Act of 1976*, Westinghouse Hanford Company is identified as 'co-operator.' Any identification of Westinghouse Hanford Company as an operator elsewhere in this closure plan is not meant to conflict with Westinghouse Hanford Company's designation as co-operator but is rather based on Westinghouse Hanford Company's contractual status (i.e., as a management and operations contractor) for the U.S. Department of Energy.

The 2101-M Pond Closure Plan (Revision 2) consists of a *Resource Conservation and Recovery Act of 1976* Part A Dangerous Waste Permit Application and a *Resource Conservation and Recovery Act of 1976* Closure Plan. An explanation of the Part A submitted with this document is provided in Section I-1. The closure plan consists of 6 chapters and 17 appendices.

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No.	Comment/Response	Concurrence
115.	A-2/13. EPA and Ecology have established action levels for concentration limits. These concentration limits can be found in the Federal Register, Part VIII Environmental Protection Agency/40 CFR Part 136. Ecology Requirement: Please refer to this guidance when establishing action levels since these are EPA action limits which are used for specific parameters. **RL/WHC RESPONSE: 40 CFR 136 is titled *Guidelines Establishing Test Procedures for the Analysis of Pollutants* and provides guidance for test procedures to support NPDES (federal or state) for permits under Section 402 of the *Clean Water Act of 1977*. This does not provide action levels for concentration limits and is not applicable to soil.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
116.	A-2/17. It cannot be determined at this time, if past practices at the BWIP laboratories have or have not contributed to contamination of the water beneath 2101-M Pond. Once missing analytical data is received, Ecology can come to a conclusion regarding this site. Ecology Requirement: Provide necessary raw data for validation by Ecology. **RL/WHC RESPONSE: The RCRA groundwater monitoring program at the Hanford Site has been in existence since 1987, and has been negotiated and under the control of an Ecology Unit Manager. The four groundwater monitoring wells around the 2101-M Pond were installed in 1988. As stated in the closure plan (page B-53, line 39) groundwater data and quality control information is provided to Ecology in the *Quarterly Report of RCRA Groundwater Monitoring Data*. It is maintained that raw data as defined by Ecology is not needed for validation and is excessive. The issue of the level of validation required is currently being worked through the *Hanford Federal Facility Agreement and Consent Order* issue resolution process. Any additional response will be dependant on final disposition of this issue.** Ecology Requirement 2: Provide necessary data as required for the quarterly groundwater monitoring program. **RL/WHC RESPONSE 2: As agreed to at the February 10, 1993 Unit Managers' Meeting, this requirement is met by the *Quarterly Report of RCRA Groundwater Monitoring Data* that is currently being submitted to Ecology.**	CLOSED 2/10/93
117.	A-2/50. The interpretation of the "remove and decontaminate" language is not in accordance with WAC 173-303-610. Ecology Requirement: Provide the interpretation for "remove and decontaminate" as stated in WAC 173-303-610. **RL/WHC RESPONSE: It is felt that this language is consistent with WAC 173-303-610 (2)(a)(ii). Nevertheless, Ecology has agreed to consider/review a proposal to close to health-based standards.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
118.	B-1/45. As stated in Webster's Dictionary, "invoke" means, "To call on for aid, support or inspiration; to call for earnestly; to call forth with incantations." Ecology Requirement: Please replace "invoke" with a more appropriate word. **RL/WHC RESPONSE: According to *Webster's New World dictionary*, invoke also means "to put into use (a law, penalty, etc.) as pertinent." A suitable synonym was not found; therefore, no change will be made.**	CLOSED 2/10/93
119.	B-2/18. See comment number 118. **RL/WHC RESPONSE: According to *Webster's New World dictionary*, invoke also means "to put into use (a law, penalty, etc.) as pertinent." A suitable synonym was not found; therefore, no change will be made.**	CLOSED 2/10/93
120.	B-4/27. If operations have been terminated, why haven't lab drains been removed from the building to the pond? Ecology Requirement: Please explain why these drains have not been removed, and if not, what purpose do they serve? **RL/WHC RESPONSE: A discussion concerning the removal of the drains plumbed to the 2101-M Pond and interim actions can be found in Section I on page I-22, lines 5 through 10, and Section B on page B-2, starting on line 20.**	CLOSED 2/10/93
121.	B-14/52. Please cite the most current SW-846 document, the document mentioned is out of date. Ecology Requirement: Change all citations regarding SW-846 to, "SW-846 1986 (as amended)", and follow the requirements as set forth in the revisions to that document. **RL/WHC RESPONSE: Citations of SW-846 will be updated unless it deals with a particular version that was actually used for a specific action.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
122.	B-15/25. If butanoic acid was not part of the BWIP laboratory and it is not a common laboratory contaminant, there must have been a discharge into the pond at one time. Ecology Requirement: Please provide an explanation for this contamination. **RL/WHC RESPONSE: A statement will be added to the text indicating that butanoic acid occurs naturally in soil as a vegetation degradation product. See also, Appendix E-1, bottom of page 13. Resampling was conducted in June 1991, which included butanoic acid as an analyte of interest (see Table E1-3, Appendix E-1). The closure plan states that further sampling to better characterize the 2101-M Pond will be completed (page A-2, lines 4-6 and page B-1, lines 24-26). Appendix E contains the phase II sampling analysis plan (SAP) and the quality assurance project plan (QAPP). Both the SAP and QAPP were submitted and approved by Ecology prior to the 1991 sampling. Submittal of revision 1 of the closure plan also occurred prior to the 1991 sampling.**	CLOSED 2/10/93
123.	B-19/11. Appendix IX has been taken from the 1988 CFR. Please use the most current edition (1991) at the time of writing the plan. **RL/WHC RESPONSE: This section of the closure plan is specific to the 1988 sampling event. The 1988 CFR was the current version when the 1988 sampling was conducted and reflects the actual list used for analyses. Use of the latest version (1991) would not be accurate as to the analyses performed in 1988. This will not be changed.**	CLOSED 2/10/93
124.	B-19/47. There have been 3 revisions to SW-846 since 1982. Therefore, the most current edition of this document shall be used. When referring to SW-846, "as amended" will be used for citing this document. Ecology Requirement: Refer to comment #121. **RL/WHC RESPONSE: Citations of SW-846 will be updated unless it deals with a particular version that was actually used for a specific action.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
125.	B-20/17-26. Dropping a pencil on a random number table is not a scientific way of determining which sample points are to be used during a sampling event. Ecology Requirement: During future sampling events, determine a scientific method to designate a sampling point. **RL/WHC RESPONSE: This description was included in the closure plan in response to Comment No. 57 in the NOD comments received for Revision 0 of the closure plan. Currently, a computer is used to generate random numbers.**	CLOSED 2/10/93
126.	B-20/48. It is stated that samples were collected in accordance with EPA Region X policy, but is not indicated which policy or document was used to determine this conclusion. Ecology Requirement: State which policy and or document was used to determine that samples were collected in accordance with Region X policy. **RL/WHC RESPONSE: Line 48 includes a reference to the particular EPA document (EPA 1986a). The title of this document as given in Section III, References is: *Method for Determining Whether Background Concentrations of Hazardous Constituents Have Been Achieved in Subsoil Beneath Hazardous Waste Management Units*. No change to the text is required.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
127.	B-30/40. If sample holding times can not be documented, and/or if holding times have been exceeded, these samples will be rejected. Ecology Requirement: If these are critical samples, a resampling effort must be established. **RL/WHC RESPONSE: The fact that the holding times for these particular samples could not be documented is the reason the rain water run-off ditch was included in the resampling that took place in 1991.** Ecology Requirement 2: Are all samples which exceeded holding times, those that are being resampled in the 1991 event? Please state if all samples that have exceeded holding times are those that were resampled. **RL/WHC RESPONSE 2: Appendix E1, Section 4.4 states the criteria for inclusion of constituents that would be sampled for in the phase II sampling effort. Bullet 3 states "Constituents whose presence in the initial sample results is of questionable validity or are present for unknown reasons." Therefore, any analyses which exceeded holding times were resampled. This comment and the response were discussed with Ecology at the February 10, 1993, Unit Managers' Meeting and the response accepted.**	CLOSED 2/10/93
128.	B-30/48. Duplicates and splits are different types of sample. Ecology Requirement: Delete the word "duplicate" which is placed after "Sample Split." **RL/WHC RESPONSE: The word duplicate will be deleted from line 48 and line 49.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
129.	B-31/1. U.S. Testing holding times are not recognized by EPA or Ecology. Only USEPA holding times are to used for chemical analyses. If UST holding times were used for samples and these holding times exceeded USEPA holding times, these samples will be rejected. Ecology Requirement: If critical samples were lost due to UST holding times which have exceeded USEPA requirements, establish a resampling schedule. **RL/WHC RESPONSE: This information was provided as a result of NOD Comment No. 64 on Revision 0 of the closure plan. The purpose was to provide required (EPA) verses actual (U.S. Testing) holding times and to highlight recognized inadequacies in the initial data. The results of the initial analyses and the data inadequacies were used in the development of the phase II sampling plan. The holding times for samples analyzed by U.S. Testing were actual holding times. U.S. Testing holding times were not approved or standard holding times used in place of those specified by the EPA. The heading in Table B-5 will be changed to "actual holding time."**	CLOSED 2/10/93
130.	B-32/6. Were inorganic water samples taken, and if so, what type of preservative was used in these samples? Ecology Requirement: Please indicate which type of preservative was used in water samples. **RL/WHC RESPONSE: No water samples were taken in the initial sampling. Water sampling was planned to be conducted in the phase II sampling (Appendix E-1); however, the pond was dry at the time sampling occurred. The former Ecology Unit Manager indicated this was not a problem, and simply documented the fact that the pond was dry.**	CLOSED 2/10/93
131.	B-32/41. This section addresses the decontamination of sampling equipment, but no mention was made as to how equipment will be decontaminated after samples are taken. Ecology Requirement: Please indicate what decontamination procedures will be implemented to clean equipment after sampling takes place. **RL/WHC RESPONSE: As stated at the end of the paragraph, the procedures are outlined in Appendix C-3, specifically on page 5, lines 26-33 and page 6. The same procedure used prior to sampling is also used after sampling.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
132.	B-36/44. This section indicates that all cyanide samples exceeded holding times, and states that no levels were found. If a sample goes beyond holding times, there is a good chance that levels will not be found. All cyanide samples which have exceeded holding times are rejected. Ecology Requirement: Since holding times were exceeded for cyanide samples, a resampling schedule needs to be established for cyanide analysis. **RL/WHC RESPONSE: Resampling was conducted in June 1991, which included cyanide as an analyte of interest (see Table E1-3, Appendix E-1).** Ecology Comment: Table E1-3 in Appendix E1 does not indicate that cyanide is an analyte of interest. **RL/WHC RESPONSE 2: Cyanide will be added to the table. Cyanide analyses were requested for samples B00GP2 through B00GP8, B00GQ9, and B00GR1. This comment and the response were discussed with Ecology at the February 10, 1993, Unit Managers' Meeting and the response accepted.**	CLOSED 2/10/93
133.	B-36/50. This section states that laboratory blanks were within established QC limits. Were these EPA or UST QC limits? Ecology Requirement: Please specify if these QC limits are EPA or UST. If they are UST, explain how they compare with the EPA limits. **RL/WHC RESPONSE: The last sentence of the opening paragraph of Section B-5d states: "Details concerning the laboratory quality control (QC) assessment are contained in Appendix C-4 and summarized in the following section." The opening paragraph of Appendix C-4 further states: "The following comments refer to laboratory performance in meeting *EPA* (emphasis added) quality control specifications outlined in IFB-WA-87K-025, -026, and -027 (EPA 1988)."**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
134.	B-37/18. Refer to comment 129. Ecology Requirement: If the holding times do not meet EPA criteria, these samples will be rejected and a resampling schedule must be established. **RL/WHC RESPONSE: All holding times for the soil analyses were met, except for those listed in Table B-5 on page B-31. See response to Comment No. 129. Resampling was conducted in June 1991 (see Table E1-3, Appendix E-1).**	CLOSED 2/10/93
135.	B-99/6. High levels of chromium were found in unfiltered samples. It was expressed that this finding was due to the natural environment. How high above background levels were the concentrations in these samples? Ecology Requirement: Provide information on elevated chromium levels found at 2101-M Pond. Please indicate where information was obtained on background levels at the site. **RL/WHC RESPONSE: As referenced in each of the Sections of B-6d(2), the actual concentrations of chromium can be found in Appendix D-2. The data are organized by sampling date. For a quick, general idea, see the results of the first semiannual sampling provided and compared to the baseline tolerance interval in Table B-23 on page B-100. The baseline was established using six additional wells located across the Hanford Site and is described in Section B-6b(6.3), lines 21 through 45, on page B-88.**	CLOSED 2/10/93
136.	B-99/38. What "tolerance intervals" were used? Was this the actual concentration levels as compared to background, or was this the detection limit? If this is the detection limit, were EPA or UST detection limits used? Ecology Requirement: Explain tolerance levels, and if these are detection limits, specify whether EPA or UST limits are being used. **RL/WHC RESPONSE: Table B-21 on page B-90 lists the upper tolerance limits established for the baseline. An explanation of tolerance intervals and how they are established can be found on page B-87. The reasoning for using this statistical method is explained in Section B-6b(6.1) on page B-86.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
137.	B-104/52. Refer to Comment Number 121. **RL/WHC RESPONSE: Citations of SW-846 will be updated unless it deals with a particular version that was actually used for a specific action.**	CLOSED 2/10/93
138.	B-105/23. Ecology Requirement: Provide a list of the UST detection limits and compare these with the EPA detection limits. Also provide the Contract Required Detection Limits (CRDLs) and the Instrument Detection Limits (IDLs) that were used. **RL/WHC RESPONSE: The contractually required detection limits used by U.S. Testing are provided with the groundwater data in Appendix D-2. Section B-6g provides summary results of a quality control review done against SW-846 and other standard methods. The table on page B-106 highlights the only U.S. Testing detection limits that were above the EPA standards. Additionally, the quality control tables at the end of Appendix C-4 provide method detection limits, limits of detection, and limits of quantitation.**	CLOSED 2/10/93
139.	B-105/50. It is stated that EPA methods were used for analysis, but U.S. Testing detection limits and holding times were implemented at this time. Most UST holding times exceeded USEPA standards. Since most standards exceeded USEPA holding times, all samples which were out of conformance will be rejected. Ecology Requirement: Refer to Comment Number 129. **RL/WHC RESPONSE: The groundwater holding times did not exceed the holding times required by the EPA, and all detection limits except those listed on page B-106 met the detection limits as stipulated by the EPA methods (Section B-6g). See response to Comment No. 129 for additional information.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
140.	B-106/8. When it is stated that pesticides, herbicides, and phenols were collected as required by 40 CFR 265, what exactly does this mean? The regulations state what type of samples are necessary, that a sampling plan must be submitted to EPA and this plan must be implemented. This section does not state how sampling is to be performed. Ecology Requirement: Give details on what is meant by samples being collected as required by 40 CFR 265. **RL/WHC RESPONSE: This means simply that pesticides, herbicides, and phenols were collected because they are required by 40 CFR 265. The text will be modified to make this clearer.**	CLOSED 2/10/93
141.	B-106/21. The statement is made that holding times were met. Which holding times, EPA or U.S. testing? Most UST holding times have exceeded EPA requirements. Samples which have exceeded EPA requirements are rejected. Ecology Requirement: If critical samples are rejected because of holding time exceedences, resampling may need to be performed. **RL/WHC RESPONSE: As mentioned in the opening paragraph of Section B-6g(1 and 2), when it says that all holding times were met, it means EPA requirements. U.S. Testing did not have different holding times. Several soil sample holding times which were developed by EPA were missed; however, no holding times for groundwater samples were missed.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
142.	B-106/27. All detection limits for ground and drinking water must be in compliance with Washington State drinking water standards or MTCA dependent upon the site. These standards are much more stringent than EPA requirements. Ecology Requirement: All Washington State requirements must be followed regarding ground and drinking water detection limits. RL/WHC RESPONSE: The RCRA groundwater monitoring program at the Hanford Site has been in existence since 1987, and has been negotiated with and under the control of an Ecology Unit Manager. WAC 173-303-110 lists SW-846 methods as appropriate and approved methods for analyses, which includes the SW-846 detection limits. WAC 173-303-645 does not list or reference any other methods or detection limits. Therefore, the detection limits established by the EPA are appropriate. Ecology Comment: Since this site is being considered for clean closure all ground water must be in compliance with MTCA standards. RL/WHC RESPONSE 2: The original comment had to do with the detection limits used in the groundwater program. It was answered, and shown that the EPA detection limits provided in SW-846 and other approved standard methods are appropriate. The groundwater data to date indicate that the 2101-M Pond has not adversely affected the groundwater. Therefore, the groundwater is not an issue for clean closure of the 2101-M Pond.	CLOSED 3/03/93
143.	B-107/4. Refer to Comment Number 138. RL/WHC RESPONSE: The text will be changed to "...all below the EPA method detection limits." Also see response to Comment No. 138 for additional information.	CLOSED 2/10/93

No.	Comment/Response	Concurrence
144.	B-107/23. The information to determine surrogate recoveries is missing. Ecology Requirement: Provide information on surrogates and the percentages found. Attachment 1, table 6 illustrates EPA requirements. **RL/WHC RESPONSE: The groundwater surrogate spike recoveries are listed in Appendix C-4 starting on page 25. A reference to this table will be added to the text.**	CLOSED 2/10/93
145.	B-107/29. Why weren't EPA matrix spike recoveries used? What are the UST matrix spike recovery limits? Ecology Requirement: Discuss in detail the spike recoveries used and the recovery limits. Explain why EPA matrix spike recoveries were not used. **RL/WHC RESPONSE: The text will be changed to EPA matrix spike recoveries. The groundwater matrix spike recoveries are listed in Appendix C-4 immediately behind the surrogate spike information. A reference to this table will be added to the text.**	CLOSED 2/10/93
146.	B-107/37. According to a previous statement, not all EPA methods were used for analyses. Spike recoveries cannot as yet be determined to have been in compliance with EPA QC limits. Samples which exceeded EPA holding times are rejected. Samples which exceeded percent recoveries by 10% or more or have not met percent recoveries by 10% or more are also rejected. Where can the information be found which indicates that control samples were used for accuracy checks? Ecology Requirement: Provide all missing QA information as listed in above statements. **RL/WHC RESPONSE: Other standard methods (i.e., ASTM, APHA) were used when EPA methods were not available. The word "approved" will be inserted between "EPA" and "methods" on line 41. All available QA information is reported in Appendix C-4. A reference to Appendix C-4 will be added to the text of Section B-6g on page B-104.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
147.	B-108/11. It is stated that data received from the 2101-M Pond System groundwater samples indicate that this site should be clean closed. What types of contamination are present from radioactive constituents? Radioactive contamination must be addressed for clean closures. Ecology Requirement: Provide information on radiochemistry to determine the amount of contamination from radioactive constituents. RL/WHC RESPONSE: There is no evidence of radioactive contamination at the 2101-M Pond as shown in Appendix C-1 and D-2. If there were radioactive contamination in the groundwater, it would not be a result of activities at the 2101-M Pond and would be remediated under CERCLA authority. Ecology Comment: Table D2 does list some radioactive constituents above detection limits. There is no indication of how high above detection limits. Please provide Ecology with rad counts for those radioactive constituents found at the Pond, so that we may be able to determine if the pond can be clean closed. RL/WHC RESPONSE 2: There are no radioactive constituents found at the 2101-M Pond. If there is radioactive contamination in the groundwater it is not from the 2101-M Pond, and therefore, would be under CERCLA jurisdiction. This comment and the response were discussed with Ecology at the February 10, 1993, Unit Managers' Meeting and the response accepted.	CLOSED 2/10/93
148.	Section II-1. In the summary, the second paragraph is contradicted by the rest of the plan as to lift thickness and permeability. Ecology Requirement: Permeability shall be verified on test pads through use of a sealed double ring infiltrometer. RL/WHC RESPONSE: The summary does not discuss permeability or specify the lift thickness. The hydraulic conductivity value on line 36 will be changed to 3×10^{-7} cm/s. The following text will be added at the end of the second paragraph: "If there is need to build a cover, then standard field verification test methods (e.g., sealed double ring infiltrometer) will be specified as part of the quality control for the final cover design. A final cover design will only be done in the event that the landfill contingency is necessary.	CLOSED 2/10/93

No.	Comment/Response	Concurrence
149.	Section II-2. Preliminary Cover Design-Energy has proposed McGee Ranch soil before, but has used bentonite modified local soil. Which will be used? Ecology Requirement: Since bentonite has been used in the past, study the bentonite alternative along with McGee Ranch, and provide Ecology with information as to what will be used as a cover. RL/WHC RESPONSE: The intent is as stated, that McGee Ranch soil only will be used. The cover design that proposed bentonite modified soil was also preliminary in nature and probably will not be implemented. Bentonite has not been used in the past; no RCRA covers have been constructed on the Hanford Site to date. As stated in the closure plan, this is a preliminary design and was included only as a contingent closure plan as required by WAC 173-303-610(3)(a). No additional design work or engineering studies will be conducted unless the contingent closure must be implemented and a definitive design is required.	CLOSED 2/10/93
150.	Section II-2a. Cover materials description: Once again the description of soil placement is contradicted by the remainder of the report. In addition, adequate compaction cannot be achieved with 12 inch lifts by any means now available to the industry. Ecology Requirement: Provide detail on how adequate compaction will be achieved. RL/WHC RESPONSE: Except for one change, noted below, this section does not contradict the rest of the report and does not require modification. The lift thickness stated on line 37 will be changed from 12 inches to 6 inches.	CLOSED 2/10/93

No.	Comment/Response	Concurrence
151.	Sheepsfoot rollers are obsolete. Does the writer mean "padfoot roller"? Ecology Requirement: An adequate roller will be required. Give details on what type of roller will be used. **RL/WHC RESPONSE: The list on lines 40 and 41 are only intended to give the reader an *idea* of the options available. However, sheepsfoot rollers are still in use, and pneumatic compactors are rubber tired. The specifics would be determined in the definitive design if the contingent plan was to be implemented.**	CLOSED 2/10/93
152.	Rubber tired construction equipment may give adequate compaction, and then again it may not. 21 yard scrapers would do it, a front end loader will not. Ecology Requirement: Provide detail on how adequate compaction will be achieved. **RL/WHC RESPONSE: The list on lines 40 and 41 are only intended to give the reader an *idea* of the options available. However, sheepsfoot rollers are still in use, and pneumatic compactors are rubber tired. The specifics would be determined in the definitive design if the contingent plan was to be implemented.**	CLOSED 2/10/93
153.	Comment/Requirement: If nuclear density gauges are used, they must be calibrated by comparison with a sand cone daily. **RL/WHC RESPONSE: If nuclear density gauges are used, they will be calibrated per operational procedures. Currently on the Hanford Site, nuclear density gauges are operated only by certified engineers and are calibrated using national standards.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
154.	Table II-3. The term "proctor" is imprecise. Ecology Requirement: Please quote American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officers (AASHTO), or Washington State Department of Transportation (WDOT). **RL/WHC RESPONSE: Specific method names will be substituted in the table (ASTM D698-78).**	CLOSED 2/10/93
155.	Section II-3a, Fifth paragraph last sentence. The removal of deep rooted plants is imperative, not optional. Ecology Requirement: Deep rooted plants must be removed. **RL/WHC RESPONSE: This sentence does not indicate this is optional. If deep-rooted plants start on the cover, they will be removed. The intent was, that deep-rooted plants may not get a start on the cover and thus, may not require removal. The text will be changed to a statement similar to the second sentence above.**	CLOSED 2/10/93
156.	Appendix C. Ecology is rejecting all data submitted which was included in Revision 1 of the 2101-M Closure plan due to samples exceeding holding times, no documentation of extraction times and recoveries being outside of QC limits. **RL/WHC RESPONSE: A certain amount of data is always going to fail some aspect of the quality control criteria. This fact does not invalidate the entire data set. Much of the data presented here has not failed any of the quality control criteria, and those data points that do could still represent useful information. All information requested in the preceding comments was supplied within the closure plan. Ecology previously proposed to use the Phase II soil data to evaluate the acceptability and usefulness of the soil data presented here.**	CLOSED 2/10/93

No.	Comment/Response	Concurrence
157.	Appendices C-4 through D-2. Is the information contained in these appendices the same data which was submitted earlier in the UST and Martin Marietta data packages? Ecology Requirement: Please indicate if this is the same data which was submitted in the data packages received by Ecology. RL/WHC RESPONSE: The data presented in the closure plan is all U.S. Testing data. Appendix C-4 contains quality control information for both soil and groundwater analyses done by U.S. Testing. Appendix D-2 contains groundwater analytical information. There has been no data package submitted from Martin Marietta for the 2101-M Pond. Data packages submitted to Ecology in 1992 were the results of the 1991 soil sampling. Analyses were performed by Data Chem and S-Cubed laboratories. The latter data was not available at the time issuance of Revision 1 occurred, and was not included in the closure plan.	CLOSED 2/10/93

The comments below are those which have been submitted in the latest NOD response table, and still require resolution.

Below are partial comments taken from the Notice of Deficiency Response Table on Revision 0 of the closure plan. This was the last Response Table for Revision 0, which was prepared after closure of the Revision 0 comments with Ecology.

No.	Comment/Response	Concurrence
16.	USDOE/WHC Proposal: Groundwater data was interpreted to the extent available at the time the closure plan was written. Additional data was presented in the plan for completeness. All the data and statistical analyses will be submitted in the 2101-M Pond RCRA Site Characterization Report. Ecology Response: This closure plan should provide enough information specific to the 2101-M Pond on which to base decisions. This means that both the available data and its interpretation should be presented within the closure plan; submittal in another report is not sufficient. It is also appropriate for similar types of information to be presented in one section, i.e., all of the data may be presented in tabular form in an appendix. USDOE/WHC Proposal: All available groundwater data will be presented in an appendix. Ecology Response: There must be enough information available in order to validate the data. Information is missing as in the other data reports submitted by USDOE, the missing data must be provided. We cannot make a determination on the groundwater analysis until all missing information is made available. Refer to the letter submitted to DOE on May 29, 1992 regarding this issue. RL/WHC RESPONSE: The original comment, "Only two quarters of groundwater data are examined, yet four quarters are currently available," dealt with the number of sampling events included in the closure plan, not validation of the data. RL/WHC feels the original comment has been satisfied as evidenced by Ecology's concurrence at the August 14, 1990, Unit Managers' Meeting. The issue of the amount of data needed to perform validation is a new and separate issue, which is addressed in the response to Comment No. 116.	CLOSED 2/10/93

No.	Comment/Response	Concurrence
24.	USDOE/WHC Proposal: Modify the closure plan to demonstrate compliance with WAC 173-303-645 and give additional clarifications about the impact the 2101-M Pond has had on groundwater. Ecology Response: This will be conditionally accepted provided that the following contradictory statements are reconciled and the results approved by Ecology. First it is stated, "while it is difficult to absolutely prove ... well E18-1 is upgradient and representative of background ..." Then it is stated, "well E18-1 provides background water quality per the definition of Appendix A in the ... [FFACO]." Ecology will determine if this revision is acceptable depending on the results of number 25. USDOE/WHC Proposal: The text will be modified to reflect the information presented at the July 11, 1990, Unit Manager Meeting. Ecology Response: There are some questions which remain regarding the analytical results taken from the groundwater samples. There is a statement made that constituents were found to be below standards or detection limits. What standards or detection limits are being referred to in this section? The statement that the issue of background is moot because groundwater beneath 2101-M Pond has not been degraded by operations in the 2101-M facility needs to be established in the closure plan. State in the plan that groundwater monitoring is in compliance with WAC 173-303-645. **RL/WHC RESPONSE:** The questions regarding the sampling results are separate issues and are addressed in the responses to Comment Nos. 138, 140, 141, 144, 147, 148, and 149. RL/WHC feels it has established in the closure plan that the groundwater has not been impacted by discharges to the 2101-M Pond. Please see Section B-6b(3.3), specifically page B-80 and Figure B-18 on page B-81, also Section B-6b(6.3), specifically Tables B-21 and B-23. The first paragraph of Section B-6, Section B-6b(6.1), and Section B-6b(6.3) discuss compliance with WAC 173-303-645. However, a reliance on 40 CFR 265 must be maintained to establish measurement parameters, because WAC 173-303-645 relies on a permit and contains almost no measurement parameters.	CLOSED 2/10/93

No.	Comment/Response	Concurrence
58.	USDOE/WHC Proposal: "The integrity of background sample data collected within 1000 ft. of the 2101-M Pond site will be assessed and documented in the 2101-M Pond Closure Plan." Ecology Response: The issue of past practice effects and RCRA/CERCLA overlap at sites chosen for background sampling is being decided at the Project Manager's level. The acceptability of the background sampling sites will be decided after this issue is resolved. Ecology Response 2: The latest background report is being reviewed. Ecology will have a better idea after this review, if the sites chosen for background are acceptable. RL/WHC RESPONSE: The original comment stemmed from the fact that Ecology did not believe the local background sites to be unimpacted by past practices. A series of historical photos were included in the closure plan to verify that the background site was not affected by past practices. RL/WHC feels the original comment has been satisfied as evidenced by Ecology's concurrence at the August 14, 1990, Unit Managers' Meeting. The background samples for 2101-M Pond were taken prior to, and are separate from, the Hanford Site soil and groundwater background study currently underway.	CLOSED 2/10/93

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SEPA ENVIRONMENTAL CHECKLIST
FOR THE
2101-M POND INTERIM STATUS CLOSURE PLAN

A. BACKGROUND

1. Name of proposed project:

Closure of the 2101-M Pond site.

Information contained in this checklist pertains only to the 2101-M Pond.

In the context of this document, "site" refers to the physical structure that is the 2101-M Pond, whereas "Site" refers to the Hanford Site.

2. Name of applicants:

U.S. Department of Energy-Richland Operations Office (DOE-RL) and Westinghouse Hanford Company (Westinghouse Hanford)

3. Address and phone number of applicant and contact person:

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

Westinghouse Hanford Company
P.O. Box 1970
Richland, Washington 99352

Contact Persons:

R. D. Izatt, Director
Environmental Restoration Division
(509) 376-7277

R. E. Lerch, Manager
Environmental Division
(509) 376-5556

4. Date checklist prepared:

February 10, 1989

5. Agency requesting the checklist:

State of Washington
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504

6. Proposed timing or schedule (including phasing, if applicable):

Initial closure activities have been completed. The 2101-M Pond was closed to disposal of dangerous wastes in July 1985. The pond soil has been sampled to assess the presence of dangerous waste constituents. Ground-water monitoring is currently being conducted to assess the impact of past waste disposal practices at the 2101-M Pond on the uppermost aquifer. Ground-water samples will be taken quarterly through May 1989. Samples will, thereafter, be collected

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on a semiannual basis until final closure has been certified. Upon approval of the 2101-M Pond Closure Plan, it is anticipated that final closure will be completed within 180 days.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

   The 2101-M Pond will remain open to disposal of nondangerous waste water from the 2101-M Building and the adjacent rainwater run-off ditch.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

   - This SEPA Checklist is being submitted to the State of Washington, Department of Ecology (Ecology) concurrently with revision 1 of the Interim Status Closure Plan for the 2101-M Pond.

   - A revised Part "A" permit application was submitted in August 1987, and again in November 1987 to Ecology, under identification number WA890008967.

   - An environmental evaluation similar to this SEPA Checklist may be prepared for DOE-RL and Westinghouse Hanford internal documentation purposes.

9. Do you know whether applications are pending for government approvals of other proposals directly affecting property covered by your proposal? If yes, explain.

   No other applications to government agencies are pending approval.

10. List any government approvals or permits that will be needed for your proposal, if known.

    Ecology and the U.S. Environmental Protection Agency (EPA) are the only agencies authorized to approve or permit final closure of the facility under requirements authorized by the Resource Conservation and Recovery Act of 1976 (RCRA), the Hazardous and Solid Waste Amendments of 1984 (HSWA), and Chapter 173-303-400 of the Washington Administrative Code. No other permits are known to be required at this time.

11. Give a brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page.

    Closure of the 2101-M Pond as a Resource Conservation and Recovery Act (RCRA) site involves:

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- Pond soil sampling. This activity has been completed. Analysis to date of the samples has demonstrated that concentrations of organic and inorganic constituents (waste residue) present in the pond soil do not represent a threat to human health or the environment.

- Ground-water monitoring. This activity is currently being conducted to assess the impact of past waste disposal practices at the 2101-M Pond on the uppermost aquifer.

  - Ground-water samples will be taken quarterly through May 1989.

  - After May 1989, samples will be collected on a semiannual basis until final closure has been certified.

- Submission of Certification of Closure to Ecology.

  - This certification will be signed by DOE-RL and an independent professional engineer registered in the State of Washington. The certification states that the pond has been closed in accordance with the approved closure plan.

The proposed future uses of the site are described in the answer to question A.7, above.

The size of the project is described in the answers to questions A.12 and B.8.c., below.

12. Give the location of the proposal. Give sufficient information for a person to understand the precise location of the proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

    The 2101-M Pond is located in the NW 1/4 of Section 10, T12N, R26E in the 200 East Area of the Hanford Site, adjacent to the 2101-M Building. The site is bordered by 2nd Street to the south and Ames Ave. to the west. Maps and plans of the site are located in the closure plan submitted with this checklist.

B. ENVIRONMENTAL ELEMENTS

1. Earth

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a. General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other.

Flat.

b. What is the steepest slope on the site (approximate percent slope)?

The approximate slope of the land around the 2101-M Pond is less than 2%.

c. What general types of soils are found on the site? If you know the classification of agricultural soils, specify them and note any prime farmland.

The general soil types found around the 2101-M Pond consist of eolian silt and fine sands overlying glaciofluvial sands with some silt and gravel. The soil becomes gravelly at approximately 350 feet to basalt bedrock at about 500 feet. No farming is permitted on the Hanford Site.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate the source of the fill.

No filling or grading is proposed for this site.

f. Could erosion occur as a result of clearing, construction, or use? If so, describe.

There is the possibility of some erosion due to wind. Three strips of land were bladed during pond soil sampling activities. Those strips are approximately 180 x 30 feet, 40 x 60 feet, and 120 x 30 feet. These strips were covered primarily by cheatgrass and tumbleweeds and are, therefore, being allowed to revegetate themselves naturally since the completion of sampling activities. (These are previously disturbed areas. In the years of use since the construction of the pond, sagebrush has given way to cheatgrass and tumbleweed.)

Reducing, to some degree, the erosion impact during the re-vegetation process is a natural wind break of trees and brush protecting the largest bladed strip on both sides of its length. The remaining two bladed areas are surrounded by sagebrush and cheatgrass.

g. Approximately what percentage of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

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None.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if there are any?

None.

2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.

Minor amounts of exhaust will be generated by vehicles used to gain access to the site for ground-water sampling. (For a detailed description of ground-water sampling activities please see the answer to question B.3.b.1, below.)

b. Are there any off-site sources of emissions or odors that may affect your proposal? If so, generally describe.

No.

c. Proposed measures to reduce or control emissions or other impacts to the air, if any?

Does not apply.

3. Water

a. Surface:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

No.

2) Will the project require any work over, in, or adjacent to (within 200 feet of) the described waters? If yes, please describe and attach available plans.

No.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

None.

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4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

No.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No.

b. Ground:

1) Will ground-water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities, if known.

During the first year, ground-water will be withdrawn from 4 sampling wells on a quarterly basis, to obtain ground water samples and data necessary to comply with state and federal ground-water monitoring requirements. During the second year, ground water will be withdrawn on a semiannual basis. If monitoring is required after the second year, it will be as proscribed by state and federal requirements.

Ground-water quality data from samples upgradient of the facility are compared to samples downgradient of the facility to determine whether contaminants are present in the ground-water and, if present, their concentration and distribution and whether they originated from disposal of hazardous wastes in the 2101-M Pond.

Prior to sample collection, wells are purged per the sample collection procedure corresponding to the type of pump installed in the well. The purge time is calculated based on the volume of water within the well and the pump discharge rate. A minimum of three borehole volumes of water are removed (purged) from each well to ensure collection of a representative sample of the water in the aquifer. The volume of ground-water withdrawn for purging and sampling depends on the conditions encountered and the needs at each well. However, withdrawals generally do not exceed 850 gallons per monitoring well, per quarter, and will not exceed 5,000 gallons per day.

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Because the 2101-M Pond is an unlined body of water, pond water will migrate to ground-water. Travel time for pond surface water to ground-water has not been determined. It is, therefore, not known how long pond water will take to migrate to ground-water.

2) Describe waste materials that will be discharged into the ground from septic waste tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals...; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

Discharges to the 2101-M Pond are comprised of nondangerous waste water from the heating, ventilation, and air-conditioning (HVAC) system for the 2101-M Building and from certain sinks in the central and south wings of that building, as well as seasonal overflow from the adjacent rainwater run-off ditch servicing the 2101-M Building parking lot.

There is no metering on the discharge lines from the cooling system (primarily "swamp coolers"); hence, no data are available regarding waste water discharged from that system to the 2101-M Pond. There is, however, metering on the steam lines of the heating system. Condensate from those lines is discharged to the 2101-M Pond at an average rate of 1,224,600 gallons per year.

Waste water from sinks in the 2101-M Building is projected to be of an insignificant volume compared to that discharged from the HVAC system. There are 41 drains (sinks, hoods, and eyewash stations) in the building that discharge to the 2101-M Pond. A number of those are to be removed. Additionally, those sinks dedicated to laboratory waste will be subject to physical and administrative controls.

To control corrosion of the piping and ducting through which the steam of the heating system flows, a filming corrosion inhibitor containing straight chain primary amines is added to the steam at a concentration of approximately 14 p/m. The material safety data sheet for the product states that it is not hazardous. To control organic growth in the water supplied to the "swamp coolers," trichloro-s-triazinetrione, a microbicide, EPA Registration No. 4643-47, is added in tablet form. It is administered to the system in keeping with the instructions governing its use such that it is not considered a hazardous waste.

c. Water Run-off (including storm water):

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1) Describe the source of run-off (including storm water) and methods of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Run-off water is not anticipated from the 2101-M Pond. This projection is based on:

- **The relationship between the depth of the pond (3 to 9 feet) and the normal standing water level in the pond (less than 1 foot).**
- **The fact that the Hanford Site is located in a low rainfall area and the sandy soil around the pond allows for rapid percolation of that rainwater.**

2) Could waste materials enter ground or surface waters? If so, generally describe.

As stated in the answer to question B.3.c.1, above, no run-off water is anticipated from the 2101-M Pond. However, as stated in the answer to question A.7 above, the 2101-M Pond will remain open to overflow from the adjacent nondangerous rainwater run-off collection ditch. Hence, it may be possible for rainwater run-off to enter groundwater via the 2101-M Pond.

d) Proposed measures to reduce or control surface, ground, and run-off water impacts, if any:

None. (Please see the answer to question B.3.c.1.)

4. Plants

a. Check the types of vegetation found on site:

___ deciduous trees
___ evergreen trees
___ shrubs
___ grass
___ pasture
___ crop or grain
___ wet soil plants
___ water plants

The water of the pond is overgrown with horsetail, cattails, and sedges. Small trees, primarily black cottonwood, peach leaf, sandbar willow, Russian olive, and Rocky Mountain Juniper, dominate the banks.

Information concerning the general Hanford Site environment can be found in the U.S. Department of Energy, 1987, Final Environmental Impact Statement - Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes, DOE/EIS-0113, Richland, Washington and the Energy Research and Development

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Administration, 1975, Final Environmental Impact Statement - Waste Management Operations, Hanford Reservation, ERDA-1538, Washington, D.C.

b. What kind and amount of vegetation will be removed or altered?

None.

c. List threatened or endangered species known to be on or near the site.

No threatened or endangered plant species are know to exist on, or in, the immediate vicinity of the 2101-M Pond. Additional information concerning the Hanford Site environment can be found in the final environmental impact statements referenced in the answer to question B.4.a.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

None.

5. Animals

a. Circle any birds and animals which have been observed on or near the site or are known to be on or near the site:

birds: hawk, heron, eagle, songbirds, other
mammals: deer, bear, elk, beaver, other
fish: bass, salmon, trout, herring, shellfish, other

The following birds are known to be in the vicinity of the 2101-M Pond: Western kingbirds, doves, starlings, barn swallows, sage sparrows, nighthawks, owls, and magpies. (The magpies have nests in the trees next to the pond.)

Mammals known to frequent the site are: deer mice, house mice, cottontail rabbits, and coyotes. Additional information concerning the Hanford Site environment can be found in the final environmental impact statements referenced in answer to question B.4.a.

b. List any threatened or endangered species known to be on or near the site.

No threatened or endangered species are known to exist on the 2101-M Pond facility site. Additional information on the Hanford Site environment can be found in the final environmental impact statements referenced in answer to question B.4.a.

c. Is the site part of a migration route? If so, explain.

No. Additional information concerning the Hanford Site environment can be found in the final environmental impact statements referenced in answer to question B.4.a.

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d. Proposed measures to preserve or enhance wildlife, if any:

None. Additional information concerning the Hanford Site environment can be found in the final environmental impact statements referenced in answer to question B.4.a.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Gasoline-powered generators will be required to power groundwater monitoring well pumps during sampling until closure is certified.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Does not apply.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

No.

1) Describe special emergency services that might be required.

In the event of an unexpected emergency, fire, ambulance, and patrol services are available on the Hanford Site.

2) Proposed measures to reduce or control environmental health hazards, if any:

Does not apply.

b. Noise

1) What type of noise exists in the area which may affect your project (for example: traffic, equipment, operation, other)?

None.

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2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

On a short-term and a long-term basis, the only noise expected to be associated with the project is the operation of generators to power sampling well pumps, and the operation of trucks to transport the generators to the site.

3) Proposed measures to reduce or control noise impacts, if any:

Generators will meet manufacturer's requirements for noise suppression, and in no case will exceed the OSHA maximum permissible 8-hour level of 90 decibels.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The 2101-M Pond is currently being used for the disposal of nondangerous waste water from the 2101-M Building and the adjacent rainwater run-off ditch. (For additional information, see the answer to question B.3.b.2.)

Property adjacent to the 2101-M Pond is part of the 200 East Area of the Hanford Site. The 200 East Area, as well as the remainder of the Hanford Site, is used for, or designated for the use of, the production of special nuclear materials and the management of the wastes associated with the production of those materials.

b. Has the site been used for agriculture? If so, describe.

No portion of the Hanford Site has been used for agricultural purposes since 1943.

c. Describe any structures on the site.

Four ground-water monitoring wells, one upgradient and three downgradient, surround the site. These wells provide information regarding stratigraphy, ground-water flow direction, and the water quality of the upper portion of the unconfined aquifer.

Each well has been constructed to a total depth of approximately 355 feet and conforms to the requirements of WAC 173-160, "Minimum Standards For Construction of Wells".

d. Will any structures be demolished? If so, what?

No.

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e. What is the current zoning classification of the site?

The Hanford Site is zoned by Benton County as an Unclassified Use (U) district.

f. What is the current comprehensive plan designation of the site?

The 1985 Benton County Comprehensive Land Use Plan designates the Hanford Site as the "Hanford Reservation". Under this designation, land on the Site may be used for "activities nuclear in nature". Non-nuclear activities are authorized "if and when DOE approval for such activities is obtained".

g. If applicable, what is the current shoreline master program designation of the site?

Does not apply.

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

No.

i. Approximately how many people would reside or work in the completed project?

None.

j. Approximately how many people would the completed project displace?

None.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

Please see the answer to question B.8.f.

9. <u>Housing</u>

a. Approximately how many units would be provided, if any? Indicate whether high-, middle-, or low-income housing.

None.

b. Approximately how many units, if any, would be eliminated? Indicate whether high-, middle-, or low-income housing.

None.

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c. Proposed measures to reduce or control housing impacts, if any:

None.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

No structures are proposed for the site.

b. What views in the immediate vicinity would be altered or obstructed?

None.

c. Proposed measures to reduce or control aesthetic impacts, if any:

None.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

None.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No.

c. What existing off-site sources of light or glare may affect your proposal?

None.

d. Proposed measures to reduce or control light and glare impacts, if any:

None.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

None. (Please see the answer to question B.8.a.)

b. Would the proposed project displace any existing recreational uses? If so, describe.

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No.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any?

None. (Please see the answer to question B.12.a.)

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

No part of the 2101-M Pond site is listed on, or proposed for inclusion on, preservation registers. Additional information concerning the Hanford Site environment can be found in the environmental impact statements referenced in answer to question B.4.a.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

There are no known archaeological, historical, or native American religious sites in the area of the 2101-M Pond. Additional information concerning the Hanford Site environment can be found in the environmental impact statements referenced in answer to question B.4.a.

c. Proposed measures to reduce or control impacts, if any:

Does not apply.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

Does not apply. The public is not allowed unauthorized/unescorted access to the Hanford Site.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

No. (Please see the answer to question B.14.a.)

c. How many parking spaces would the completed project have? How many would the project eliminate?

None.

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d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

No.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

No.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

None.

g. Proposed measures to reduce or control transportation impacts, if any:

Does not apply.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

No.

b. Proposed measures to reduce or control direct impacts on public services, if any:

None.

16. Utilities

a. List utilities currently available at the site (electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other):

None.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

None.

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C. SIGNATURES

The above answers are true and complete to the best of my knowledge. We understand that the lead agency is relying on them to make its decision.

EABracken

R. D. Izatt, Director
Environmental Restoration Division
U.S. Department of Energy
Richland Operations Office

9-22-89
Date

R E Lerch

R. E. Lerch, Manager
Environmental Division
Westinghouse Hanford Company

9-7-89
Date

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ACRONYMS AND ABBREVIATIONS

ABN	acid-base neutralization
ASTM	American Society for Testing and Materials
ANOVA	analysis of variance
BWIP	Basalt Waste Isolation Project
CABF	Cochran's Approximation to the Behrens-Fisher Student's t-test
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DW	dangerous waste
DWS	drinking water standards
EC	equivalent concentration
Ecology	Washington State Department of Ecology
EHW	extremely hazardous waste
EP	extraction procedure
EPA	U.S. Environmental Protection Agency
FFTF	Fast Flux Test Facility
HELP	hydrologic evaluation of landfill performance
HEPA	high-efficiency particulate air
HMS	Hanford Meteorological Station
HPT	health physics technicians
HVAC	heating, ventilation, and air conditioning
HQ	hazard quotient
ICP	inductively coupled plasma
ID	inside diameter
LD50	lethal dose 50% of the population
LOQ	limit of quantitation
MSDS	material safety data sheet
MTCA	*Model Toxics Control Act*
NIOSH	National Institute of Occupational Safety and Health
NWPA	*Nuclear Waste Policy Act of 1982*
NWPAA	*Nuclear Waste Policy Amendments Act of 1987*
PCB	polychlorinated biphenyl
PNL	Pacific Northwest Laboratory
QA	quality assurance
QC	quality control

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ACRONYMS AND ABBREVIATIONS (cont)

RCRA	*Resource Conservation and Recovery Act of 1976*
RfD	reference dose
RPD	relative percent difference
RTECS	registry of toxic effects of chemical substances
SCBA	self-contained breathing apparatus
SCP	site characterization plan
SMCL	secondary maximum contaminant level
TCLP	toxic characteristic leach procedure
TI	tolerance interval
TIM	Technical Information Memorandum
TOC	total organic carbon
TOX	total organic halogen
TSD	treatment, storage, and/or disposal unit
U.S. Testing	United States Testing Company, Incorporated
U.S.L.E.	Universal Soil Loss Equation
VOA	volatile organic analysis
VOC	volitile organic compounds
WAC	Washington Administrative Code
WEQ	Wind Erosion Equation
Westinghouse Hanford	Westinghouse Hanford Company
XRF	X-ray fluorescence

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I. GENERAL CLOSURE REQUIREMENTS

I-1. INTRODUCTION

This document describes activities for the closure of a surface impoundment (2101-M Pond) at the Hanford Site, operated by the U.S. Department of Energy, Richland Operations Office (DOE-RL) and co-operated by the Westinghouse Hanford Company (Westinghouse Hanford). The 2101-M Pond is located adjacent to the fence encompassing the 2101-M Building in the 200 East Area of the Hanford Site. The 2101-M Pond was initially constructed in 1953 to serve as a drainage collection area for the 2101-M Building. Until the Basalt Waste Isolation Project (BWIP) Laboratory was constructed in the 2101-M Building in 1979-1981, the only source contributing discharge to the pond was condensate water from the 2101-M Building heating, ventilation, and air conditioning (HVAC) system. The drains for the BWIP Laboratory rooms were plumbed into a 4-in., cast-iron, low-pressure drain pipe that carries waste water from the HVAC system to the pond. Since 1986, small amounts of rainwater run-off have been discharged to the pond from a ditch located adjacent to the pond.

The BWIP Laboratory supported the BWIP site characterization studies conducted to evaluate the feasibility of locating the first national geologic repository for radioactive waste at the Hanford Site. Site characterization studies were directed at obtaining information on the geologic, hydrologic, geochemical, climatologic, and geoengineering characteristics of the Hanford Site and surrounding area through exploratory drilling, testing, and analysis of rock and water samples, geophysical surveys, and mapping.

On December 22, 1987, President Reagan signed into law the Nuclear Waste Policy Amendments Act of 1987 (NWPAA), which substantially amended the Nuclear Waste Policy Act of 1982 (NWPA). The passage of the NWPAA terminated the BWIP; however, the laboratory continued to operate on a small scale through April 1988, conducting BWIP closeout activities.

During the active life of the BWIP Laboratory, solutions of dissolved barium in groundwater samples were discharged to the 2101-M Pond via the laboratory drains. Other laboratory chemicals may have been discharged to the pond through the laboratory drains from 1981 through July 1985 (Section B-3). Administrative controls were established in July 1985 to prohibit disposal of any dangerous waste via the laboratory drains.

As a result of the discharges of solutions containing barium to the 2101-M Pond, a Part A permit application was initially submitted to the Washington State Department of Ecology (Ecology) in August 1986. A revised Part A permit application was submitted in August 1987, and again in November 1987 under identification number WA7890008967. A copy of the November 1987 permit application is provided in Appendix A. The Part A permit application designates the 2101-M Pond as a surface impoundment.

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An initial closure/postclosure plan for the 2101-M Pond was submitted to Ecology in April 1987, Revision 0 in September 1989, and Revision 1 in April 1991. Site characterization has been conducted at the 2101-M Pond to determine if dangerous waste constituents are present in the pond soil and the groundwater. Soil characterization was conducted in two phases. Based on the Phase I soil sampling results, Phase II was developed to further characterize the top 2 ft of the pond soil and the pond water. The revised closure plan (Revision 2) is being submitted to Ecology to provide the characterization results and the closure strategy for the 2101-M Pond.

The Phase I soil characterization activities and results are described in Section B-5. The Phase II characterization activities and results are described in Appendix D-1 and D-4. Groundwater monitoring activities and results are described in Section B-6.

The closure strategy presented in this plan for the 2101-M Pond is summarized as follows.

- Clean close the 2101-M Pond. Clean close as used in this context means that no waste or waste contaminated soil, structures, or equipment will remain onsite that pose a present or potential threat to human health or the environment. If clean closure is achieved, the DOE-RL and Westinghouse Hanford intend to continue use of the 2101-M Pond for receipt of nondangerous waste water for the present. However, all discharges to the 2101-M Pond will cease by June 1995, per Milestone M-17-43 (Ecology et al. 1992).

- Verify that potential contaminants have not migrated from the 2101-M Pond into the groundwater in concentrations that pose a present or potential threat to human health or the environment.

I-2. LOCATION AND GENERAL DESCRIPTION

The Hanford Site is a 560-mi^2 tract of semiarid land that is owned by the U.S. Government and is set aside for activities of the U.S. Department of Energy (DOE). The Site is located primarily west and south of the section of the Columbia River that is immediately north of the City of Richland, Washington (Figure I-1). In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for reactor and chemical separation facilities for the production and purification of plutonium. A total of eight graphite-moderated reactors, using Columbia River water for once-through cooling, and a new type of dual-purpose reactor (N Reactor), using a recirculating water coolant and producing both plutonium and steam for electricity, were eventually built along the Columbia River. Companion fuel-fabrication plants, chemical-processing plants, and waste-management facilities were constructed.

Activities at the Hanford Site are centralized in numerically designated areas. The reactor facilities are located along the Columbia River in what are known as the 100 Areas. The reactor fuel processing and waste management

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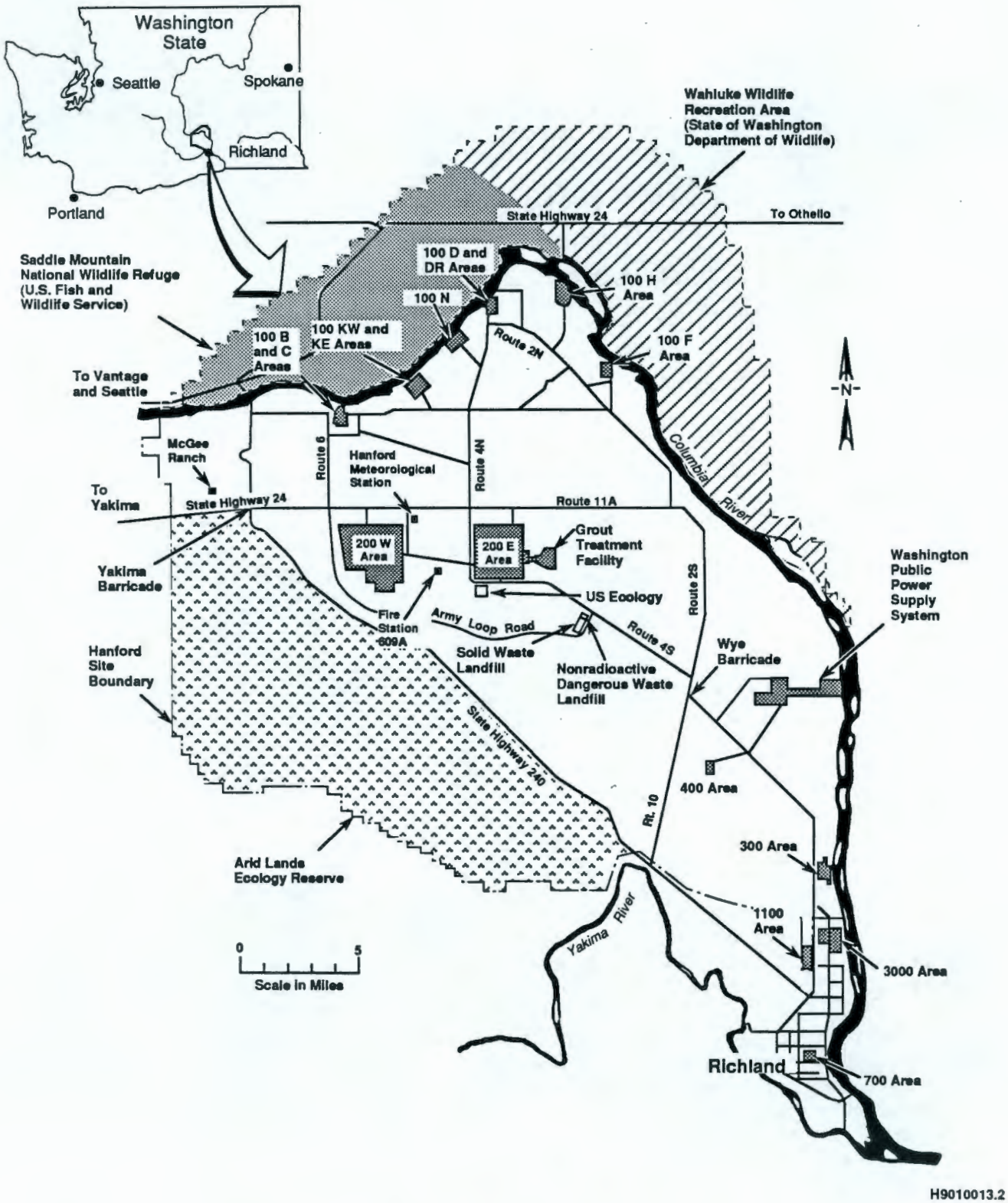

Figure I-1. Hanford Site and Regional Map.

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facilities are located in the 200 Areas, situated on a plateau about 7 mi from the river. The 300 Area, located north of Richland, contains the reactor fuel manufacturing facilities and the research and development laboratories. The 400 Area, 5 mi northwest of the 300 Area, contains the Fast Flux Test Facility (FFTF). Administrative buildings and other research and development laboratories are found in the 3000 Area, also located north of Richland. The 1100 Area, north of Richland, contains facilities associated with maintenance and transportation functions for the Hanford Site.

I-3. 2101-M POND LOCATION AND GENERAL DESCRIPTION

The 2101-M Pond is located adjacent to the 2101-M Building in the 200 East Area of the Hanford Site, which is a controlled access area. The location of the pond is shown on the 200 East Area Site Plan in Figure I-2. The location of the pond in relation to the surrounding facilities is shown in Figure I-3.

The 2101-M Pond is a manmade earthen, unlined, uncovered U-shaped surface impoundment. The east arm of the pond is approximately 70 ft in length, the south arm approximately 210 ft in length, and the north arm approximately 205 ft in length. The total area occupied by the pond is less than 1 acre. The pond bottom varies from approximately 10 ft wide and 5 ft below grade in the south arm to approximately 3 ft wide and 9 ft below grade in the north arm. A generalized scale drawing of the pond is shown in Figure I-4.

Discharge from the 2101-M Building enters the pond through a 4-in. cast-iron, low-pressure drain pipe at the southeast corner of the pond. Water entering the pond pools at the outfall and slowly migrates to the three arms of the pond. The water tends to accumulate in the south arm of the pond first, as it is farther below grade and wider than the east arm. The water in the south arm of the pond generally averages only 3 to 6 in. deep over the entire wetted portion, with the exception of the outfall area. The east arm is narrow and the water in this arm is shallow (generally averaging 1 to 2 in. deep). The water must rise to a certain level in the south arm and outfall area before it will flow into the east arm and subsequently into the north arm of the pond. Seasonal variations influence the amount of water entering the pond, and for part of the year, the north arm is dry. Typically, when the north arm is wetted, water occupies an area approximately 2 to 3 ft wide and approximately 1 to 3 in. deep.

The 2101-M Pond is surrounded by expanses of sagebrush, rabbitbrush, Russian thistle, cheatgrass, and Sandburg's bluegrass. The riparian habitat in existence at the pond is typical of the wetland communities created by man in the arid conditions of the shrub-steppe desert. The areas of open water at the pond are extremely limited. Most of the wetted portion of the pond is overgrown with horsetails, cattails, and sedges. Trees, primarily black cottonwood, peach leaf, and sandbar willow, along with scattered individual Russian olive and Rocky Mountain juniper, dominate the banks. Photographs of the pond, taken in October 1988, are shown in Figures I-5, I-6, and I-7. Photographs taken in April 1993 are shown in Figures I-8, I-9, I-10, and I-11.

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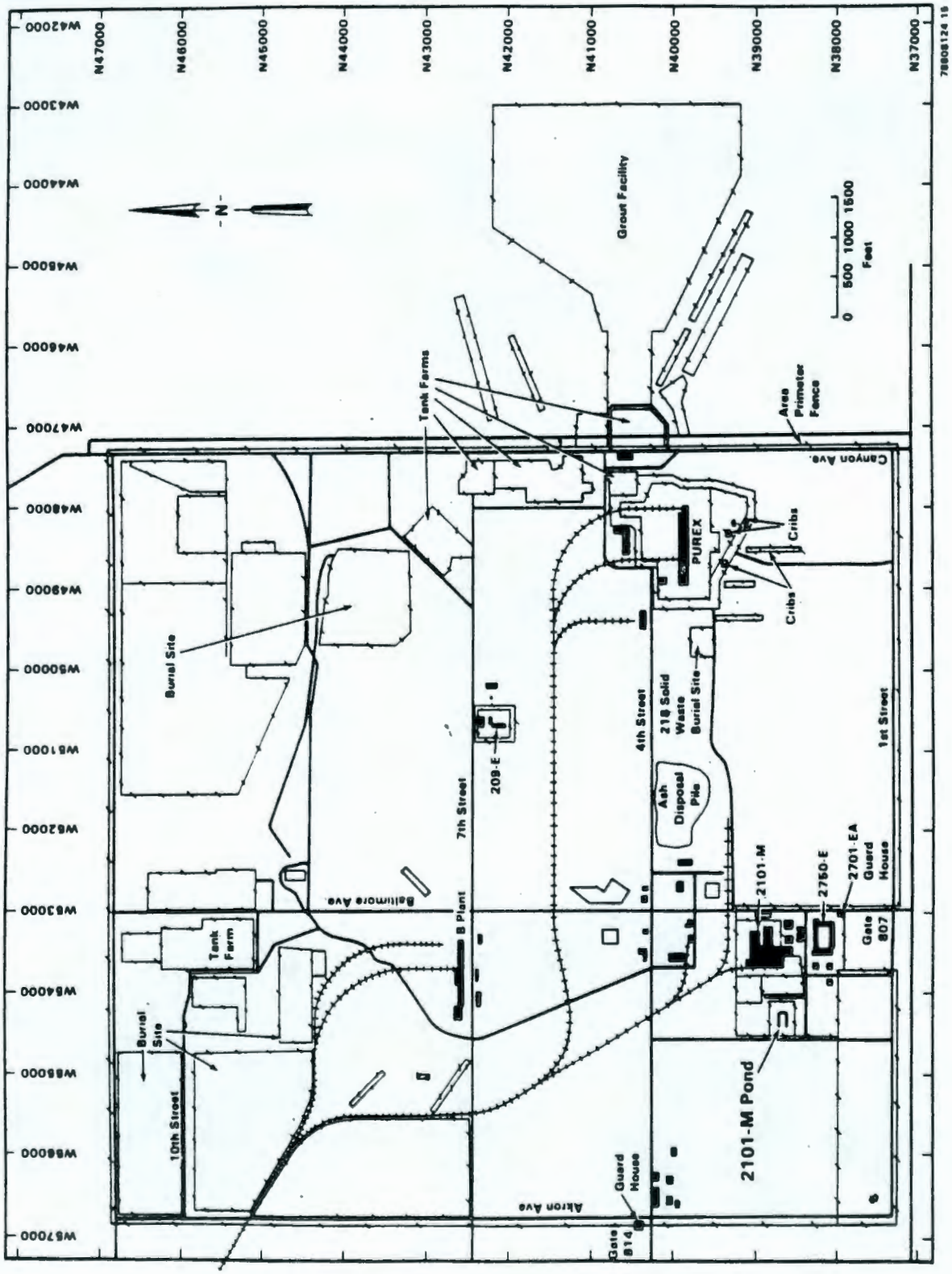

Figure I-2. 200 East Area Site Plan.

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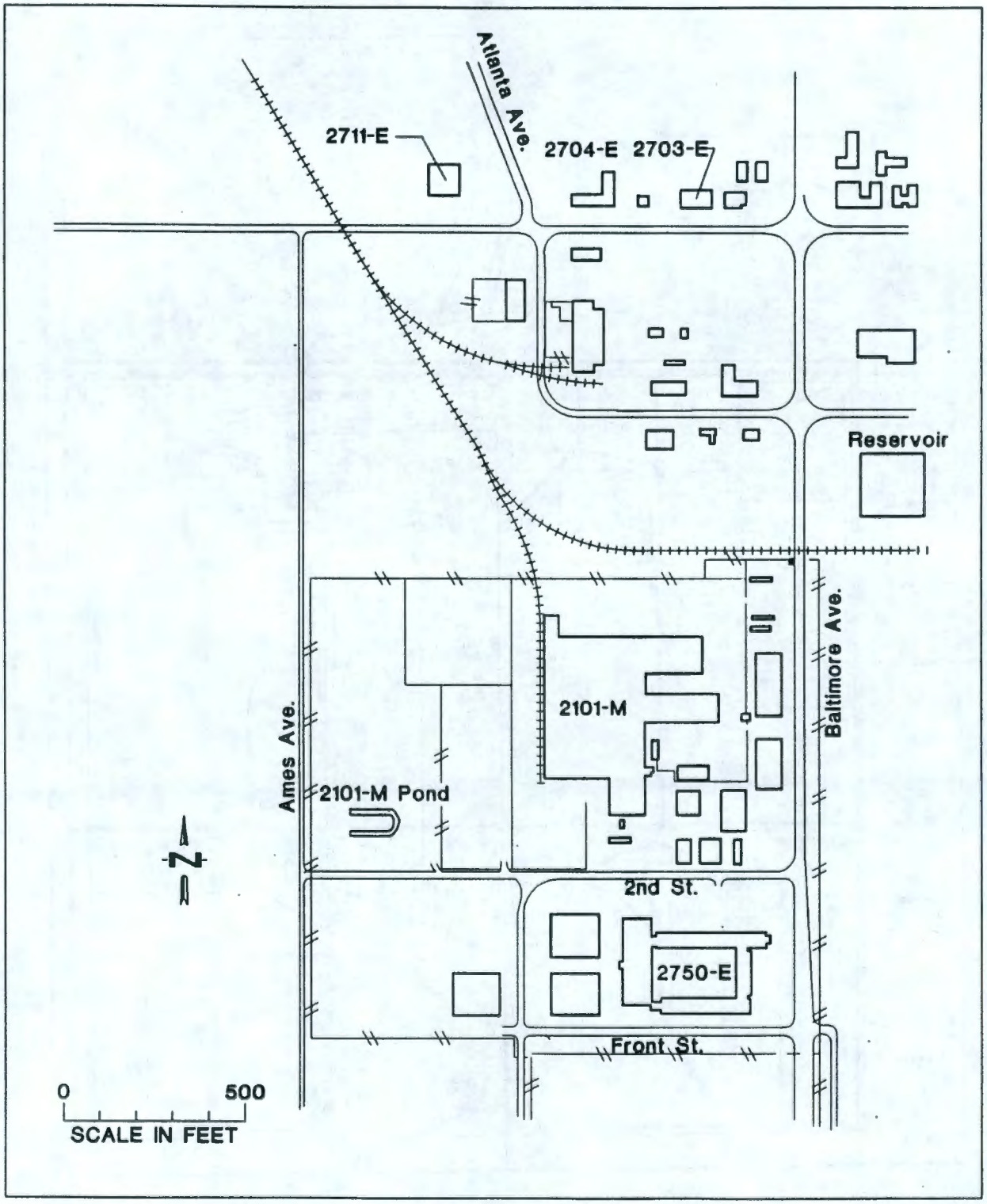

Figure I-3. Location of the 2101-M Pond in Relation to Other Facilities.

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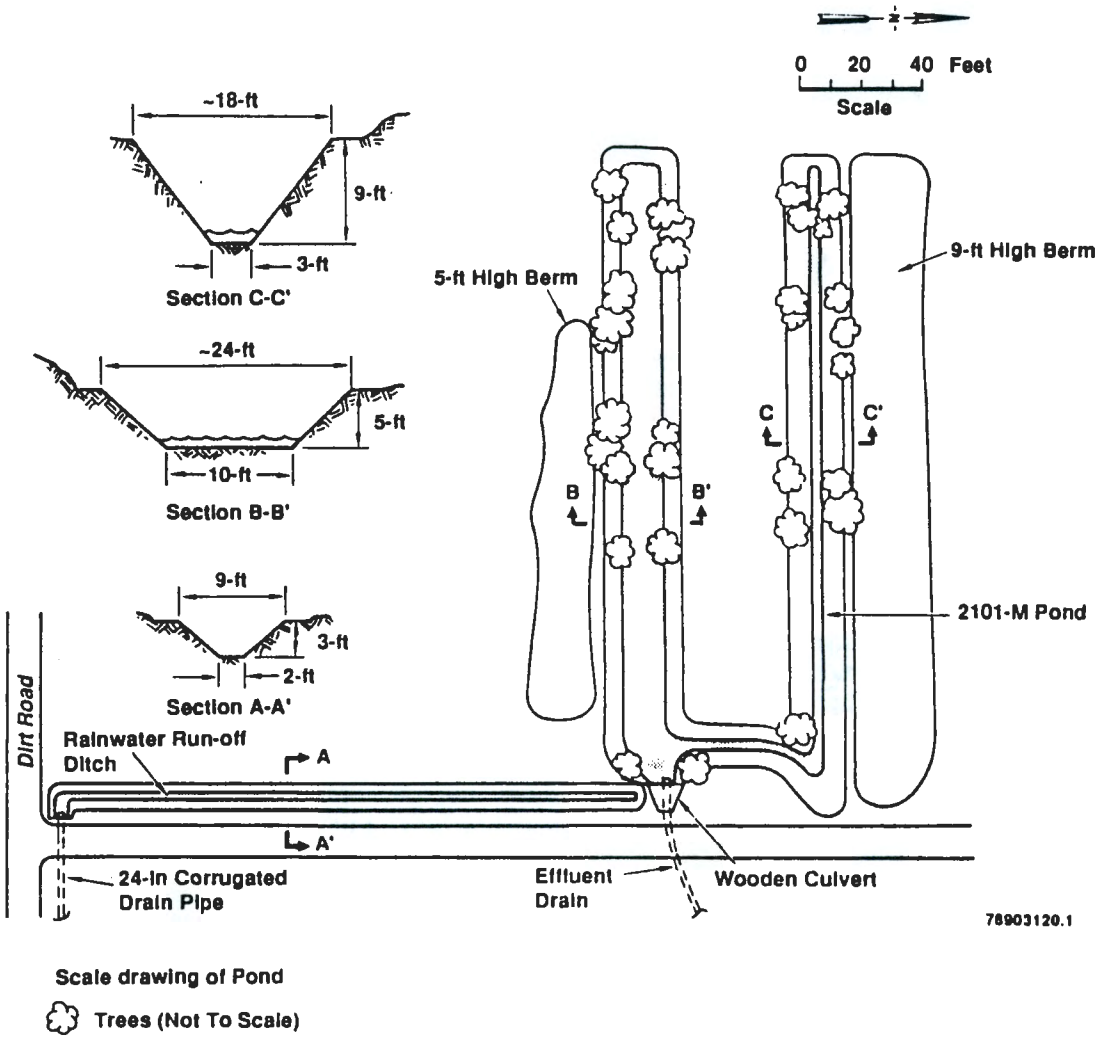

Figure I-4. Generalized Scale Map of the 2101-M Pond.

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A drainage ditch adjacent to the 2101-M Pond (Figure I-4) collects rainwater run-off from surrounding streets, storage areas, and parking lots. Run-off is discharged to the ditch through a 24-in. corrugated drain pipe located at the south end of the ditch. This run-off is typically of the type that would be produced from parking lots and streets used by motor vehicles. None of the run-off is from any chemical or dangerous waste storage areas. There is no evidence that the run-off is a dangerous waste.

The rainwater run-off ditch rarely contains standing water or wetted sediments. Conditions of low rainfall and quick percolation into the sandy soil allow for rapid infiltration of run-off. A parking lot and street drainage construction project in 1986 greatly increased the surface area and the amount of run-off that drains to the ditch. A topographical map including the parking lots, street improvements, and subsurface drainage in the area is shown in Figure I-12. As a result of the increased discharge, the water level in the ditch during periods of higher rainfall may rise to a level that allows drainage water to discharge to the 2101-M Pond.

No aquatic or riparian vegetation grows in this ditch or along its banks, and the appearance of the ditch bottom at the outfall shows little organic material present.

The ditch is constructed above the grade of the 2101-M Pond and approximately the last 30 ft slopes slightly away from the pond. The physical design of the ditch and the water level in the pond coupled with an earthen barrier prevent backflow from the pond to the ditch. The water in the pond has never been observed to reach the level of the ditch, even during the months of maximum discharge. Because the ditch is not physically connected to the 2101-M Pond and has not received discharge from the pond, it is not included as part of the waste management unit with the pond.

The lateral movement of water through the soil separating the rainwater run-off ditch and the 2101-M Pond is not considered to be a point of concern. The soil separating the run-off ditch and 2101-M Pond is composed of the sandy material found in the area. The lateral movement of water through a sandy textured soil is limited by the texture, and is predictable. The best way to demonstrate this is to treat the rainwater run-off ditch as if it were a large irrigation furrow.

A irrigation furrow is used to irrigate crops by pulling a small ditch through the area to be irrigated. The spacing of these furrows is highly dependent upon the texture of the soil in which they are used. The loamier or finer grained the soil, the wider the spacing can be because water moves in all directions in a fairly uniform manner. The coarser grained soils do not possess as much surface area as the finer grained soils, and hence, do not have as great a matrix potential force as loamier and finer grained soils. For this reason, the coarser the soil particles become, the smaller the amount of horizontal movement through the soil because of the greater influence of gravitational forces on water movement.

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1 Figure I-5. View of 2101-M Pond Facing West.

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1 Figure I-6. View of 2101-M Pond Facing East.

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Figure I-7. View of 2101-M Pond and Adjacent Rainwater Run-off Ditch Facing Southwest.

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1 Figure I-8. View of 2101-M Pond Influent Facing South.

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1 Figure I-9. View of 2101-M Pond Facing Southeast.

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1 Figure I-10. View of 2101-M Pond North Arm Facing East.

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1 Figure I-11. View of 2101-M Pond, South Arm Facing East.

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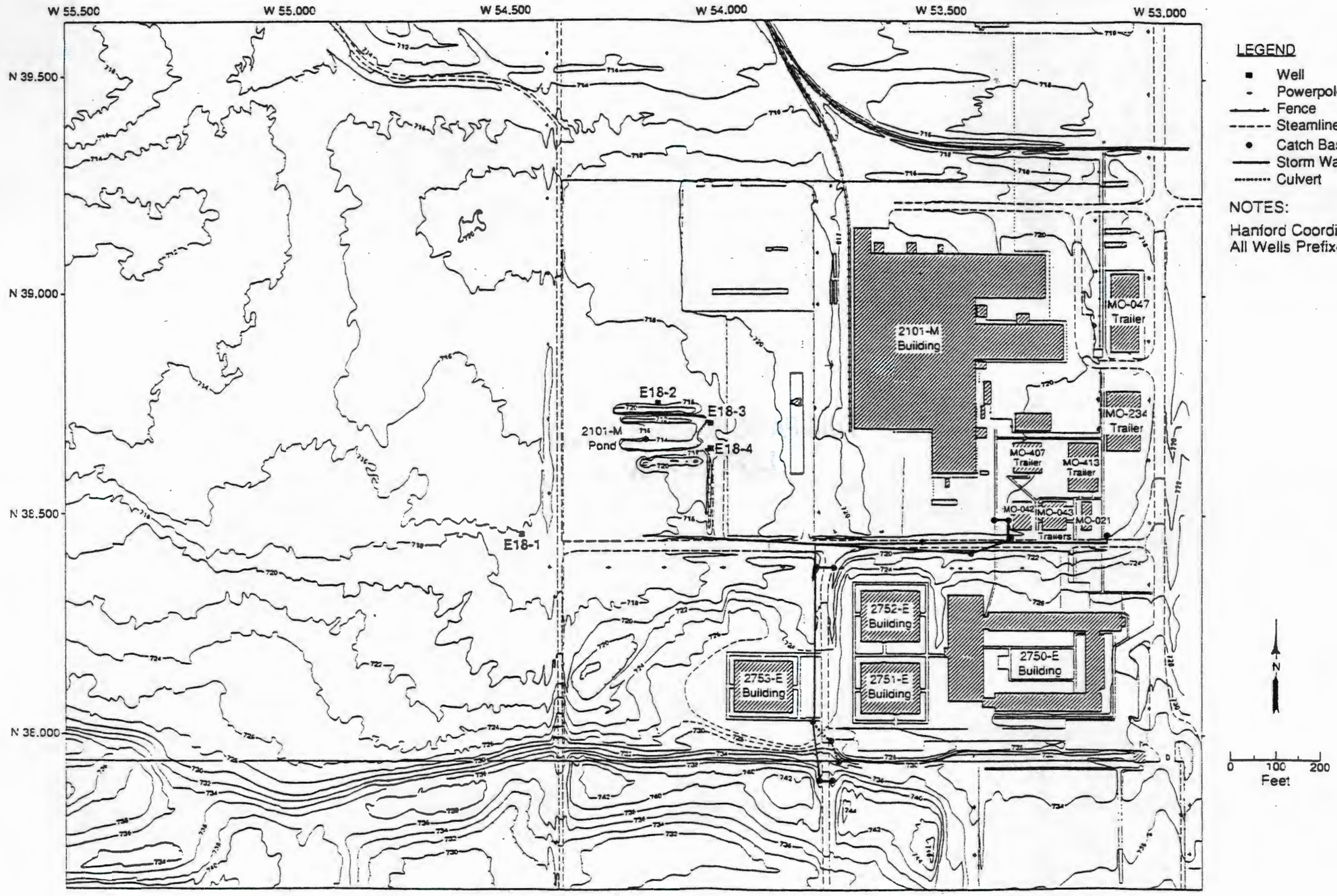

Figure I-12. Topographical Map of the 2101-M Site.

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Typical water movement through soils of different texture is demonstrated in Figure I-13. By applying this knowledge to the 2101-M Pond and adjacent rainwater run-off ditch, it is concluded that the lateral movement of water through the soil (between the two) is not expected in unsaturated conditions.

I-4. 2101-M BUILDING GENERAL DESCRIPTION AND PROCESS INFORMATION

The 2101-M Building has hosted a number of facilities since its construction in 1953. However, until the addition of the BWIP Laboratory in 1979-1981, the only discharge to the 2101-M Pond was condensate water from the 2101-M Building's HVAC system. Drains for the laboratory were plumbed into the 4-in. low-pressure drain pipe for the building's HVAC system. In 1985, administrative controls were emplaced to prohibit disposal of chemical waste via the laboratory drains. The BWIP was terminated in December of 1987, although the laboratory continued operating on a small scale conducting closeout activities until 1988.

Figure I-14 depicts all drains still operational as of March 1991 and their final destinations. Investigations of the 2101-M Building plans and subsequent conversations with the facility engineer indicate that the former BWIP Laboratory was the only facility plumbed into the low-pressure drain pipe for the building HVAC system.

The former BWIP Laboratory consisted of several rooms located along the west side of the south wing of the 2101-M Building. Each room was set up to conduct different types of experiments and analyses. One laboratory room was constructed in the central part of the building. This laboratory room was used by BWIP to develop and test concrete and grout. It also was used by BWIP and other organizations to perform sieve analyses on sediment samples and to determine the calcium carbonate content of sediment samples using hydrochloric acid. The BWIP Laboratory contained 41 drains in the form of sinks, hoods, and eyewash stations that contributed liquid waste to the low-pressure drain pipe.

The various BWIP Laboratory activities conducted are summarized below.

- Hydrothermal--An experimental program was set up to test the stability of basalt/bentonite packing material in the hydrothermal environment expected in the geologic repository. Solid material was reacted with synthetic groundwater at temperatures as high as 300 °C for periods of several months. Reaction products were sent to the solids analysis section of the BWIP Laboratory and reacted fluids were sent to the solution chemistry section of the BWIP Laboratory.

- Physical Properties--Physical properties of basalt were determined in a specialized rock mechanics section of the BWIP Laboratory. Properties measured included tensile, compressive, and shear strengths, P- and S-wave velocities, and electrical conductivity. The hydraulic conductivity and swelling pressure of basalt/bentonite

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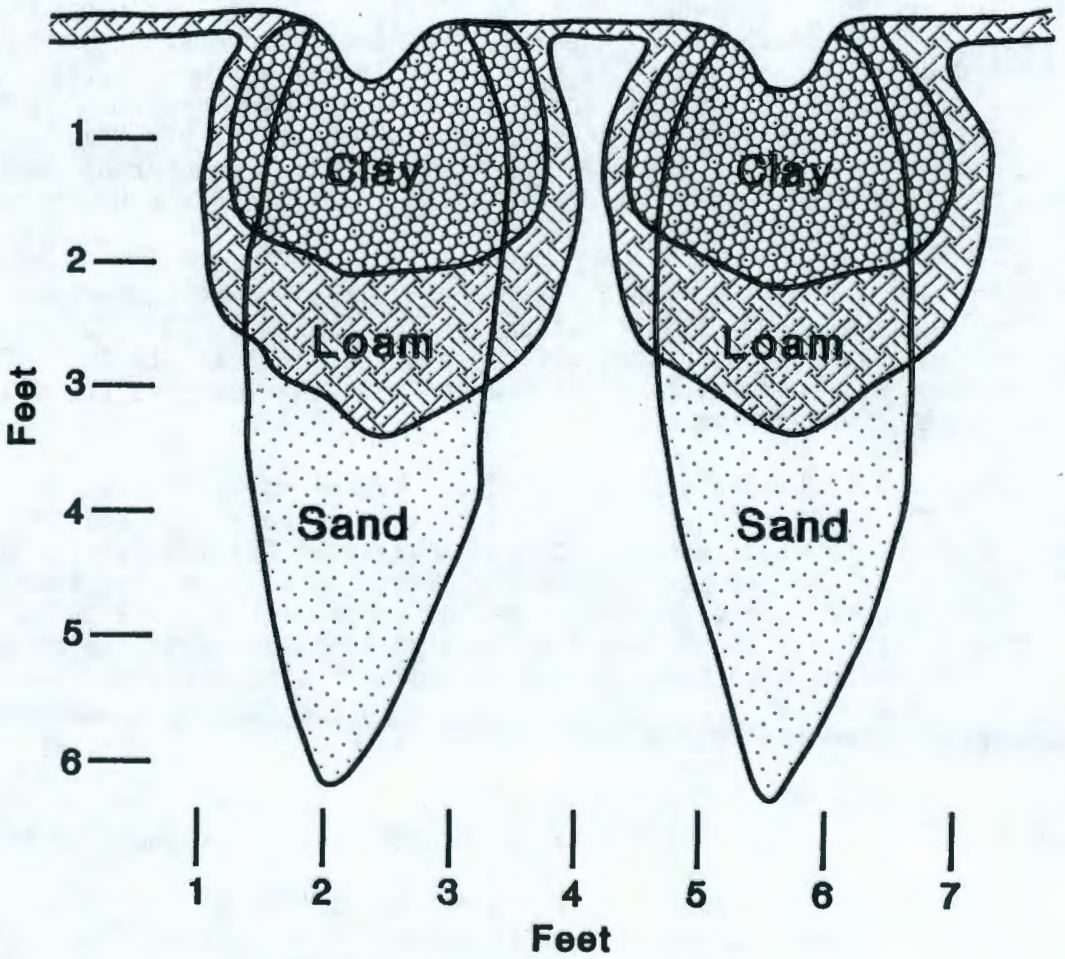

Figure I-13. Typical Patterns of Moisture Penetration for the Same Amount of Water in Different Homogenous Soils (USDA 1983).

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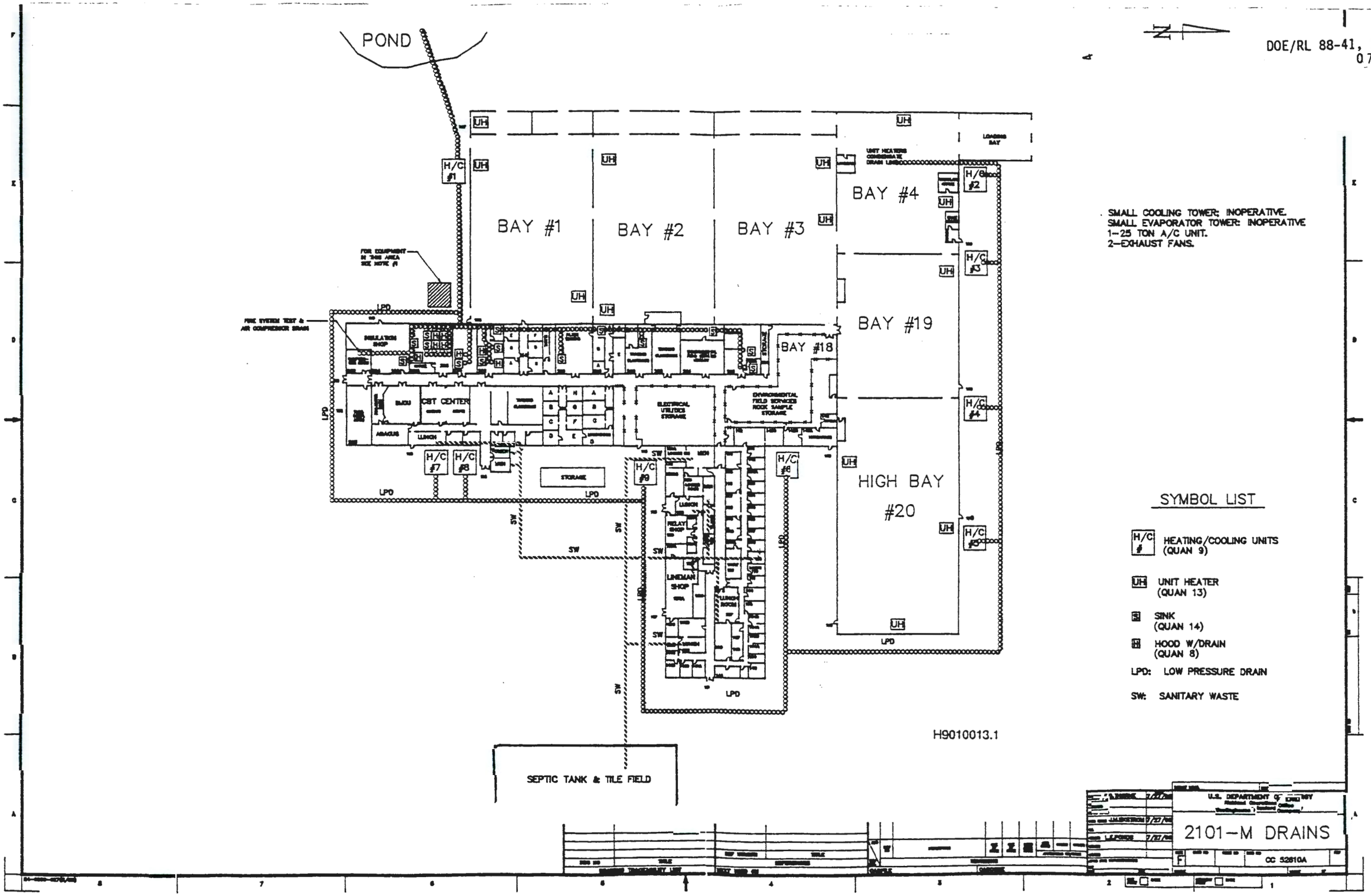

Figure I-14. 2101-M Building Drains.

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packing material were measured in pressure cells. Solid samples were archived or sent to the solids analysis section of the BWIP Laboratory. Groundwater that passed through the packing material was analyzed in the solution chemistry section of the BWIP Laboratory.

- Concrete and Grout--Concrete and grout were important structural elements in the BWIP design for repository excavations and seals. Laboratory experiments were performed to optimize mixtures, determine setting characteristics under repository conditions, and assess long-term stability of the seals. Concrete and grout were mixed, set, and tested in the laboratory. Solid reaction products were archived or sent out for analysis, while the fluids were generally incorporated into the concrete or grout.

- Solids Analysis--Experimental reaction products and geologic materials from the Hanford Site were studied in the solids analysis section of the BWIP Laboratory. Techniques included optical and electron microscopy, electron microprobe analysis, and X-ray diffraction. Standard photographic chemicals were employed in the darkroom, which supported the electron microscopes.

- Solution Chemistry--Experimental reaction fluids and Hanford Site groundwater were analyzed in the solution chemistry section of the BWIP Laboratory. Techniques included inductively coupled plasma (ICP) spectrometry, ion chromatography, atomic absorption spectrometry, ultraviolet/visible spectrometry, and gas chromatography. In addition, samples were prepared for shipment to offsite laboratories for absolute dating and trace-gas analysis.

Currently, the 2101-M Building houses a spare parts storage area, a geologic sample storage area, an insulator shop, a high-efficiency particulate air (HEPA) filter test shop, a substation maintenance shop, an instrument maintenance shop, the Vent and Balance Group (maintains the HVAC for part of the Hanford Site), the Solids Characterization and Barriers Laboratory, classrooms, and offices. Some of the rooms formerly occupied by the BWIP Laboratory have been remodeled for more general purposes, and some of the drains have been removed. Current use of the renovated rooms include the filter test shop, the instrument maintenance shop, offices, training classrooms, and the soil mechanics laboratory.

The substation maintenance shop is not plumbed to the 2101-M Pond. However, polychlorinated biphenyls (PCB) were analyzed during the initial soil sampling (Section B-5). Analyses during the Phase II sampling also included PCBs (Appendix D-1).

The insulation shop was plumbed to the 2101-M Pond. However, the shop did not handle any asbestos products during the time the shop was equipped with a drain that emptied into the pond. The one sink in the insulation shop has been removed and the drain closed.

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The Solids Characterization and Barriers Laboratory currently has plans to move from the 2101-M Building by mid-June 1993. At that time, the one remaining sink left in those rooms will be permanently closed. As an interim measure, the laboratory currently collects all liquid waste, including rinse water, in a carboy for designation and disposal.

All other drains have been closed with the exception of the compressor room floor drain. Plans to grout the floor drain closed are in place. Once the two remaining drains are closed, there will be no possibility of further dangerous waste discharge to the pond from the 2101-M Building.

I-5. SECURITY

Because of the continuing 200 Areas activities and the presence of several facilities that handle dangerous and radioactive materials, the Hanford Site maintains an effective site security program in the 200 Areas. Although originally intended for protection of government property, classified information, and special nuclear material, the current security program meets the requirements as outlined in Washington Administrative Code (WAC) 173-303-310 for dangerous waste sites. The security systems on the Hanford Site prevent unknowing entry and minimize the possibility for unauthorized entry of persons or livestock into the 2101-M Pond.

Unauthorized or unintended entry to the facility is prevented by 24-h surveillance systems in the form of staffed barricades at the entries to controlled-access areas, and fences, gates, locks, and warning signs. The Wye and Yakima Barricades (Figure I-1) control access to the Hanford Site. Only personnel who have obtained a proper a security badge or visitors escorted by badged personnel are permitted to enter Hanford Site controlled-access areas. The Hanford Patrol provides routine surveillance patrols of the controlled-access areas.

Hanford Site personnel receive training on security regulations in the form of required security education and on-the-job training. Procedures for ensuring personnel compliance with safety and security requirements, providing security education, and training personnel are developed and maintained on the Hanford Site. Performance of periodic security compliance audits and inspections ensure that these procedures are followed.

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A. CLOSURE PERFORMANCE STANDARDS

In accordance with WAC 173-303-610, the 2101-M Pond will be closed in a manner that:

- Minimizes the need for further maintenance
- Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, postclosure escape of dangerous waste, dangerous waste constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground or surface water, or to the atmosphere
- Returns the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity
- Complies with specific closure requirements of WAC 173-303-650.

Each closure performance standard and the rationale for how each standard is satisfied by the clean closure approach proposed for the 2101-M Pond is discussed in the following sections.

A-1. MINIMIZE THE NEED FOR FURTHER MAINTENANCE

The 2101-M Pond will be clean closed, and no maintenance will be required after closure has been certified. However, if clean closure cannot be achieved, 2101-M Pond will be closed as a landfill requiring a 30-yr minimum maintenance schedule as discussed in Section II. During the closure period, the only maintenance required would be associated with the groundwater monitoring wells.

As required by WAC 173-303-645 and 40 Code of Federal Regulations (CFR) Part 264, Subpart F, groundwater samples will be collected quarterly for the first year and semiannually thereafter until closure has been certified. Once closure has been certified, groundwater monitoring will not be required.

The groundwater monitoring wells must be maintained through closure to ensure that representative groundwater samples are collected. The types of activities that might be required to maintain the wells include inspection and repair of the sample pumps and flushing screens to ensure an adequate flow of water into the wells.

A-2. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The 2101-M Pond soil and soil from a nearby site, for background comparison, have been previously (1988) sampled from 0 to 12 ft on a 2-ft sample interval. These samples were analyzed for a broad spectrum of

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constituents. They include drinking water quality, 40 CFR Part 264, Appendix IX, and WAC 173-303-9905 constituents. A complete analytes list is contained in Appendix C-1.

The Phase II Sampling (1991) further characterized the top 2 ft of soil on a 6-in. sample interval. The Phase II Sampling Plan and the results are presented in Appendix D-1 and D-4.

Analytes that have values above detection limits are compared to background concentrations to determine the presence of contamination. Those constituents found to be significantly above background concentrations will then be evaluated by the human health model presented in Section B-5g to determine the significance of the contamination and to establish action levels. Action levels refer to concentration thresholds that the soil constituents should not exceed, or remediation would be required for clean closure of the facility.

The groundwater data collected thus far, and the analytical results suggest that the groundwater beneath the pond has not been contaminated by past disposal practices at the BWIP laboratories (Section B-3).

A-3. LAND RESTORATION

Clean closure is the primary closure strategy proposed for the 2101-M Pond. After Ecology accepts certification of clean closure, the DOE-RL intends to continue to use the pond for disposal of nondangerous condensate water from the 2101-M Building HVAC system. Therefore, no site reclamation actions are planned at this time. All discharges to the 2101-M Pond will cease by June 1995, per Milestone M-17-43 (Ecology et al. 1992).

In the event that the disposal unit cannot be clean closed, the final cover design specifies select cover vegetation for the site (Section II).

A-4. SPECIFIC CLOSURE REQUIREMENTS OF WAC 173-303-650

At closure, the owner or operator must conduct one of the following activities:

(1) Remove or decontaminate all dangerous waste, dangerous waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and structures and equipment contaminated with dangerous waste and leachate and manage them as dangerous waste; or

(2) Close the impoundment and provide postclosure care for a landfill.

The EPA interpretation of the "remove and decontaminate" language in (1) above has been provided in the March 19, 1987, Federal Register (EPA 1987). The EPA interprets the terms "remove and decontaminate" to mean removal of all

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waste and liners and the removal of leachate and materials contaminated with the waste or leachate that pose a present or potential threat to human health or the environment.

The 2101-M Pond is unlined; therefore, no contaminated containment system components exist to be removed. There are no other associated structures or equipment that would be contaminated with waste and leachate that would require removal or decontamination.

The 2101-M Pond will be clean closed; therefore, it is anticipated not to be subjected to the closure or postclosure requirements for a landfill. However, a contingent closure/postclosure plan is included in Section II.

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B. CONTENT OF CLOSURE PLAN

In accordance with WAC 173-303-610, this plan identifies the steps necessary to perform final closure of the 2101-M Pond.

B-1. DESCRIPTION OF FINAL CLOSURE

The pond soil was initially sampled and analyzed in 1988 to assess the presence of dangerous waste and dangerous waste constituents. A total of 23 soil samples were taken in the pond from 0.0 to 12.0 ft (Section B-5a, Figures B-2 and B-5). Soil samples also were taken from four nearby locations for background comparison (Section B-5a, Figures B-3 and B-4). In 1991, a total of 26 soil samples were taken in the pond from 0 to 2 ft. An additional four samples also were taken from the dry background site (Section B-5a, Figure B-3) as a reference for intralaboratory bias. Analytes with all concentration values below detection limits were eliminated from further consideration. Analytes with concentrations above detection limits were compared to background concentrations. Analytes with all concentration values below background concentrations were also eliminated from further consideration. The remaining analytes were then compared to the human health risk model presented in Section B-5g. Complete discussions of the soil sampling activities and results are provided in Section B-5 and Appendix C-1, D-1, and D-4.

The results suggest that the concentration of constituents in the pond soil, attributed to past waste disposal practices at the 2101-M Pond, does not pose a present or potential threat to human health or the environment.

The EPA interpretive regulations (EPA 1987) acknowledge that, at certain sites, limited quantities of dangerous constituents might remain in the subsoil and yet present only insignificant risk to human health and the environment. However, if the levels of dangerous constituents exceed the action levels established by the proposed health risk model in Section B-5g, remediation in the form of soil removal would be required.

To define the potential impact that past 2101-M Pond disposal practices may have on the uppermost aquifer underlying the pond, a groundwater monitoring program was implemented. During the summer of 1988, four groundwater monitoring wells were installed into the upper aquifer below the 2101-M Pond, and quarterly monitoring was initiated. Quarterly groundwater monitoring continued through November 1989. Thereafter, sampling is done semiannually until clean closure is certified, or to the end of the post-closure care period in the event clean closure is not achieved. If contamination or statistically significant changes in the indicator parameters are detected, resampling will be performed. If the presence of dangerous waste constituents is confirmed, an assessment-level program may be invoked.

The assessment-level program would be used to determine if detected contamination is attributed to past disposal practices at the 2101-M Pond. Results from the samples collected thus far indicate that the groundwater

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beneath the pond has not been contaminated by past disposal practices at the 2101-M Pond (Section B-6). Groundwater analysis results are contained in Appendix E and are reported to Ecology in quarterly reports for the Hanford Site. A site characterization report (Chamness et al. 1990) was generated by Pacific Northwest Laboratory (PNL) that includes information obtained during this first year of monitoring.

During well drilling, sediment samples were taken by PNL. Some of these samples were submitted for analysis. These samples were analyzed to determine the presence of dangerous waste and dangerous waste constituents. The analytical results suggest that there is no evidence of unusually high concentrations of metals or occurrence of volatile organics in the vadose zone sediment. Section B-5a(3.1) presents a more complete discussion of vadose zone sampling and Appendix C-1 presents analytical results.

An independent professional engineer, registered in the State of Washington, will certify that closure activities were performed in accordance with an approved closure plan for the 2101-M Pond.

In addition to the activities discussed previously, administrative and physical controls will be invoked to ensure that dangerous waste is not discharged to the 2101-M Pond by future occupants of the former BWIP Laboratory. Physical controls constitute the removal of sinks/hoods and capping drains plumbed to the 2101-M Pond. Administrative controls constitute interim measures to be used until the physical controls are completed. These administrative measures include the following:

- Posting all operational sinks with signs reading "Do Not Use For Waste Disposal," or an equivalent legend

- Inspection of all operational drains bimonthly and semiannually; semiannual inspections will be random and unannounced

- Collection of laboratory waste water in a carboy for designation and disposal

- Monitoring of the 2101-M Building effluent semiannually to include, but not limited to, ICP metals, volatile organics, and semi-volatile organics (WHC 1992).

B-2. MAXIMUM EXTENT OF OPERATION

In accordance with WAC 173-303-610(3)(a)(ii), the description of final closure must, "identify the maximum extent of the operation which will be unclosed during the active life of the facility."

The 2101-M Pond was originally constructed in 1953 to receive discharges of nondangerous waste water from the 2101-M Building HVAC system. A physical description of the pond is contained in the introductory portion of Section I. Until the BWIP Laboratory was constructed in 1979-1981, the only discharge to

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the pond was water from the 2101-M Building HVAC system. Since 1986, when the parking lot and street drainage were constructed, small amounts of rainwater run off also have been occasionally discharged to the pond from the adjacent rainwater run-off ditch.

From 1981 through July 1985, the only source of dangerous waste would have been the BWIP Laboratory. Closure of the 2101-M Pond to dangerous waste was initiated in July 1985 with the implementation of administrative controls. These controls required dangerous waste to be collected, packaged, and shipped offsite for disposal at a dangerous waste management unit. Estimates of the maximum volume of dangerous waste that may have been discharged to the 2101-M Pond from the BWIP Laboratory drains are presented in Section B-3a.

B-3. REMOVAL AND MANAGEMENT OF DANGEROUS WASTE

In accordance with WAC 173-303-610(3)(a)(iii and iv), the following information is to be included in the closure plan:

> An estimate of the maximum inventory of dangerous wastes ever on-site over the active life of the facility. (Any change in this estimate is a minor modification under WAC 173-303-830(4)); a detailed description of the methods to be used during partial closures and final closure, including, but not limited to, methods for removing, transporting, treating, storing, or disposing of all dangerous wastes, and identification of the type(s) of the off-site dangerous waste management units to be used, if applicable;

An estimate of the maximum inventory of dangerous waste ever onsite over the active life of the facility is provided in Section B-3a. The relevancy of the methods to be used during partial and final closure of the 2101-M Pond and the identification and types of offsite dangerous waste management unit(s) to be used are presented in Sections B-3b and B-3c, respectively.

B-3a. Estimate of the Maximum Inventory of Dangerous Waste

Since 1953, the 2101-M Pond has received waste water from the 2101-M Building. Most of the waste is nondangerous waste water from the 2101-M Building HVAC system. The BWIP Laboratory drains were plumbed into the low-pressure drain pipe that carries waste water from the building HVAC system to the 2101-M Pond. It is from these laboratory drains that dangerous waste would have been discharged to the 2101-M Pond. The BWIP administrative controls were implemented in July 1985 to ensure that dangerous waste was not discharged to the pond. No other facilities at the 2101-M Building are plumbed into the low-pressure drain pipe that carries waste water to the 2101-M Pond.

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All available documentation of waste-disposal practices has been collected and evaluated. The inventory estimate presented in Section B-3A(1) relies on the following:

- Documents that exist and can be confirmed as reliable
- Estimates of potential waste volumes
- Information obtained from personnel who worked at the 2101-M Building
- Analyses of the soil in the 2101-M Pond and at background locations near the pond.

Before the time that it was determined that RCRA guidelines applied to nonradioactive dangerous waste operations at DOE facilities, detailed RCRA records documenting the waste generated and the amounts of this waste that may have been discharged to the 2101-M Pond were not maintained. Thus, much of what is discussed in the following sections is based on worst-case assumptions. Some or all of the dangerous waste described below, with the exception of barium, may not have been actually disposed of at the 2101-M Pond. The intent is to identify the potential types of dangerous waste that may have been generated and the maximum amount of dangerous waste that could have been discharged to the 2101-M Pond.

The following sections also include an estimate of the volume of nondangerous waste water discharged to the pond.

B-3a(1). Inventory of Types of Waste That May Have Been Discharged to the 2101-M Pond from the BWIP Laboratory. From 1981 to 1985, BWIP Laboratory operations at the 2101-M Building have sporadically generated small quantities of laboratory chemical waste water. Estimates of waste volumes generated are provided in the following three sections. The BWIP Laboratory was not a production facility that continuously generated large volumes of chemical waste. Operations at the laboratory have been terminated and existing chemical stocks have been removed for offsite disposal or have been transported to other laboratories onsite. An inventory of the chemicals the BWIP Laboratory may have had on hand during its active life is provided in Appendix B-1. The types of chemicals on stock at the laboratory are typical of earth science research analytical laboratories. Records concerning the amount of chemicals on stock over the operational life of the laboratory are not available.

With the exception of barium, sodium hydroxide, and dilute quantities of acids, there is no written evidence that potentially dangerous waste or waste constituents from the BWIP Laboratory were discharged down the drains. According to available records and personnel who worked at the BWIP Laboratory, no unused chemical products have ever been discarded down the laboratory drains. According to laboratory personnel, unused chemicals were transferred to other onsite laboratories for use or transported offsite for disposal. Thus, any chemicals discharged down the laboratory drains to the 2101-M Pond would have been used or spent chemicals.

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It is possible that these waste laboratory chemicals, if disposed of, could have been designated dangerous waste as one of the following:

- Listed solvents F002, F003, and F005 under WAC 173-303-082 and -9904
- For the properties of ignitability, corrosivity, reactivity, extraction procedure (EP) toxicity and/or toxic characteristic leach procedure (TCLP), toxicity, persistence, and carcinogenicity under WAC 173-303-090, -101, -102, -103
- Dangerous waste mixtures under WAC 173-303-084.

Chemicals on the BWIP Laboratory inventory may have been discharged to the 2101-M Pond through July 1985. Since 1985, BWIP Laboratory disposal practices have been formalized in written procedures (Appendix B-2) that required packaging and offsite disposal of laboratory chemical waste, used and unused.

The following sections describe the waste and provide estimates of the quantity of waste that were, or may have been, discharged to the 2101-M Pond before implementation of administrative controls.

B-3a(1.1). Barium. From spring 1982 to July 1984, groundwater samples were subjected to inorganic analyses and age dating. Part of this process involved the addition of NaOH and 2.6 oz of $BaCl_2$ to each of two 5-gal groundwater samples to precipitate inorganic carbon as $BaCO_3$ (total of 5.2 oz $BaCl_2$ for each groundwater sampling event). After settling of the precipitant, the supernatant was removed from the samples and discharged to the 2101-M Pond via the laboratory drains.

During the 2 yr that barium discharges occurred, 123 groundwater samples (10 gal each) were handled at the laboratory. Assuming the worst case, that no barium ion was precipitated in the samples, up to 3.5 oz of barium ions could have been discharged for each groundwater sample. For 123 total samples (1,230 gal), this amount would be a maximum of 26.9 lb of barium ions over the 2-yr period.

Assuming that the supernatant discharged to the 2101-M Pond contained enough barium ions to cause it to be designated for EP toxicity and/or TCLP, up to approximately 10,250 lb of dangerous waste water (assuming 1 gal to be approximately 8.34 lb), designated D005, were disposed of in the 2101-M Pond from 1982 to July 1984.

B-3a(1.2). Acids. From 1981 through July 1985, BWIP Laboratory operations generated waste acids, principally nitric and hydrochloric acids. Other waste acids generated at the laboratory included hydrofluoric and sulfuric acid. The laboratory staff indicated that discharges of nitric and hydrochloric acids may have ranged from 2.2 to 22 lb/yr during the 4 to 5 yr that the BWIP Laboratory could have disposed of dangerous waste to the 2101-M Pond. Any waste acids that might have been discharged to the 2101-M Pond may have had a low enough pH at the time of disposal to cause them to be designated for corrosivity (D002).

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The amount of other laboratory chemicals that may have been discharged to the 2101-M Pond is described below. The amount of waste acid is included in this total.

B-3a(1.3). Other Waste That May Have Been Discharged to the 2101-M Pond from the BWIP Laboratory. On-site shipping documents generated as a result of administrative controls indicate that for a 1-yr period (September 1985 to September 1986), approximately 1,800 lb of dangerous waste was collected for disposal. The on-site shipping documents record the chemical waste and quantities of the waste collected for disposal at a dangerous waste management unit. Copies of the on-site shipping documents are provided in Appendix B-3. Of the 1,800 lb, approximately 1,050 lb were barium solutions from analysis of groundwater samples as discussed previously. Excluding the barium, approximately 750 lb of dangerous waste was collected for disposal. As can be seen by reviewing the disposal analysis records, also in Appendix B-3, water comprised a large percentage of the 750 lb. Approximately 100 lb of chemical waste was determined to be nondangerous waste or nondangerous with neutralization and was discharged down the laboratory drains. Although actual volumes may have varied from year to year during the BWIP Laboratory operation, the September 1985 to September 1986 disposal records provide the best information available at this time for estimating annual waste generation quantities. However, not all of these chemicals are expected to have been discharged to the 2101-M Pond via the laboratory drains (e.g., toluene, benzene).

Based on the above, it is possible to calculate that during the period of 1981 through 1985, approximately 3,750 lb of dangerous waste, excluding barium, may have been disposed of in the 2101-M Pond [750 lb (1985-1986 annual estimate) times 5 yr of disposal (1981 through 1985)]. Water would have made up a very large percentage of this volume. This 3,750-lb estimate is believed to be a very conservative estimate of the quantities that may have been discharged.

The Part A permit application (Appendix A) states that the 2101 M-Pond receives approximately 18,750 gal/d of waste water. The historic discharge of dangerous waste constitutes approximately 6 percent of the total discharge. Based on the information presented in this section, the estimated amount that may have been discharged is considerably less than that reported in the permit application.

It is important to reemphasize that the conclusions are based on the following conservative assumptions.

- All of the chemicals disposed of by the BWIP Laboratory could be designated dangerous waste.

- Past waste chemical disposal rates were equivalent to the September 1985 to September 1986 disposal amounts.

- Up through 1985, all waste chemicals were discharged down the laboratory drains to the 2101-M Pond, rather than sent offsite for disposal.

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B-3a(2). Other Dangerous Waste That May Have Been Discharged to the 2101-M Pond from the 2101-M Building. Previous documents provided to Ecology indicated the possibility that the substation maintenance shop in the 2101-M Building may have released PCB waste to the 2101-M Pond. Subsequent investigation of the plans for the 2101-M Building and interviews with the facility engineer indicate that the substation maintenance shop is not plumbed to the low-pressure pipe draining to the 2101-M Pond. Therefore, it has been concluded that PCB waste was never discharged to the pond and need not be considered for dangerous waste designation purposes. Analyses of the 2101-M Pond soil for PCBs support this conclusion (Appendix C-1). Analysis for PCBs also was done during the Phase II sampling.

B-3a(3). Other Nondangerous Waste Discharged to the 2101-M Pond. A large volume of nondangerous waste water has been, and continues to be, disposed of in the 2101-M Pond from the 2101-M Building HVAC system. A small amount of water is discharged to the 2101-M Pond from the rainwater run-off ditch adjacent to the pond during periods of higher rainfall. The following paragraphs discuss the contribution of waste water from these sources to the 2101-M Pond.

B-3a(3.1). Rainwater Run-off Ditch. The waste water discharged to this ditch is from parking lots and streets used by motor vehicles. None of the run-off is from any chemical or dangerous waste storage areas, and there is no evidence that the run-off is a dangerous waste. Water is discharged from this ditch to the 2101-M Pond only during periods of high rainfall. The volume of water discharged to the pond is very small, and there is no way to accurately estimate the volume. This ditch has not received any waste water from the 2101-M Pond and is not considered as part of the 2101-M Pond waste management unit. For the reasons mentioned above, the contribution of waste water from this ditch will not be considered in the inventory estimate. A physical description of the rainwater run-off ditch is provided in the introductory portion of Section I.

B-3a(3.2). Heating/Cooling Waste Waters. The HVAC system for the 2101-M Building discharges waste water to the 2101-M Pond. Steam piped to the 2101-M Building is used to heat the building. Condensation is discharged from the steam traps to the low-pressure drain pipe that discharges waste water to the 2101-M Pond. Condensate is discharged from the steam traps year round, as steam is piped to the 2101-M Building even when the heating system is not in use. A portion of the water piped to the 2101-M Building is used to run the building air conditioners. Overflow from these air conditioners also is discharged to the low-pressure drain pipe that discharges waste water to the 2101-M Pond. Two of the nine air conditioners were eliminated in January 1992 per the Hanford Federal Facility Agreement and Consent Order Milestone M-17-43A. The water supply for the HVAC system is derived from the Columbia River.

A filming corrosion inhibitor containing straight-chain primary amines is added to the steam at a concentration of approximately 14 parts per million to control corrosion of the piping and ducts. The material safety data sheet (MSDS) for the product states that it is not a dangerous product. The water

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is treated with tablets of trichlorostriazinetrione, a microbicide. The EPA-registered number for the chemical as provided on the MSDS is 4643-47. It is administered to the system in keeping with the instructions governing its use such that it is not considered a dangerous waste.

The HVAC waste water does not come in contact with any chemical sources of contamination other than the corrosion inhibitor, trichlorostriazinetrione, and any materials that may be in the piping through which it flows.

The amount of water used by the building air conditioning system or the BWIP Laboratory was not metered. Hence, it is not possible to determine the exact amount of nondangerous waste water discharged from these facilities to the 2101-M Pond.

The steam used to heat the building is generally metered just before entering the 2101-M Building. Incomplete records of monthly steam use for 1982 through 1988 have been located. In any given year, totals for some months were not recorded. For the purposes of estimating the total annual discharge of waste water from the heating system for 1982 through 1988, the monthly average for a particular year was used for months where no values were reported. Table B-1 provides an estimate of the amount of steam piped to the 2101-M Building and then discharged as waste water to the 2101-M Pond. The amount of steam metered at the building has been converted to gallons of condensate water discharged to the pond.

Table B-1. Condensate Water Discharged to the 2101-M Pond from 1982 to 1988.

Year	Gal/yr
1982	979,464
1983[a]	1,391,296
1984	2,437,116
1985	1,560,756
1986	1,220,856
1987	869,892
1988	1,279,592
Total	9,739,072

NOTE: [a]The average of 1982 and 1984 through 1988 was used as the value for the total gallons for 1983.

In a document prepared for the DOE-RL (DOE-RL 1978), the audited steam use of the 2101-M Building HVAC system was reported to be 3,299 MBtu/month (419,162 gal of water per month). This equates to an annual total of 5,029,944 gal of water that would have been discharged to the 2101-M Pond

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during 1977. This value is assumed to be a reasonable annual estimate of the amount of water that may have been discharged to the 2101-M Pond from the building heating system since its construction in 1953 through 1979, as this is the only information available at this time.

The 1978 DOE-RL document states that the HVAC system was scheduled to be modified to conserve energy. This would result in a decrease in the annual steam consumption. A comparison of the annual steam use for 1977 with the values for 1982-1988 shows a definite decrease in the steam consumption. For this inventory estimate, the assumption is made that the HVAC system was modified in 1979 and that the average annual discharge from the building heating system to the 2101-M Pond for 1980 through 1981 is similar to the average annual value for 1982 through 1988 (1,391,296 gal), rather than the average value for 1953 through 1979.

Based on the information presented above, the total amount of water that may have been discharged to the 2101-M Pond from the heating system, since the BWIP Laboratory went into operation in 1981, is estimated to be 11,000,000 gal. Given the available information, it is not possible to further refine this estimate.

B-3a(4). Analyses of the 2101-M Building Effluent Discharges to the 2101-M Pond. Samples of effluent being discharged to the 2101-M Pond were obtained on September 17, 1985; May 23, 1986; July 17, 1986; October 30, 1986; and January 26, 1987. The raw analytical data is available in Appendix F-1. The analytical results for these samples are presented in Table B-2. All of these samples were obtained after administrative controls were in place at the BWIP Laboratory (July 1985).

Acetone was detected in one of the five samples at the very low level of 40 parts per billion (ppb). This datum could indicate the possibility that a listed F003 solvent may have been discharged to the 2101-M Pond in October 1986. However, such a discharge is highly unlikely because procedures had been in place since July 1985 to prevent discharging chemicals down the BWIP Laboratory drains. Given the extremely low level of acetone and its proximity to the detection limit (10 ppb), it is more likely that other sources were responsible for the acetone detected in the sample (i.e., contamination introduced by sample bottles or by laboratory equipment used by the company analyzing the samples).

Based on these limited results, waste water discharged to the 2101-M Pond does not exhibit the characteristic of EP toxicity (40 CFR 261, Table I) for EP toxic metals. (Arsenic was not analyzed at the time that these effluent samples were taken because there was no reason to believe that potential levels of arsenic would have exceeded threshold values for EP toxicity.) The results also indicate that the effluent would not have been designated for corrosivity caused by pH. Finally, the results indicate that the effluent is neither ignitable nor reactive. Therefore, the effluent discharge analyses

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Table B-2. The 2101-M Building Waste Water Analytical Data[a].

Sampling	1st	2nd	3rd	4th	5th
Sampling date	09/17/85	05/23/86	07/17/86	10/30/86	01/26/87
U.S. Testing number		50051	50089	50167	50232
Stream fraction		1.0000	1.0000	1.0000	1.0000
Constituent	Amount detected (ppb unless otherwise noted)				
Aluminum	<150.0	330.0	200.0	230.0	<150.0
Ammonium	<20.0	<50.0	<50.0	120.0	180.0
Antimony	<100.0	<100.0	<100.0	<100.0	<100.0
Barium	21.0	30.0	30.0	170	10.0
Beryllium	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium	<2.0	<2.0	<2.0	<2.0	<2.0
Calcium	14,000.0	17,000.0	NIC[b]	11,000.0	5,800.0
Chromium	<10.0	<10.0	<10.0	<10.0	<10.0
Copper	42.0	180.0	89.0	530.0	460.0
Iron	94.0	500.0	280.0	1,300.0	240.0
Lead	<30.0	NR[c]	NR[c]	NIC[b]	<5.0
Magnesium	3,200.0	4,100.0	4,200.0	2,100.0	1,300.0
Manganese	6.0	8.0	6.0	19.0	7.0
Mercury	<0.1	1.5	0.3	<0.1	<0.1
Nickel	<10.0	<10.0	<10.0	<10.0	<10.0
Potassium	880.0	770.0	800.0	660.0	320.0
Silver	<10.0	<10.0	<10.0	<10.0	<10.0
Sodium	2,100.0	2,300.0	NIC[b]	2,800.0	740.0
Strontium	<300.0	<300.0	<300.0	<300.0	<300.0
Uranium	0.34	0.68	0.57	0.75	0.31
Vanadium	<5.0	<5.0	<5.0	<5.0	<5.0
Zinc	81.0	69.0	70.0	140.0	46.0
Chloride	2,300.0	2,700.0	3,500.0	2,900.0	700.0
Cyanide	<10.0	<10.0	NIC[b]	<10.0	<10.0
Fluoride	<500.0	<500.0	<500.0	<500.0	<500.0
Nitrate	<500.0	<500.0	<500.0	<500.0	<500.0
Phosphate	1,500.0	<1,000.0	<1,000.0	<1,000.0	<1,000.0
Sulfide	<1,000.0	HTE[d]	<1,000.0	HTE[d]	HTE[d]
Sulfate	13,000.0	13,000.0	14,000.0	8,600.0	5,000.0
Acetone	NR[c]	<10.0	<10.0	40.0	<10.0

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Table B-2. The 2101-M Building Waste Water Analytical Data[a]. (cont)

Sampling	1st	2nd	3rd	4th	5th
Sampling date	09/17/85	05/23/86	07/17/86	10/30/86	01/26/87
U.S. Testing number		50051	50089	50167	50232
Stream fraction		1.0000	1.0000	1.0000	1.0000
Constituent	Amount detected (ppb unless otherwise noted)				
Chloroform	11.0	25.0	32.0	<10.0	<10.0
Amount (L/mo)	380,000.0	380,000.0	380,000.0	380,000.0	380,000.0
pH (dimensionless)	7.51	7.10	6.07	5.10	5.24
Temperature (°C)	22.0	21.9	22.4	NR[c]	31.7
Alpha Activity (pCi/L)	1.3	<4.0	0.12	0.59	<0.057
Conductivity (µS/cm)	130.0	14.0	130.0	92.0	63.0
Total organic carbon	1,200.0	2,300.0	2,000.0	2,200.0	13,000.0
Total organic halogen	<100.0	160.0	HTE[d]	100.0	40.0

NOTE:
[a]Modified from Jungfleisch (1988).
NIC = measurement made by methods that were not in control
NR = data not recorded
HTE = measurements made after holding times were exceeded.

performed to date support a conclusion that, at the time of discharge, waste from the 2101-M Building disposed of in the 2101-M Pond was not designated dangerous waste by the characteristics. As part of the effort at the Hanford Site to characterize effluent streams that discharge to the soil column, the 2101-M laboratory waste water will be further evaluated as described in the *Liquid Effluent Study Plan* (WHC 1989). To support that effort, a *2101-M Wastestream Sampling and Analysis Plan* (WHC 1992) was submitted to EPA and Ecology in January 1992 in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1992) Milestone M-17.

B-3a(5). Analyses of Soil in the 2101-M Pond. The purpose of the following discussion is to assess the potential inventory of dangerous waste and dangerous waste constituents that may be in the 2101-M Pond, based on the results of the Phase I soil analyses. The discussion for the Phase II soil analyses are presented in Appendix D-4.

Samples of the soil in the 2101-M Pond and at background locations near the pond were obtained and analyzed for constituents that could be associated with the dangerous waste that may have been disposed of in the pond. The

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majority of the reported values for the analytes were below detection limits. Analytes with all values below detection limits were eliminated from further consideration. Analytes with concentrations above detection limits were compared to background concentrations and then to action levels developed using the models presented in Section B-5g. The action levels (i.e., health-based standards) for the constituents discussed in the following are presented in Section B-5g. The sampling and analytical methods used, the constituents tested, and the results of the analyses are presented in Section B-5 and Appendix C-1.

B-3a(5.1). Evaluation of the 2101-M Pond Soil for Waste Designation. Once the soil constituents were identified, procedures for determining whether or not the 2101-M Pond soil is dangerous waste (DW) or extremely hazardous waste (EHW) were followed in accordance with WAC 173-303-70.

According to available records and personnel who worked at the BWIP Laboratory, no unused chemical products have ever been discarded down the laboratory drains, thereby eliminating designation in accordance with WAC 173-303-081.

As discussed previously, under worst-case scenarios, listed waste F002, F003, and F005 could have been discharged to the 2101-M Pond from 1981 to 1985. Some of the constituents associated with this solvent waste have been detected in the 2101-M Pond soil [see Section B-3a(5.2)].

However, the levels detected are very low and, in many cases, are near the limit of detection and occur for only a few of the total number of locations from which samples were collected. The concentrations of the constituents are below health-based standards and are not present in concentrations that would pose a present or potential threat to human health or the environment.

The soil was evaluated for waste designation under equivalent concentration (EC) in accordance with WAC 173-303-084 (5)(b). Samples M159, M164, and M147 were selected to be evaluated in this way. These three samples are all surface samples, and contain the most significant number of contaminant hits from the initial round of sampling. It was not necessary to calculate individual ECs for each cation in each sample because the rest of them have concentrations below those already calculated. The ECs listed in Table B-3 were calculated on the most concentrated cation in the sample consistent with the concentration of available anions and making the most toxic compound. The majority of the cations can be accounted for as oxides from the soil. According to the CRC Handbook of Chemistry and Physics (1985), the average sediment has a makeup of 58% SiO_2, 13.1% Al_2O_3, 5.9% CaO, 2.7% MgO, 2.9% K_2O, 1.1% Na_2O, and about 6.0% FeO and Fe_2O_3, plus trace elements. This is a reasonable approximation of the Basaltic rock common to the Hanford Site.

As demonstrated by the EC values in Table B-3, these samples are well below the minimum value of 1.0 E-03 shown in WAC 173-303-9906.

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Table B-3. Waste Evaluation by Equivalent Concentration.

Sample	Cation	Concentration (ppm)	Anion	Concentration (ppm)	Compound	Category	EC percent
M159	Zn	220	SO_4	12.3	$ZnSO_4$	C	8.0 E-06
	Ba	151	CL	13.3	$BaCl_2$	C	3.9 E-06
	Cr	15.7	SO_4	12.3	$Cr_2(SO_4)3$	C	4.6 E-06
	Ni	13	Cl	13.3	$NiCl_2$	B	2.8 E-05
	Cu	1,340	Cl	13.3	$CuCl_2$	A	2.5 E-04
	Pb	35.2	SO_4	12.3	$PbSO_4$	B	1.8 E-05
						Total =	2.6 E-05
M147	Na	1,280	Cl	14.5	NaCl	D	2.4 E-07
	V	71	Cl	14.5	VCl_3	C	4.5 E-06
	Mn	418	Cl	14.5	$MnCl_2$	D	3.1 E-07
	K	1,400	Cl	14.5	KCl_2	D	2.2 E-07
	Mg	6,090	Cl	14.5	$MnCl_2$	C	1.9 E-06
						Total =	6.5 E-09
M164	Sr	40	SO_4	101.0	$SrSO_4$	C	8.2 E-06
	Ca	16,400	Cl	7.2	$CaCl_2$	D	1.0 E-07
	Al	10,200	SO	101.0	$Al_2(SO_4)3$	D	6.2 E-06
	Fe	24,800	SO_4	101.0	$FeSO_4$	C	2.7 E-05
	As	3.5	Cl	7.2	$AsCl_3$	X	8.4 E-04
						Total =	8.4 E-04

EC = equivalent concentration.

The pond soil does not contain more than 0.01% total organic halogens (TOX); therefore, the soil cannot contain more than 0.01% halogenated hydrocarbons [the designation concentration limit established in WAC 173-303-084(6)]. The pond soil contains less than 1.0% total organic carbon (TOC); therefore, the soil cannot contain more than 1.0% polycyclic aromatic hydrocarbons [the designation concentration limit established in WAC 173-303-084(6)], nor can it contain more than 1.0% organic carcinogens [the designation concentration limit established in WAC 173-303-084(7)]. Inorganic carcinogens are not known to be present in the 2101-M Pond soil.

The 2101-M Pond soil has been evaluated for the dangerous waste characteristics as outlined in WAC 173-303-090. The pond soil does not exhibit any of the characteristics of ignitability, corrosivity, reactivity, or EP toxicity, as explained in the following paragraphs.

The pond soil does not exhibit any characteristics of ignitability. The soil is not a liquid (so does not have a flashpoint); does not cause fire through friction, absorption of moisture, or spontaneous chemical changes; is not an ignitable compressed gas; and is not an oxidizer.

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Based on analyses of the pond soil, the pH of the soil was never greater than or equal to 12.5 and was never less than or equal to 2.0. The pH of the soil samples ranged from 6.8 to 8.5. Thus, the soil does not exhibit the characteristic of corrosivity.

The pond soil does not exhibit any of the characteristics of reactivity. The soil is not unstable; does not react violently with water; does not form explosive mixtures with water; does not generate toxic gases, vapors, or fumes when mixed with water; does not generate cyanide or sulfide gases, vapors, or fumes at a pH of 2.0 to 12.5; is not capable of detonation or explosion; and is not a forbidden Class A or Class B explosive.

The pond soil has been tested both for total metals and for EP toxicity, and the soil is well below the limits for the characteristic of EP toxicity.

The following section discusses the constituents of concern that may reside in the 2101-M Pond and their significance. Potential health risks are discussed in detail in Section B-5g.

B-3a(5.2). Organic Constituents. Soil analyses indicate that a few specific organic constituents may be present in the 2101-M Pond soils. The following constituents have been detected:

- Acetone
- Methylene chloride (not on BWIP Laboratory inventory, Appendix B-1)
- Toluene
- Butanoic acid (not on BWIP Laboratory inventory, Appendix B-1)
- Ethanol
- Propanol
- Total organic carbon.

Acetone was reported above the detection limit in 5 of 13 samples at a maximum concentration of 0.27 part per million, well below any health-based standards. Acetone may be potentially ignitable at ambient concentrations of greater than 2 parts per million, but this condition does not exist at the 2101-M Pond.

Methylene chloride was reported above the detection limit in 3 of 13 samples. The concentrations were 0.027, 0.022, and 0.010 part per million. It is suspected that the constituent was introduced into the soil sample at the laboratory performing the soil analyses. Further substantiation of this likelihood rests on the fact that methylene chloride has not been identified as part of the BWIP Laboratory inventory. The levels of methylene chloride, if actually present in the soils, are below health-based standards.

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Toluene was reported above the detection limit at a concentration of 0.072 part per million in 1 of 13 samples. This concentration is well below any health-based standard.

Acetone, toluene, and methylene chloride are considered to be artifacts introduced by the analytical laboratory, based on the following information.

Under the U.S. EPA Contract Laboratory Program, acceptable laboratory blanks contain less than or equal to five times the contract required quantitation limit of 5 parts per billiom for methylene chloride and toluene, and 10 parts per billion for acetone. Because these compounds are routine laboratory contaminants, concentrations of methylene chloride and toluene at ≤25 parts per billiom and acetone at ≤50 parts per billion are considered to be indistinguishable from blanks. These provisions have been identified because method interference caused by the routine use of solvents and reagents in glassware cleaning and other sample processing hardware lead to artifacts and/or elevated baselines in gas chromatograms (EPA 1988a). Furthermore the EPA, in SW-846 (EPA 1986), has established a practical quantitation limit of 100 parts per billion for acetone in either groundwater or low soil/sediment.

Under these circumstances, validity of apparent, minimal soil contamination, with respect to the only three organic constituents recognized by the EPA to be routine laboratory contaminants, is questionable.

An integral part of this evaluation is a consideration of the time organic contaminants would be expected to persist in the 2101-M Pond water and soils at the concentrations reported. Using the most conservative measurements of the evaporation half-lives of acetone, methylene chloride, and toluene, their persistence was calculated as a function of time. The half-lives are: 1 day dry and 10 day wet for acetone; .017 day for methylene chloride; and .77 day for toluene.

Based on this information methylene chloride would be gone from the pond water and topsoil after about 4 hr; toluene would be gone after 8 hr; and acetone (wet) could last for up to 65 days. It would be essentially impossible for any of these compounds to exist in the 2101-M Pond water or soil at the time of sampling if they had originated from BWIP Laboratory operations.

Butanoic acid was reported in one sample above the detection limit at a concentration of 2.3 parts per million, below even the most stringent health-based concentrations for this chemical. In addition, this chemical has not been identified in the BWIP Laboratory inventory, and therefore, is not directly attributable to this source. Butanoic acid occurs naturally in soil as a vegetation degradation product and could reasonably be expected to be present in the 2101-M Pond soil.

Ethanol and propanol were identified in very low concentrations in two surface samples (0 to 2 ft). These constituents are both present in the same two samples. Propanol was detected at a concentration of 0.005 and 0.006 part per million. Ethanol was detected at 0.005 and 0.027 part per million. Both of these compounds are a very common product of the microbial organic

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degradation process and could well be attributed to such mechanisms. The concentrations of these constituents in the pond soil are below health-based standards. A higher TOC value (2.8 times the background threshold), although nearly at the level of background, is most probably attributed to increased vegetation density as a result of perennial pond water.

It has been concluded that the organic constituents present in the 2101-M Pond soil do not pose a present or potential threat to human health or the environment. However, because these organic constituents do appear to be present at very low levels, they will be included in the inventory of constituents to be considered during closure of the 2101-M Pond.

B-3a(5.3). Inorganic Constituents. Soil analyses indicate that a number of specific inorganic constituents are present in the pond soil at concentrations above background levels. The following elements/compounds have been detected:

- Ammonium
- Copper
- Fluoride
- Lead
- Strontium
- Vanadium
- Zinc.

Ammonium is found consistently in background soils in concentrations similar to the pond soil, and the reported values are well below identified health-based standards. Analysis for ammonium indicates a maximum value in the pond soil of 4.3 parts per million, which is higher than the maximum background value of 2.8 parts per million. The slightly higher concentration of ammonium in the pond soil is likely to be due to the presence of decaying plant materials. The concentration of ammonium in the pond soil is well below identified health-based standards.

Analytical data indicate that 5 of the 23 pond samples exhibit copper above background concentrations. Examination of the distribution of copper shows a decrease in copper concentrations with depth. The soil was tested for copper, nickel, and zinc under the EP toxicity procedure as suggested by Ecology's Technical Information Memorandum (TIM) (Ecology 1986). The maximum sum total EP toxicity level for these three metals is 3.52 parts per million, which is below the threshold value of 5.0 parts per million suggested by the TIM. The memorandum states that if the sum total is less than 5.0 parts per milliom, and there is no other reason to believe the waste would be designated as dangerous, the sample does not need to be tested against the aquatic toxicity criteria (WAC 173-303-101). Therefore, it can be assumed that the copper is being retained in the soil, is not bioavailable, and would not fail an aquatic bioassay. In addition, the copper is not designated as a dangerous waste in accordance with WAC 173-303-084.

It has been determined that the source of the copper would have been primarily from a nonregulated source: the piping in the 2101-M Building HVAC system. The HVAC system has been discharging waste water to the 2101-M Pond since 1953.

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Fluoride was reported to occur two times above background. Once at the discharge (4.9 times background) and once in the south arm (1.1 times background). These occurrences are attributed to the potable water being cycled through the 2101-M Building.

Lead, strontium, and vanadium were all detected at 2.8, 1.3 and 1.04 times the background thresholds, respectively. Lead, strontium, and vanadium are found only one time, each in the pond soil and their concentrations are well below health-based standards.

B-3(5.4). Anomalous Constituents. The following is a list of constituents that were produced from the soil analysis where; 1) elevated levels were expected and not found or 2) were unexpected and found in isolated instances:

- Acids
- Barium
- Silver
- Sulfate.

The pH of the 2101-M soil ranged from 6.8 to 8.5, which is within the secondary maximum contaminant level (SMCL) established for groundwater (6.5 to 8.5); therefore, the acidity of the pond soil is within acceptable levels. Thus, if strongly concentrated acids were discharged to the 2101-M Pond, it does not appear that these acids reside any longer in the pond sediments and soils.

The levels of barium found in the 2101-M Pond are not statistically at variance with the levels of barium in the background soil. In fact, barium in the pond appears to have lower mean levels than background soil. Thus, if any barium did reach the 2101-M Pond, it does not appear to have caused a statistically detectable increase over background levels. Barium is not a mobile element and would not be expected to leach from the surface soil into the groundwater. Barium has not been detected above drinking water standards (DWS) in the quarterly groundwater samples.

Silver was reported above the detection limit in one sample at a concentration of 2.20 parts per million. Dissolved silver is normally precipitated from solution, and sorption by manganese dioxide and precipitation with halides serves to reduce the mobility in surface and groundwater. This one isolated silver value is not considered to pose a present or future threat to human health or the environment.

Sulfate was detected in the pond soil at a maximum isolated value of 101 parts per million. The concentration of sulfate in the pond soil is below the secondary DWS for this constituent. This single sulfate value is inconsistent with all other analyses for the pond and background soils, which show comparable values.

None of these inorganic constituents are indicative of DW being present in the pond soil because they occur naturally in the Hanford Site soil. Based on this and the following conclusions, it is unwarranted to consider that the soil in the 2101-M Pond is a DW because inorganic constituents are present.

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However, because these chemical constituents have been found in some of the pond soil samples, the chemicals have been included in the inventory of constituents to be considered during closure. Table B-8 in Section B-5 lists all the constituents that were detected in the pond soil.

B-3a(5.5). Conclusions. The purpose of this estimated maximum inventory discussion was to identify and summarize the DW and constituents that should be considered when carrying out closure of the 2101-M Pond. Based on the information presented previously, the following has been determined.

1. Assuming that DW and/or DW constituents did enter the 2101-M Pond, the waste is present in concentrations that do not pose a present or potential threat to human health or the environment.

2. The estimated maximum inventory of DW and DW constituents present in the 2101-M Pond is limited to extremely low concentrations of a few residual organic and inorganic constituents.

B-3b. Detailed Description of the Removal of Dangerous Waste Inventory

The BWIP Laboratory equipment and chemicals have been dispositioned and shipped to other laboratories for use, or shipped offsite for proper disposal.

B-3c. Detailed Identification and Type of Offsite Dangerous Waste Management Units

In the event that soil removal is necessary for clean closure of the 2101-M Pond, the soil would be packaged for shipment offsite. A contractor licensed to receive this type of material will be engaged to dispose of the soil at the permitted disposal unit.

B-4. DESCRIPTION OF DECONTAMINATION AND REMOVAL OF DANGEROUS WASTE RESIDUES

In accordance with WAC 173-303-610(3)(a)(v), the following information must be included in the closure plan:

> A detailed description of the steps needed to remove or decontaminate all dangerous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure, including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to satisfy the closure performance standards;

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The only waste residues that might be present at concentrations high enough to be of significant human health or environmental concern would be located in the 2101-M Pond soil. The shallow pond soil has been sampled and analyzed to assess the presence of DW and DW constituents. The concentrations of constituents found in the soil do not pose a present or potential threat to human health, nor do they pose a threat to the environment. The soils in the pond were resampled to better characterize them and to help determine the extent of any contamination (Appendix D1 through D4). After analyses were performed, the new data were compared with the initial data and then both used as a whole to determine any significant human health or environmental concerns, and the extent of remediation, if any, necessary to satisfy the closure performance standards. Remediation would be in the form of soil removal and packaging for shipment to a permitted disposal unit (see Section B-3c).

B-5. SOIL SAMPLING AND ANALYSIS PLAN FOR THE 2101-M POND

Soil sampling at the 2101-M Pond was implemented to assess the DW characteristics of the shallow soil directly beneath the facility. Soil samples were tested for a multitude of chemicals including a broad spectrum of drinking water quality (WAC 173-303-9905) and 40 CFR Part 264 Appendix IX constituents.

All soil sampling at the 2101-M Pond was performed during calendar years 1988 and 1991. Initial sampling of the pond soil and adjacent rainwater run-off ditch was done as part of a preliminary soil assessment from March 23 through March 25 and May 3 through May 4, 1988. Sampling of an undisturbed area in an equivalent soil horizon was performed June 27 through June 30, 1988. This sampling was done to establish a baseline chemical profile for comparative purposes. The soil contained in and directly beneath the 2101-M Pond was sampled from July 27 through August 3, 1988. The Phase II sampling information is contained in Appendix D-1 through D-4.

After receiving the analytical results, the data were judged for reliability (based on quality assurance/quality control (QA/QC) tables in Appendix C-4), reviewed, and summarized. To make the data more manageable, constituents with all results below the detection limit were eliminated. After statistical testing was applied, certain chemicals were eliminated from further consideration if found to be within background concentrations. Chemicals found to vary significantly from background levels were appraised separately as potential contaminants.

The sampling approach and rationale, sampling methods, data acquisition and evaluation, and final conclusions are included as part of this discussion. Detailed information concerning sampling procedures, documentation of field activities, decontamination protocols, personnel responsibilities and training, field safety, statistical evaluation methods and calculations, and the data package are presented in Appendices C-1 through C-5.

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B-5a. Soil Sampling Methods and Materials

Methods and materials presented in this section are based on the Site Characterization Plan for the 2101-M Pond Soils and Sediments (SCP) (Mitchell 1987).

B-5a(1). Phase I Sampling Design. The sampling strategy and design developed for this project were based on the sampling plan information contained in SW-846 (EPA 1982b) and other EPA guidance manuals and technical documents (DeVera et al. 1980; Barth and Mason 1984; EPA 1988a; Ford et al. 1984; Ford and Torina 1985). Based on the configuration of the site and existing environmental conditions, the following sampling strategy was applied to characterize the soil of the upper portion of the unsaturated zone underlying the 2101-M Pond, rainwater run-off ditch, and undisturbed background location.

B-5a(1.1). Sampling Locations. The pond proper was divided into four subsites to facilitate a stratified random-sampling approach. A single sample site was chosen randomly within each subsite (stratum) for characterization. Each of the three arms of the pond was designated as a separate sample stratum. The area near the effluent pipe was included as an individual subsite because chemical constituents discharged from the pipe may have preferentially concentrated in the soil at this location. This configuration, shown in Figure B-1, designates the strata as A, B, C, and D. The stratification enabled the use of a random sampling approach without raising the possibility of clustering the four sample locations in one area of the pond as might occur using a simple random design. Within each sample area, the specific sample location was determined using a random-numbers generator to identify a unique point along the centerline of the pond proper. The random numbers were generated for each of the three arms of the pond in the following manner.

- A point in the random number table was selected by dropping a pencil on the random number table.

- The number, which the pencil landed on or was closest too, determined the column and the row within the table that was used as the starting point (i.e., if 63 was the number that the pencil landed closest to, the 6th column, 3rd row was the starting point).

- The table was evaluated from left to right until a number that met the criterion for that arm of the 2101-M Pond was reached.

An identical process was used in determining the sample points for the rainwater run-off ditch.

Information developed before the site characterization indicated that the rainwater run-off ditch did not appear to be, or to ever have been, directly connected to the 2101-M Pond system. To confirm this assumption, separate soil samples were collected from the ditch in the following manner.

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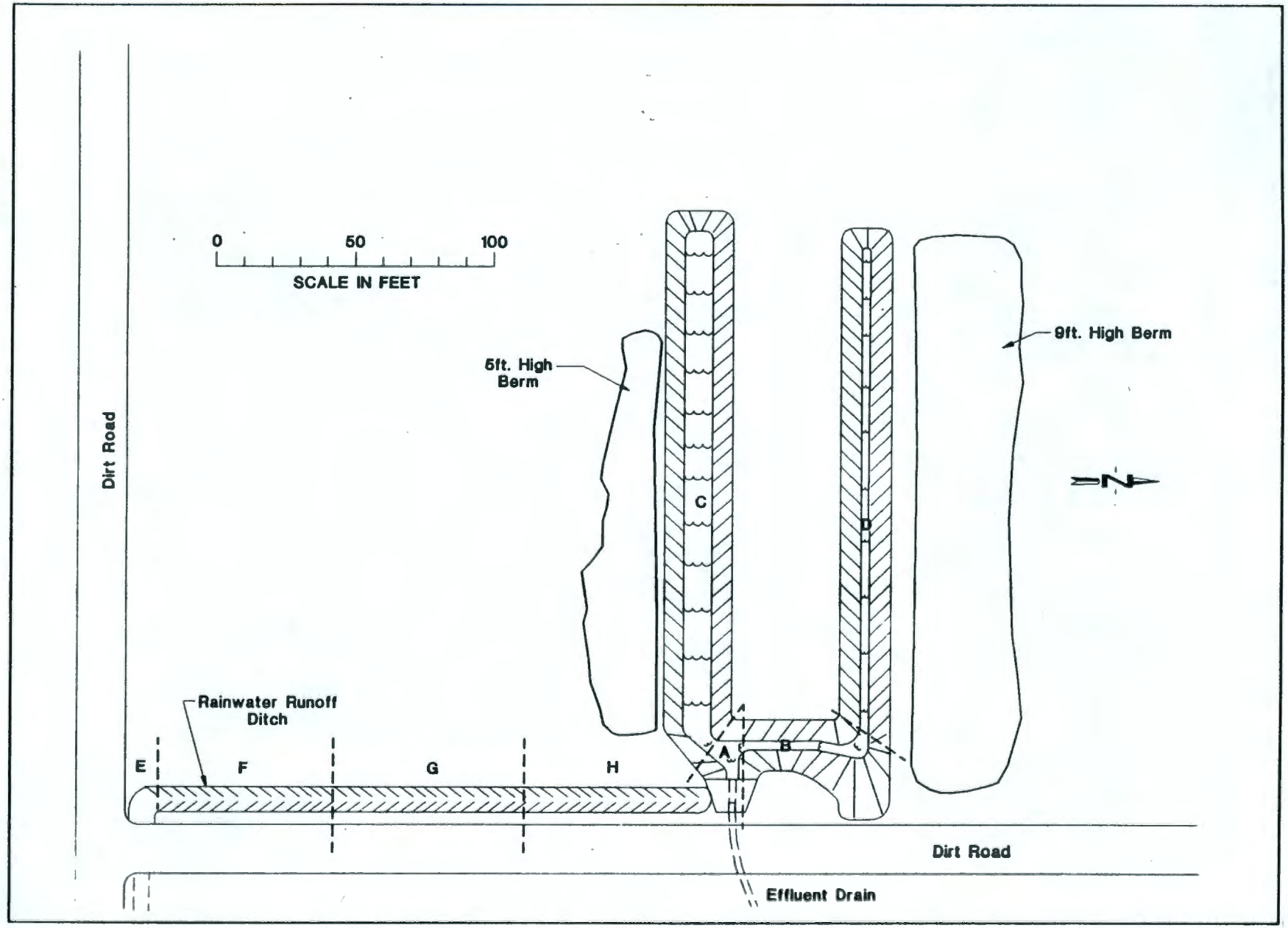

Figure B-1. Schematic of the 2101-M Pond Showing Location of Strata to be Sampled.

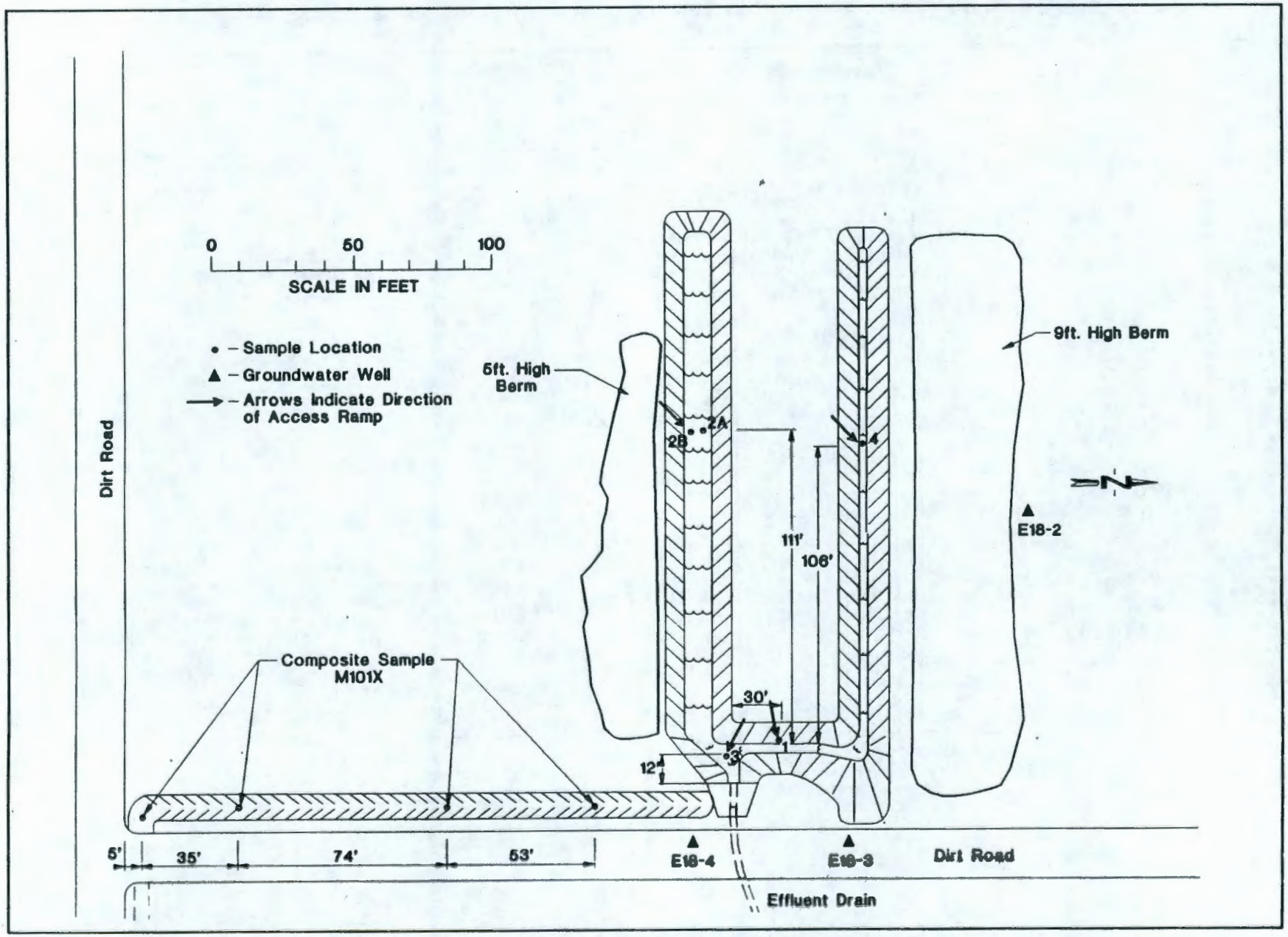

Figure B-2. Sample Sites Location Map.

The ditch was divided into four composite sample subsites: the ditch out-fall, and three sections each 65 ft long, designated E, F, G, and H, respectively, in Figure B-1. A transect was established down the center of the ditch, and a random numbers table was used to select a sample location along the transect within each sample subsite. The specific locations for the composite sample are shown in Figure B-2. After collection, the four individual samples were combined to form a single composite sample (M101X) and submitted for complete laboratory analyses. The analytical results for this sample are included as part of the data package in Appendix C-1.

Background samples were collected to establish baseline values for concentrations of chemical constituents in the pond soil. These samples were collected in accordance with EPA Region 10 policy (EPA 1986a) from a locale near the 2101-M Pond, but sufficiently distant (approximately 1,000 ft) to be unaffected by past operations. Historical photos showing past operational 2101-M Site conditions are included in Appendix C-2. Within this area, two sites were selected for sampling, a 'wet' site associated with drainage from a nearby water tower and dominated by poplar trees and a 'dry' site approximately 100 yd to the west in a sagebrush/cheatgrass community (Figures B-3 and B-4). The two sites were selected to demonstrate differences in concentration of particular chemicals that may have occurred because of the leaching effect of continual additions of water. Background points 2 and 4 (Figure B-4) were sampled at different depths than points 1 and 3, and the pond samples. The sample interval for these two locations were chosen to replicate the sample depths used in the preliminary sampling effort described in Section B-5a(3.2). Analytical results from these background sites showed a generally lower concentration of sodium, calcium, and potassium in samples taken from the 'wet' site. Appendix C-2 contains a graphic representation of the distribution of each chemical, in both pond and background soils, that was found to be above the detection limit.

B-5a(1.2). Site Modifications. To accommodate sampling of the pond in a manner consistent with the site characterization plan (Mitchell 1987), it was necessary to modify the site. An access ramp was excavated to pond level at each of the four sites and fill was added at three (Sites 2, 3, and 4 in Figure B-2) to allow entry of the drill rig to the centerline of the pond at the randomly selected location. The fill material was placed over the sample points as the access ramps were excavated in the banks. The berms alongside the north and south arms of the pond were used as borrow sites for this fill material. Upon completion of sampling, the fill material was returned to its original location.

At Site 1 in the east arm of the pond, the narrow dimensions, flowing conditions of the effluent at the time of sampling, and general configuration of the trench, necessitated that the borehole be situated approximately 12 in. from the "centerline" of the pond. Figure B-2 shows the general configuration of the site that was present during the sampling phase.

B-5a(1.3). Criteria for Soil Sampling Depths. The chemical constituents documented to have been discharged to 2101-M Pond (2.2 to 22 lb/yr of nitric and hydrochloric acid and less than or equal to 26.9 lb of barium ions) were

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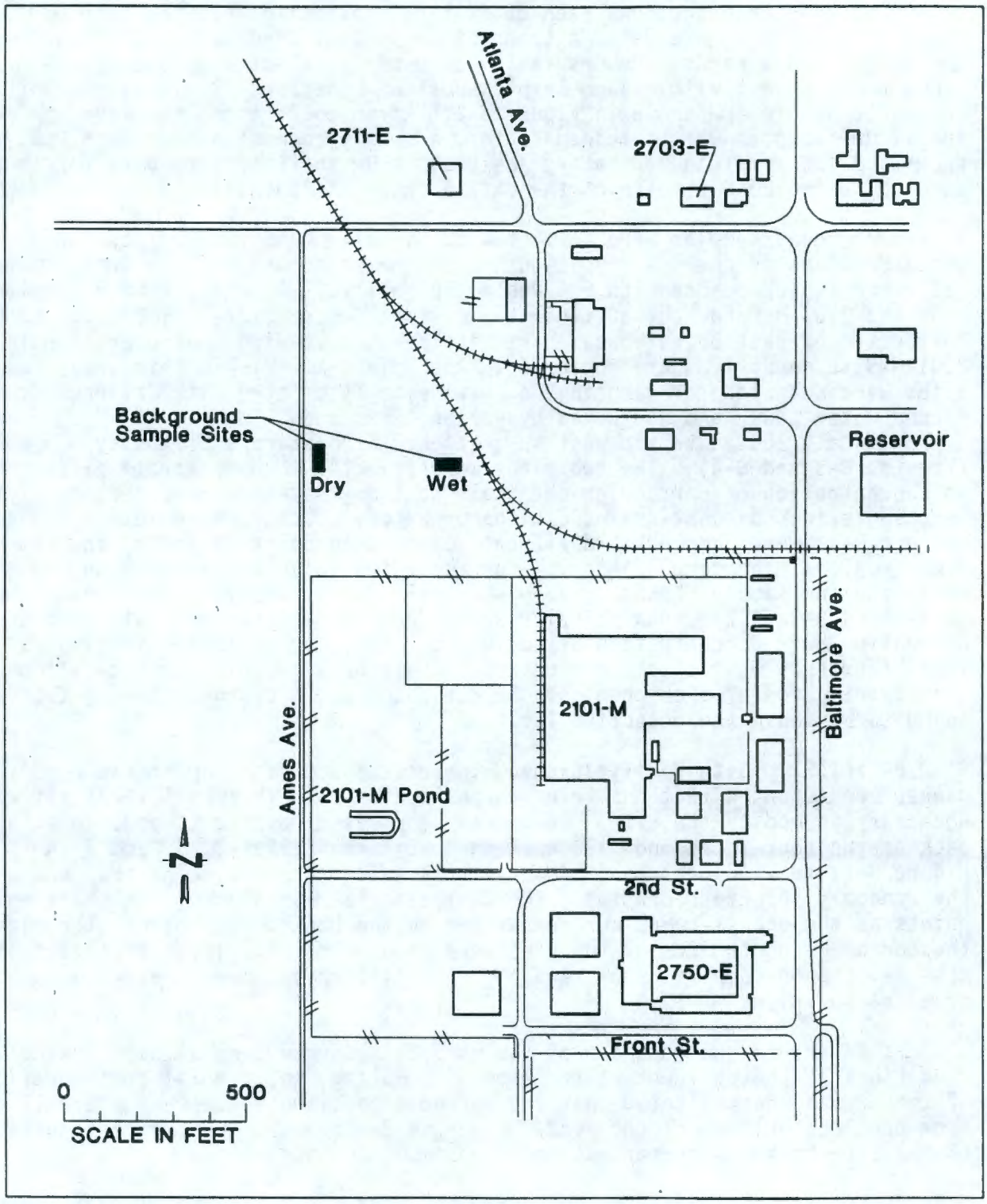

Figure B-3. Location of Background Sample Sites.

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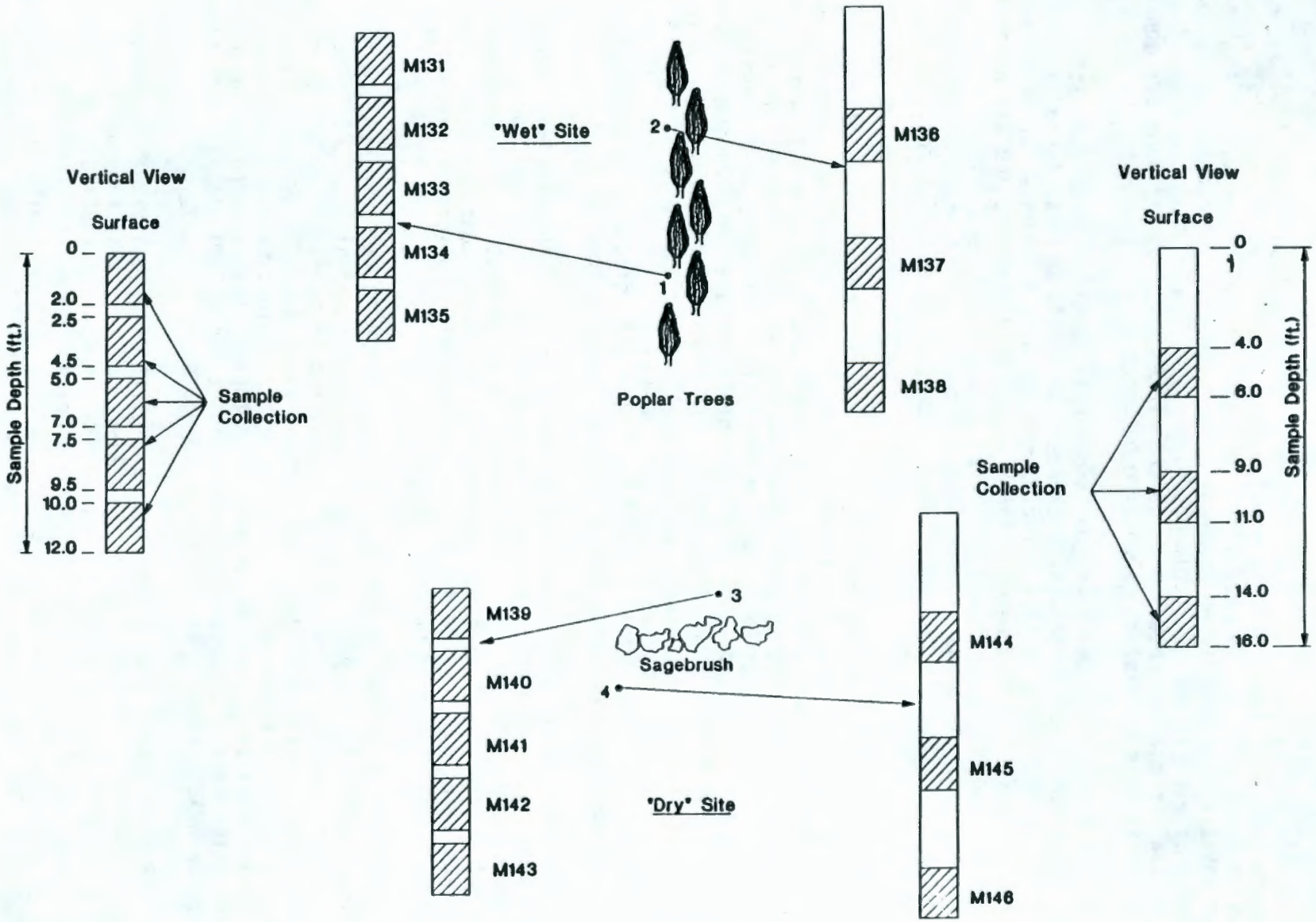

Figure B-4. Location, Depths, and Codes for the 2101-M Pond Background Samples.

generally not expected to have leached or moved to significant depths. Later geochemical and flow/transport modeling has provided additional justification for this assumption. The results of geochemical modeling indicate that any contamination of the 2101-M Pond soil should be highly concentrated in the uppermost part of the soil column. Also, it indicates that the mass of potential inorganic contaminants in the 2101-M Building effluent are generally insufficient to be distinguished from background.

The mass of barium, chromium, and copper required to produce soil concentrations that exceed the background threshold values (Appendix C-5) within a 10-ft radius of the effluent outfall were calculated at depths from 1 in. to 12 ft. It was assumed for the purpose of these calculations that all potential contamination would be included in the soil analysis (i.e., leachable). It also was assumed that any contamination would be homogeneously distributed within the indicated soil volume and that the average density of the soil is 2.5 g/cm^2.

As indicated from the results of these calculations, about 1/4 lb of copper or chromium (metal) and about 2.5 lb of barium must be added to each foot of soil within the 10-ft radius of the outfall to be distinguishable from background values. Two to three times as much would be required if the metals were discarded as reagents. These amounts also correspond to disposal of about 100 L of standard 1,000 parts per million copper or chromium solutions, or 1,140 L of barium standard solution, for each foot of soil. Nearly six times as much of these metals would be required for each foot of soil if the impacted area were extended to the north arm of the 2101-M Pond. Proportionally larger amounts would be required to discernably impact larger soil volumes, either deeper and/or laterally more extensive.

The BWIP Laboratory inventory (Appendix B-1) and inventories from laboratories of the same type and size were used to judge the amount of chemicals typically handled. The results indicate that the BWIP Laboratory did not handle enough constituent reagents to produce contamination below the uppermost part of the 2101-M Pond soil or beyond the discharge, even if the entire inventory was to be discarded.

Mass balances for copper were considered for 10-ft radius around the effluent outfall. To yield average concentrations as high as 500 to 800 parts per million would require 140 to 225 lb of copper metal for each foot of soil. Again, this is far in excess of the amount handled by the BWIP Laboratory. The corrosion of copper alloys such as wires or pipes typically are the most likely sources of copper contamination in topsoil (Kabata-Pendias and Pendias 1984). The source of copper contamination at the 2101-M Pond is most likely from the HVAC piping in the 2101-M Building.

Also, it can be shown that the concentration of constituents (such as copper, barium, and chromium) potentially added to the soil by sorption from a drinking water source can be very large in the upper few millimeters, and decreases rapidly with depth in the soil column (Conway 1982; Freeze and Cherry 1979; Kabata-Pendias and Pendias 1984). Any contamination remaining in the 2101-M Pond soil would be the result of equilibrium reactions and/or

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irreversible sorption. In either case, residual contamination would be concentrated in the uppermost part of the soil column, with rapidly decreasing concentrations downward.

The results of this assessment indicate that the effects of sorption in the soil column are strongest, and expected to be distinguishable primarily in the upper few millimeters of the soil column. Therefore, the mass of inorganic constituents (e.g., copper, chromium, and barium) introduced into the 2101-M Pond soil from the discharge of drinking water in volumes comparable to those of the building discharges, would be similar, or greater in magnitude, to those discharged from the laboratory.

This discussion supports the decision to sample to a 12-ft depth. This decision was based on the following.

- A depth of 12 ft would provide the ability to develop an adequate soil profile to detect significant changes in chemical concentrations with depth.

- Samples needed for profiles in the vadose zone, greater than 12 ft deep, could be collected during the drilling of adjacent groundwater monitoring wells (see Figure B-2 for well locations).

- Soluble compounds, if present in elevated concentrations, would likely be detected in the groundwater as part of the quarterly monitoring process.

- The maximum depth of contaminated material that could be exhumed from a cost-effective design engineering perspective is 12 ft.

B-5a(1.3.1). Sample Intervals. Pond soil samples were collected every 2.5 ft, in 2-ft increments, to a depth of 12 ft. Each sample site was represented by samples at depths of 0.0 to 2.0 ft, 2.5 to 4.5 ft, 5.0 to 7.0 ft, 7.5 to 9.5 ft, and 10.0 to 12.0 ft. Figure B-5 is a graphic representation of the location and depth of samples taken at the pond. At Site 2, problems with heaving sand caused the sampling effort to be abandoned after the top two samples were collected (0.0 to 2.0 ft, and 2.5 to 5.0 ft). The rig was moved 9 ft to the south and all the samples were taken (0.0 to 12.0 ft). These are shown as 2A and 2B in Figure B-2. Results of the initial two samples taken at Site 2A (sample codes M152 and M153) are included as part of this evaluation.

Collection of background samples at two sites was conducted in an identical manner and depth as those taken for the pond samples. An additional six samples were collected at two other sites using the same procedure, but at different depths (4.0 to 6.0 ft, 9.0 to 11.0 ft, and 14.0 to 16.0 ft), to provide ancillary data on chemical concentrations with depth. Figure B-4 is a graphic representation of the location and depth of samples taken for background information.

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The rainwater run-off ditch was sampled at four locations, using a hand auger, to a depth of approximately 12 in. The four samples were then composited into one sample and submitted for complete laboratory analyses.

B-5a(2). Sample Containers. Containers for soil samples were chosen based on their compatibility with the potential waste, resistance to leaking or breakage, ability to seal tightly, and being of the required volume for an optimum sample. Sample containers used in this sampling effort were purchased from I-Chem Research, Incorporated, in a precleaned condition. Table B-4 shows the type and size of containers used for this sampling effort. Protocols used to clean the sampling containers are included as part of Appendix C-3.

B-5a(3). Sampling Equipment and Sample Collection. A B-34 mobile power auger rig was employed in conjunction with the continuous flight hollow-stem auger sampling method modified from American Society for Testing and Materials (ASTM) standard D 1586-84 (ASTM 1985). A stainless-steel split-barrel sampler (3-in. nominal outside diameter) fitted with a stainless-steel solid inner barrel (2 ft long and 2.25-in. nominal inside diameter) was used to obtain the sample. Retainer springs were made of Teflon* or steel depending on availability. This method provides a representative, continuous sample of the sample point.

The auger drill was situated at, or as near as possible to, the centerline of the pond for sample collection. When drilling through the emplaced fill (thickness at Site 2 = 3 ft, Site 3 = 2.5 ft, and Site 4 = 3 ft), evidence of organic material or a change in the character of the sediment marked the point at which the 0.0 to 2.0-ft sample was taken. Additional samples were then taken to a total depth of 12.0 ft as previously described.

B-5a(3.1). Vadose Zone Soil Sampling. During the drilling of groundwater monitoring wells 299-E18-3 and 299-E18-1, soil samples were taken by PNL for chemical analysis. The samples were preferentially acquired as close to the top of fine grained or wetted sediments as possible to maximize the possibility of detecting any sorbed constituents. The samples were acquired from depths of 45, 62, 84, 97, 194, and 195 ft (duplicate of the 194-ft sample) in downgradient well 299-E18-3, and one sample was collected at a depth of 194 ft from the upgradient well 299-E18-1. These samples followed the same handling and preservation protocols as did the pond soil samples discussed in Section B-5a(4). The samples were analyzed by PNL using the x-ray flourescence (XRF) method for metals and by U.S. Testing Company, Incorporated, Richland, Washington (U.S. Testing), for volatile organic compounds. Although both the ICP and XRF methods test for metals, it is difficult to make a direct comparison of the results from these two analytical techniques on a one-to-one basis. This is because the XRF method measures the quantity of metals in particles of the entire rock, while the ICP method

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*Teflon is a registered trademark of the E.I. du Pont de Nemours & Company.

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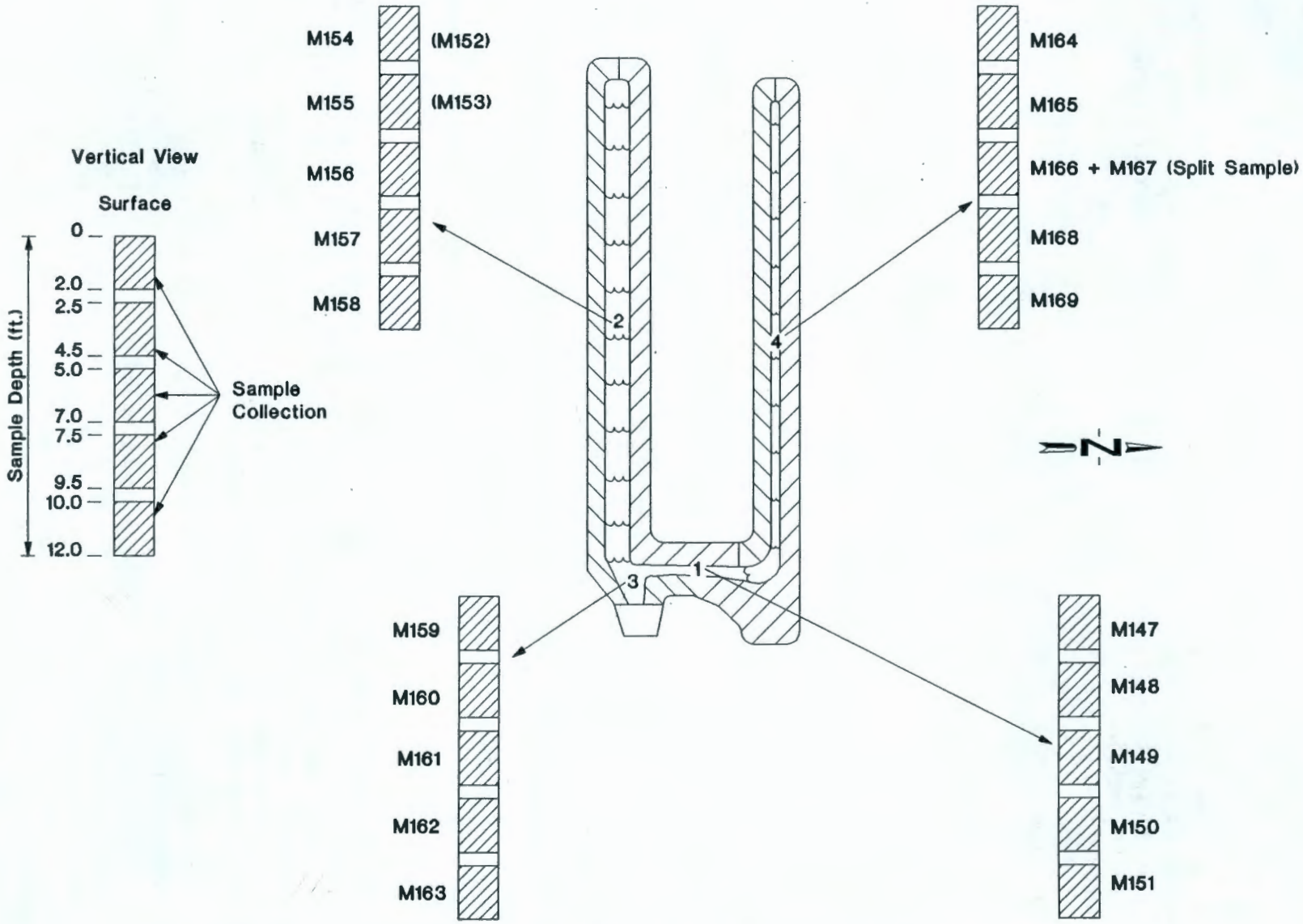

Figure B-5. Location, Depths, and Codes for the 2101-M Pond Samples.

Table B-4. Sample Containers.

Analyte	Container volume	Container/lid
Inductively coupled plasma metals	(1)250 mL	Plastic/Teflon
Mercury		
Arsenic		
Selenium		
Thallium		
Lead		
Ammonium		
Anions		
Cyanide		
Sulfide		
conductivity		
pH		
Total organic carbon		
Total organic halogen	(1) 40 mL	Amber glass/Teflon
Volatile organic analysis	(2) 40 mL	Amber glass/Teflon
Extractable organics	(1 each) 125 mL/250 mL	Amber glass/Teflon
Pesticides		
Herbicides		
Polychlorinated biphenyls		
Thiourea		
Ethylene glycol		

requires dissolution of the soil in acid, which usually leaves a residue of the more insoluble minerals. The volatile organic analysis showed one value above detection for methylene chloride (0.029 part per million) in the 194-ft sample from well 299-E18-3. This compound is likely to be a contaminant introduced during the analytical process, because the duplicate sample showed a value less than the detection limit.

To compare the results from the pond soil with the vadose zone soil, several samples taken during the drilling of three wells were analyzed using the ICP method. Three samples were selected each from wells 299-E18-1, 299-E18-2, and 299-E18-4. The samples used in this investigation were originally acquired as geologic samples and had not been preserved at 4 °C, did not have a chain-of-custody record, and were not taken under controlled conditions. Therefore, the results of these analyses are used for informational purposes only.

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B-5a(3.2). Precharacterization Soil Sampling. Before implementation of the sample design called out in the site characterization plan (Mitchell 1987), a preliminary reconnaissance sampling effort was performed. A hand auger was used to bore shallow pond sediments (0 to 3.5 ft), and a power auger was used to obtain samples at depth (4 to 12 ft) from two sites adjacent to the pond. Although the samples were delivered to the analytical laboratory the same day that sampling occurred, the time that elapsed between taking the samples and performing sample analyses was as long as 44 days. Therefore, the results were considered of questionable validity and function only as indicators of the chemical parameters present in the soil at the pond. Results also were used by the site safety officer to confirm the level of personal protection equipment and extent of safety training required for site sampling personnel. An anomalous result from this effort, not reported in the characterization sampling, include one positive result for mercury of 0.25 part per million, which is close to the detection limit of 0.20 part per million. The rainwater run-off ditch composite sampling also was performed during the preliminary phase of sampling. Holding times for several of these analyses either exceeded SW-846 recommended holding times, or documentation of meeting the extractable holding time is unavailable. See Table B-5 for a listing of the analysis which did not meet SW-846 sampling protocol.

Table B-5. Rainwater Run-off Ditch Holding Time Exceedances.

Analysis	SW-846 holding time	Actual holding time
731 (VOA)	14 d	36 d
733 (extractable organics)	7 d extract, 40 analysis	15 d extraction 42 d total
737 (chlorinated herbicides)	14 d	45 d
739 (PCBs)	10 d	23 d
C 70 (cyanide)	14 d	33 d
C 78 (sulfide)	7 d	27 d
C 80 (ammonium)	28 d*	30 d

NOTES:
*This holding time is for ammonia, no reference found for ammonium holding times.
VOA = volatile organic analysis
PCB = polychlorinated biphenyl.

B-5a(4). Sample Handling Quality Assurance/Quality Control. Information presented in this section is based on the requirements contained in Mitchell (1987).

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B-5a(4.1). Sample Split. One sample from Site 4 in the north arm of the pond was randomly selected and split in the field. The sample was divided into approximately equal parts and placed into separate containers. The containers were labeled with a unique sample number (M167) and identified as a split only in the field logbook.

B-5a(4.2). Identification of Samples. Each sample was identified uniquely at the time of collection. Sample containers were labeled, at a minimum, with the following information:

- Site contractor
- Unique sample number
- Collector's name
- Analysis code(s)
- Date and time collected
- Container size.

Specific sample codes, correlative to the sample location, are shown in Figures B-4 and B-5.

B-5a(4.3). Sample Seal. Evidence tape was used as a sample seal to prevent and/or detect tampering with samples following collection and until the analyses were performed. Seals were applied to the sample container before leaving the location. Each sample seal was attached in a manner that required breaking the seal to open the container.

B-5a(4.4). Sample Preservation and Storage. Sample preservation was initiated immediately upon sample collection to ensure chemical and physical integrity of the sample. After the soil or sediment was containerized, labeled, and sealed, all samples were stored in a refrigerated container or packed on ice to be cooled to less than or equal to 4 °C. Samples remained refrigerated until the analyses were performed. Any remaining sample was re-refrigerated until all sample holding times had expired.

B-5a(4.5). Chain of Custody. To ensure the integrity of the sample from collection through analyses and to final disposition, a chain-of-custody record was used to document the history of persons who had been in possession of samples. The form was completed by the sample collector, the sample custodian, and all others in possession of the samples.

B-5a(4.6). Sample Analysis Request. A sample analysis request form accompanied the samples to the laboratory, designating the analysis to be performed on each sample. The form also provided a check to ensure that all samples had been received and that correlation between sample analysis and sample numbers was accurate and complete.

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B-5a(4.7). Laboratory Receipt and Logging of Samples. U.S. Testing, the analytical laboratory, has procedures in place to control receipt of samples; the procedures include inspection for damage and tampering, logging samples in a logbook, assigning laboratory numbers, and protection from loss or damage. It is the responsibility of the laboratory to notify the collector of misrepresented, lost, damaged, or expired samples.

B-5a(4.8). Field Logbook. Personnel conducting the sampling maintained an official logbook to document field activities. Each day's activity or separate sampling episode was recorded and signed by, at a minimum, the field team leader. The logbook was the responsibility of the field team leader and was retained as a permanent record. Further information concerning the specific details contained in the field logbook, as well as personnel training requirements and field safety, is presented in Appendix C-3.

B-5a(4.9). Decontamination of Sampling Equipment. All sampling equipment to come in direct contact with the sample was precleaned under laboratory conditions. The equipment included split tube core barrels and inserts, sample retainer springs, bowls, spoons, and spatulas. All of the sampling equipment, with the exception of the retainer springs, was constructed of stainless steel. Protocols used to clean the sampling equipment and containers are included as part of Appendix C-3.

B-5b. Analytical Parameters and Procedures

The analytical parameters for soil collected at the 2101-M Pond were determined based on the following:

- General lack of information about the effluent discharged to the pond before 1985, which may have contained small amounts of chemicals present in the BWIP Laboratory

- Evidence that barium chloride (less than or equal to 26.9 lb barium ions) and hydrochloric and nitric acid (2.2 to 22 lb/yr) may have been discharged to the pond.

For these reasons, selected samples from the 2101-M Pond area were analyzed for a broad spectrum of constituents. All chemicals listed in the BWIP inventory that appear in 40 CFR 261, Appendix IX were included as part of these analyses. Table B-6 summarizes the analytical parameters.

To facilitate a more cost-effective sampling program without compromising the usefulness of the information gained, the scheme for analyses of pond soil samples was as follows: samples collected at depths of 0.0 to 2.0 ft, 5.0 to 7.0 ft, and 10.0 to 12.0 ft were analyzed for all of the constituents listed in Table B-6 (14 samples total). Soil samples collected at 2.5 to 4.5 ft, and 7.5 to 9.5 ft (9 samples total) were analyzed only for the following:

- Inductively coupled plasma metals

- Conductivity

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- Lead
- Total organic halogen
- Arsenic
- Total organic carbon
- pH.

The methodology resulted in improved cost efficiency, while still providing detailed information on the concentration of barium as well as many other potential pollutants.

For comparative purposes, background samples and the rainwater run-off ditch composite sample also were analyzed for the chemicals listed in Table B-6.

The U.S. Testing Company served as the contractor for analyses of environmental samples collected at the 2101-M Pond. All samples collected were shipped to the U.S. Testing facility in Richland, Washington, within 8 h of collection. For comparative purposes, Table B-7 shows a listing of the U.S. Testing analytical method and the equivalent EPA analytical method.

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B-5c. Data Evaluation Criteria

For each analytical parameter shown in Table B-6, the following approach was used to evaluate the data.

1. Evaluate the QC of the sample analyses to assess the reliability of the data.

2. Examine the analytical data and eliminate from further consideration constituents that are present below detection levels in the pond soils.

3. Exclude primary constituents in native rocks and soils from statistical evaluation. Constituents eliminated from statistical evaluation are: aluminum, iron, calcium, manganese, magnesium, and potassium.

4. Prepare background summary statistics for constituents.

5. Perform statistical goodness-of-fit test to examine data distributions by the following steps:

   a. Apply the Shapiro-Wilk test for normality procedures to the raw data (e.g., unit of measurement is parts per million).

   b. If raw data are not normally distributed the Shapiro-Wilk test is applied to the logarithms (natural logarithms) of the data

Table B-6. List of Analytical Parameters for Selected Soil Samples from 2101-M Pond.

Zinc*	Ethylene glycol
Mercury	Enhanced thiourea
Calcium*	Total organic carbon
Strontium*	Total organic halogen
Magnesium*	Phosphate pesticides
Potassium*	Chlorinated pesticides
Barium*	Chlorinated herbicides
Cadmium*	Polychlorinated biphenyls
Chromium*	Extractable organics
Lead	Volatile organics
Arsenic	
Silver*	Nitrate
Sodium*	Sulfate
Selenium	Chloride
Nickel*	Cyanide
Thallium	Phosphate
Copper*	Ammonium
Vanadium*	Sulfide
Antimony*	Fluoride
Aluminum*	
Manganese*	Conductivity
Iron*	pH
Beryllium*	

NOTE: *Inductively coupled plasma metals.

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Table B-7. Comparison of U.S. Testing Company, Incorporated, and U.S. Environmental Protection Agency Methods.

Analysis	Analyte(s) determined	Analytical method number: U.S. Environmental Protection Agency[a]	Analytical method number: U.S. Testing Company, Inc.
Metals[b]		SW-846[c], No. 6010	726
Mercury	Mercury	SW-846, No. 7470	A21
Arsenic	Arsenic	SW-846, No. 7060	A20
Lead	Lead	SW-846, No. 7421	A51
Selenium	Selenium	SW-846, No. 7740	A22
Thallium	Thallium	SW-846, No 7841	A23
Ammonium	NH_4^+	ASTM 1426-D-79[d]	C80
Anions	Cl^-, F^-, NO_3^-, SO_4^{-2}, PO_4^{-3}	In-hours ion chromatography	735
Cyanide	CN^-	SW-846, No. 9010	C70
Sulfide	S^{-2}	SW-846, No. 9030	C78
Thiourea	7 compounds	SW-846, No. 8330	727
Chlorinated pesticides	18 pesticides	SW-846, No. 8080	729
Phosphorous pesticides	6 pesticides	SW-846, No. 8140	734
Chlorinated herbicides	3 herbicides	SW-846, No. 8150	737
Polychlorinated biphenyls	7 PCBs	SW-846, No. 8080	739
Total organic carbon	Total organic carbon	SW-846, No. 9060	C69
Total organic halogen	Total organic halogen	SW-846, No. 9020	C68
Volatile organics analysis	52 organics	SW-846, No. 8240	731
Extractable organics	141 organics	SW-846, No. 8270	733
pH		SW-846, No. 9045	207
Conductivity		SW-846, No. 9050	088

NOTES:

[a]When EPA methods were not available, techniques from Standard Methods for the Examination of Water and Wastewater (APHA 1981) were used whenever possible.

[b]Aluminum, silver, barium, beryllium, calcium, cadmium, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, antimony, strontium, vanadium, and zinc.

[c]EPA (1986).

[d]ASTM (1979).

PCB = polychlorinated biphenyl.

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to examine whether the logarithms of the concentrations has a normal distribution. This is equivalent to test the hypothesis that the constituent has a lognormal distribution.

c. If the proportions of less-than-detection-limit values are more than 50%, a goodness-of-fit test is not performed and a nonparametric tolerance interval is calculated, to the extent possible.

6. Use the tolerance interval approach to calculate the background threshold values based on the results obtained in Step 5.

7. Compare 2101-M Pond soil sample individually with the background threshold values and evaluate the significance of exceedance.

8. Make assessment as to whether the levels of various chemical constituents in the pond soil are of a health and/or environmental concern.

B-5d. Analytical Laboratory Quality Assurance/Quality Control

Analytical data received for the 2101-M Pond soil samples were scrutinized against the Hazardous Substance Analysis Quality Control Report - Fiscal Year 1988 (UST 1988) to assess the reliability of the results. Details concerning the laboratory QC assessment are contained in Appendix C-4 and summarized in the following section.

B-5d(1). Inorganic Chemical Analyses. Inorganic chemical analyses laboratory QC assessment is summarized as follows.

- Holding times were acceptable for all metals and ions with the exception of the cyanide analysis. The analysis for cyanide was outside the EPA QC limit of 14 days for samples M131 through M154. No positive results were reported for cyanide in any samples taken for this characterization effort.

- Contractual detection limits were below those required by the EPA.

- Laboratory blanks were within established QC limits.

- Laboratory duplicates were within established QC limits for inorganic analytes with the exception of copper, barium, and manganese. Significant percent differences outside QC limits for these elements occur in samples M132 and M143. (Appendix C-4, Page App C4-3)

- Spike sample percent recoveries are outside QC limits for arsenic, cadmium, lead, selenium, sulfate, phosphate, and fluoride. Results for sulfate, fluoride, and phosphate in samples M136, M143, and M152 (a total of three positive results) are considered of questionable validity because of low percent recoveries in spike samples.

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Problems with percent recoveries and percent differences are most likely caused by matrix interference and the heterogeneous nature of the soil.

B-5d(2). Organic Chemical Analyses. Organic chemical analyses laboratory QC assessment is summarized below.

- Holding times were acceptable for all organic analyses [(i.e., TOC, TOX, VOA, extractable organics or acid-base neutralization (ABN), pesticide/PCB)].

- Instrument detection limits, blank recoveries, surrogate recoveries, and spike recoveries were all found to meet EPA QC established limits except for spike recovery for TOX analysis of sample M146. However, sample analysis showed a value below the detection limit.

B-5e. Soil and Sediment Chemical Analyses

Summary tables are provided showing the analytical results of the pond samples (Table B-8) and the background samples (Table B-9). Values for specific soil and sediment analyses at sample depths and locations can be correlated with corresponding sample codes (i.e., M147, M148, etc.) in Figures B-4 and B-5. A graphic representation of the analytical data correlated with sample location is provided in Appendix C-2. Values below detection, representing the majority of the data, were not included in the summary tables. However, a complete data set for all Phase I soil sediment analyses are provided in Appendix C-1. Inclusion of the data packages serves to illustrate the extent of chemical analyses, U.S. Testing data format, and overall results. Detection limit information is provided in Appendix C-4.

B-5f. Statistical Evaluation

With the exception of specific organic compounds that were not identified in background samples, the individual pond sediment samples were compared to the summarized background sample data. The background sample constituents are assumed to be normally distributed. This assumption was then tested for validity. If the normal distribution assumption was proven false, a test was done to determine if the constituent is log-normally (natural logarithm) distributed.

The background threshold values were determined using a tolerance interval (TI) approach to set an upper bound on background values. If the constituent was determined to not be normally or log-normally distributed, then a nonparametric method was used to determine the background threshold TI. Evaluations are presented in Tables C5-4 and C5-5, Appendix C-5.

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Table B-8. Summary of Sampling Results Above Detection Limit at the 2101-M Pond. (sheet 1 of 2)

Sample no.	Constituent (ppm)													
	Strontium	Zinc	Calcium	Barium	Chromium	Sodium	Nickel	Copper	Vanadium	Aluminum	Manganese	Potassium	Iron	Magnesium
M147	24.1	104.0	7,710.0	102.0	9.4	1,280.0	8.1	19.0	71.0	9,740.0	418.0	1,400.0	32,900.0	6,090.0
M148	22.7	70.1	5,210.0	104.0	9.1	1,310.0	7.3	---	86.8	9,890.0	481.0	843.0	38,800.0	6,130.0
M149	24.4	37.7	6,860.0	72.2	8.2	1,060.0	7.2	---	50.7	7,690.0	364.0	856.0	23,000.0	4,860.0
M150	29.8	51.0	8,450.0	53.3	9.0	1,180.0	7.2	6.4	40.9	7,020.0	253.0	770.0	19,600.0	4,590.0
M151	25.8	137.0	8,210.0	48.6	11.6	1,210.0	8.7	---	36.9	7,150.0	255.0	886.0	18,000.0	5,100.0
M152	31.8	43.2	4,570.0	93.8	11.3	1,250.0	7.8	---	55.9	8,790.0	333.0	1,290.0	24,700.0	5,050.0
M153	27.9	39.0	7,730.0	80.3	8.0	1,250.0	7.0	---	52.6	7,570.0	338.0	703.0	25,000.0	5,060.0
M154	20.3	60.0	3,990.0	80.9	9.1	287.0	6.6	51.6	77.6	6,970.0	302.0	896.0	26,300.0	4,030.0
M155	23.6	52.2	4,480.0	75.6	10.2	241.0	8.1	42.9	67.6	7,060.0	278.0	946.0	24,100.0	4,200.0
M156	28.3	31.7	5,010.0	71.6	8.3	292.0	7.3	1.6	39.4	7,040.0	235.0	596.0	20,300.0	4,720.0
M157	27.5	31.6	5,540.0	59.1	7.5	154.0	6.1	---	38.1	7,830.0	261.0	958.0	21,400.0	5,610.0
M158	21.5	28.7	8,370.0	53.9	9.5	120.0	8.0	1.2	28.4	7,300.0	226.0	1,280.0	17,900.0	5,770.0
M159	30.7	220.0	5,520.0	151.0	15.7	312.0	13.0	1,340.0	74.1	14,000.0	475.0	1,880.0	39,200.0	7,450.0
M160	22.2	39.3	3,360.0	75.3	9.4	166.0	6.4	9.3	47.6	7,780.0	307.0	937.0	22,800.0	5,040.0
M161	18.8	30.9	5,040.0	69.5	10.1	200.0	7.1	---	42.8	5,660.0	245.0	732.0	18,500.0	4,370.0
M162	28.0	30.0	12,000.0	65.5	7.3	160.0	6.6	---	35.9	7,450.0	271.0	895.0	20,000.0	5,510.0
M163	24.6	28.0	8,890.0	44.4	11.0	168.0	7.7	1.8	25.8	6,010.0	229.0	1,000.0	13,600.0	5,000.0
M164	40.0	83.4	16,400.0	96.7	12.1	309.0	10.4	270.0	49.0	10,200.0	332.0	1,580.0	24,800.0	6,290.0
M165	20.3	30.9	2,830.0	70.0	8.9	163.0	6.9	---	37.4	6,710.0	255.0	806.0	17,500.0	4,330.0
M166	55.3	29.1	5,210.0	81.0	10.5	195.0	8.1	1.7	37.2	7,980.0	270.0	886.0	21,000.0	4,990.0
M167	32.5	31.2	5,000.0	66.3	9.8	240.0	8.2	---	42.4	8,700.0	271.0	859.0	23,100.0	5,320.0
M168	18.7	27.0	14,400.0	49.4	6.4	136.0	5.3	1.6	34.8	7,000.0	230.0	675.0	21,700.0	5,280.0
M169	28.2	32.9	14,900.0	62.4	10.8	143.0	7.2	6.1	32.3	10.300.0	286.0	1,770.0	25,000.0	6,930.0

Table B-8. Summary of Sampling Results Above Detection Limit at the 2101-M Pond. (sheet 2 of 2)

Sample No.	pH	Conductivity	Constituent (ppm)[a]														
			Sulfate	Chloride	Arsenic	Lead	TOC	TOX	Ammonium	Fluoride	Methylene chloride	Acetone	Toluene	Butanoic acid	Proponal	Ethanol	Unknown organics
M147	7.4	641.0	39.5	14.5	1.8	7.8	112.0	15.60	1.7	---	0.022	---	---	---	---	---	---
M148	7.0	124.0			1.8	5.6	18.4	--	1.6	---	---	---	---	---	---	---	---
M149	7.8	197.0	2.7	---	1.2	4.7	---	2.15	1.6	---	---	---	---	---	---	---	---
M150	8.1	197.0			0.8	4.2	---	---									
M151	8.2	197.0	2.1	---	3.6	4.2	---	4.00	1.6	---	---	0.036	---	---	---	---	---
M152	7.6	141.0	25.5	3.8	1.5	5.3	13.6	---	1.7	---	---	0.120	---	---	---	---	1.7
M153	8.2	146.0			0.7	3.6	---	---									
M154	6.8	265.5	4.1	6.8	---	5.5	116.0	2.30	2.0	3.3	---	0.071	0.072	---	0.005	0.005	---
M155	7.1	354.0			0.5	5.6	98.7	19.30									
M156	8.0	199.0	1.7	1.3	---	3.9	17.8	2.10	2.6	---	---	---	---	---	---	---	---
M157	8.2	190.0			1.0	4.7	---	10.10									
M158	8.5	147.0	---	---	2.5	6.4	---	---	1.7	---	---	---	---	---	---	---	---
M159[b]	6.9	395.0	12.3	13.3	2.7	35.2	318.0	8.50	2.3	15.2	---	0.270	---	2.3	0.006	0.027	1.7[c], 1.4, 1.2, 1.0
M160	7.1	67.7		0.8	5.8	16.8	4.20										
M161	7.7	169.0	1.7	---	0.7	3.0	---	7.50	1.7	---	0.027	0.039	---	---	---	---	2.9, 4.5
M162	8.0	164.0			1.3	4.9	---	21.50									
M163	8.0	187.0	2.8	---	2.7	6.6	---	---	3.8	---	---	---	---	---	---	---	1.4
M164	7.7	623.0	101.0	7.2	3.5	8.8	137.0	---	4.3	2.0	---	---	---	---	---	---	---
M165	8.0	168.0			1.6	4.1	---	5.10									
M166	8.1	172.0	4.0	---	1.0	3.9	---	8.00	3.6	---	---	---	---	---	---	---	---
M167	8.0	171.0	2.0	---	1.6	4.0	---	---	3.2	---	---	---	---	---	---	---	---
M168	8.0	168.0			1.2	4.2	---	---									
M169	8.1	158.0	---	---	2.9	6.9	---	---	2.5	---	---	---	---	---	---	---	---

NOTE: --- = data values are less than detection limits. Blank spaces shown in this table indicate that this chemical analysis was not requested for the corresponding sample.

[a] All values in this table are reported in ppm with the exception of pH and conductivity.

[b] One value not reported in this table is identified in sample M159 for silver (2.20 ppm).

[c] Identified as an aliphatic hydrocarbon.

Table B-9. Summary of Background Sampling Results Above Detection Limits.

Sample No.	Constituent (ppm)													
	Strontium	Zinc	Calcium	Barium	Chromium	Sodium	Nickel	Copper	Vanadium	Aluminum	Manganese	Potassium	Iron	Magnesium
M131[a]	22.7	112.0	3,770.0	61.7	16.6	937.0	9.2	3.3	59.0	10,100.0	164.0	1,620.0	26,900.0	4,700.0
M132	31.6	61.8	4,750.0	88.8	15.5	1,170.0	12.7	5.5	65.2	8,870.0	268.0	1,290.0	23,100.0	5,310.0
M133	22.4	48.4	4,540.0	205.0	8.0	991.0	13.0	---	65.3	5,770.0	2,870.0	643.0	25,400.0	4,030.0
M134	15.0	30.9	2,770.0	63.0	5.9	820.0	5.7	---	35.1	5,060.0	264.0	547.0	16,400.0	3,550.0
M135[b]	18.3	31.4	2,800.0	55.9	8.3	848.0	9.1	11.9	35.0	6,570.0	237.0	723.0	18,600.0	4,680.0
M136	18.9	33.9	3,050.0	77.0	7.5	852.0	6.8	---	38.0	7,210.0	361.0	910.0	19,500.0	4,930.0
M137	17.2	30.4	2,790.0	96.1	6.8	814.0	6.3	---	33.4	5,920.0	383.0	723.0	16,700.0	3,990.0
M138	26.9	28.9	7,040.0	81.5	8.6	838.0	6.6	1.5	24.6	6,290.0	234.0	746.0	15,300.0	4,780.0
M139	20.3	44.7	3,550.0	85.9	8.5	827.0	7.8	---	55.1	8,560.0	380.0	1,810.0	25,500.0	4,660.0
M140	22.7	32.3	8,340.0	46.3	8.3	1,430.0	6.2	---	42.2	6,050.0	252.0	833.0	18,800.0	4,430.0
M141	27.3	44.9	14,000.0	97.3	6.6	1,170.0	6.8	---	69.8	7,230.0	393.0	1,120.0	29,200.0	5,110.0
M142	39.2	33.8	10,600.0	65.6	9.0	1,640.0	7.4	---	42.5	7,740.0	279.0	1,340.0	20,000.0	5,860.0
M143	29.3	39.7	8,440.0	117.0	8.3	1,620.0	7.1	---	53.8	7,260.0	533.0	924.0	23,600.0	4,980.0
M144	36.9	43.4	10,700.0	80.4	8.1	1,710.0	7.2	---	66.3	8,910.0	392.0	916.0	28,300.0	5,980.0
M145	25.6	37.2	5,890.0	57.9	8.6	1,280.0	7.2	---	47.0	7,960.0	272.0	1,250.0	21,800.0	5,420.0
M146	28.7	34.4	9,700.0	46.6	10.1	1,130.0	6.7	---	36.2	8,710.0	243.0	1,670.0	23,200.0	6,910.0

Sample No.	pH	Conductivity	Constituent (ppm except pH and conductivity)							
			Sulfate	Chloride	Arsenic	Lead	TOC	TOX	Ammonium	Fluoride
M131	6.1	688.0	19.1	37.0	1.7	12.7	157.0	---	2.6	3.1
M132	5.8	80.0	7.8	4.1	3.3	8.9	71.9	5.9	0.9	---
M133	6.2	94.0	6.1	---	8.1	3.9	42.3	6.0	1.2	---
M134	6.6	30.0	1.9	---	1.2	3.1	---	---	1.5	---
M135	6.9	38.0	1.7	---	1.4	3.7	---	2.0	1.6	---
M136	6.4	57.0	4.6	2.3	2.6	4.9	19.6	3.8	1.2	---
M137	7.2	46.0	2.3	1.8	1.3	3.8	---	5.8	1.5	---
M138	7.8	222.0	1.3	---	1.6	4.5	---	---	2.0	---
M139	6.1	371.0	---	28.3	1.1	7.1	53.6	---	1.9	---
M140	6.8	258.0	1.2	---	1.9	5.0	48.7	---	1.9	1.2
M141	7.0	376.0	9.6	---	2.1	6.8	58.7	28.5	2.0	1.4
M142	7.1	326.0	5.0	---	1.7	3.9	---	10.1	2.0	1.1
M143	8.2	254.0	1.5	---	1.1	3.6	---	---	2.0	---
M144	7.3	587.0	34.5	7.1	1.6	4.8	39.7	---	1.6	1.4
M145	8.0	290.0	25.5	9.9	3.6	3.3	---	16.8	1.4	---
M146	7.2	674.0	17.3	37.1	1.3	4.2	---	---	2.2	---

NOTE: --- = data values are less than detection limits.

[a]Two values not reported in this table were identified as unknown aliphatic hydrocarbons in sample M131 (1.1 and 2.4).

[b]One value was reported for sulfide in sample M135 (12.0 ppm).

Background Threshold Value Exceedances--Upon comparison of the individual samples with the background threshold values, constituents that demonstrated exceedance of these values were noted for location and depth of occurrence. Appendix C-5, Table C5-6 identifies the constituent and sample(s) that have exceedances. Based on these results, the need to evaluate potential contaminant levels in the top 2 ft and certain locations in the pond is determined to be necessary. This second phase of sampling is discussed in Appendix D-1 through D-4.

Exceedances by Location--There are 17 background threshold exceedances at 2101-M Pond. These exceedances occur in a somewhat identifiable pattern. Nine of the exceedances occur at the effluent discharge point, five in the north arm location, four in the east arm location, and three in the south arm. Of these 17 exceedances, 10 are metals, and of these 10 exceedances, 4 occur at the effluent discharge point and 3 occur in the east arm.

The east arm and the effluent discharge point contain 9 of the 17 exceedances. The rational behind this depositional pattern seems to point to the metals sorbing relatively close to the discharge point.

Exceedances by Depth--Of the 17 background threshold exceedances at the 2101-M Pond, 10 occur in the 0.0 to 2.0 ft range, 2 each in the 2.5 to 4.5 and 5.0 to 7.0 ft range, and 3 in the 10.0 to 12.0 ft range. With this number of exceedances occurring in the upper 2 ft, it will be important to determine the spatial extent and the significance of these exceedances. To do this, the upper 2 ft of the 2101-M Pond soil is was resampled based on the statistical information obtained from this sampling effort (Appendix D-1 through D-4).

Copper--Copper exceedances are generally surficial, and occur without regard to location. The differences in these exceedances are in the degree of significance of the exceedance. The statistically determined background threshold level of the 2101-M Pond soils is 11.9 parts per million. Table B-10 details these exceedances by location and significance of exceedance. Only two of the exceedances are more than an order of magnitude higher than the background threshold value.

Ammonium--Ammonium has the next highest number of exceedances with four occurrences. Three of the exceedances occur in the north arm at different depths. This arm contains water only during periods when the discharge volume exceeds the carrying capacity of the south and east arms. The soils in this area are wetted on a variable interval. It is theorized that the presence of ammonium is attributable to organic breakdown and subsequent migration.

Zinc--Zinc has two exceedances above the background threshold value of 112 parts per million. One occurrence is in the east arm and the other is at the discharge point, which would seem to indicate a potential location effect. The exceedances occur in the surface sample and at the 10 to 12 ft range.

Fluoride--Fluoride has two exceedances that occur in the south arm and at the discharge point. These exceedances are most likely because of the potable water cycled through the 2101-M Building.

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Table B-10. Background Threshold Exceedances.

Constituent	Background threshold (ppm)	Level of occurrence (ppm)	Location	Significance (times higher)
Copper	11.9	1,340	Discharge (0-2 ft)	112.6
		270	North arm (0-2 ft)	22.7
		51.6	South arm (0-2 ft)	4.3
		42.9	South arm (2.5-4.5 ft)	3.6
		19	East arm (0-2 ft)	1.6
Ammonium	2.8	4.3	North arm (0-2 ft)	1.5
		3.8	Discharge (10-12 ft)	1.4
		3.6	North arm (5-7 ft)	1.3
		3.2	North arm (10-12 ft)	1.1
Zinc	112	220	Discharge (0-2 ft)	2
		137	East arm (10-12 ft)	1.2
Strontium	42.5	55.3	North arm (5-7 ft)	1.3
Vanadium	83.8	86.8	East arm (2.5-4.5 ft)	1.04
Lead	12.7	35.2	Discharge (0-2 ft)	2.8
Fluoride	3.1	15.2	Discharge (0-2 ft)	4.9
		3.3	South arm (0-2 ft)	1.1
TOC	157	318	Discharge (0-2 ft)	2

Strontium, Vanadium, Lead, TOC--These four constituents all have one background threshold exceedance. Two of the exceedances occur in the surface sediments at the discharge point (TOC being the only nonmetal). The TOC exceedance is most likely attributed to the high natural organic content of the pond sediments. The metals occur at very low concentrations above the background threshold value.

The exceedances, which do not occur at the discharge (strontium and vanadium) occur in the north and east arms. Both exceedances are extremely close to background threshold values.

B-5g. Human Health Considerations

The principal contamination scenario for the 2101-M Pond is contamination of the upper pond soil from liquid waste received from the 2101-M Laboratory. The most probable potential exposure routes of soil contaminants to humans or the ecosystem include the following:

- Direct contact with contaminated surface soils
- Exposure to contaminated groundwater or surface water through drinking, recreation or food
- Inhalation of contaminated dust.

Contact with contaminated surface soils appears to pose the greatest risk to members of the surrounding ecosystem or humans and is the basis for soil ingestion as the exposure model of choice. No groundwater contamination from the Pond is indicated from the groundwater analysis of monitoring wells (Section B-6). Moreover, exposure to groundwater or surface water is remote because neither is used for drinking purposes and there is no evidence of flow into rivers 5 to 6 mi away. Inhalation of contaminated dust that may become airborne because of prevailing winds is minor compared to direct contact with soil. This exposure route also presents an insignificant hazard because of the small surface area of the 2101-M Pond (less than one-tenth acre). The pond soil lies in a depression surrounded by a berm, so this exposure route is of inconsequential risk to the nearest residential areas (10 mi away) downwind of the 2101-M Pond.

B-5g(1). Action Levels

Action levels are concentrations of constituents that prompt an action, such as soil removal and/or treatment or further evaluation. Initial action levels will be the greater of two levels: Site-wide background threshold value or limit of quantitation. The limit of quantitation is the level above which quantitative analyses can be obtained with a specific degree of confidence (generally the mean background signal plus 10 standard deviations). If concentrations exceed initial action levels, those constituents were

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assessed against health-based action levels. Table B-11 lists the constituents and maximum concentrations found in the 2101-M Pond soil that were above the background values.

The 2101-M Pond site is in the 200 East Area, which is planned to be used for waste operations in the future. This use is consistent with the criteria in WAC 173-340-745 for determining industrial sites. Therefore, the health-based action levels chosen for this site are the Model Toxics Control Act (MTCA), WAC 173-340-745(4)(a)(iii)(A and B), industrial method C calculated levels (Ecology 1991). However, for comparative purposes only the constituents found in the pond soil were also compared to MTCA, WAC 173-340-740(3)(a)(iii)(A), residential method B calculated levels (Table B-11). For noncarcinogens, the principal variable relating human health to action levels is the oral reference dose (RfD). The reference dose is defined as the level of daily human exposure at or below which no adverse effect is expected to occur during a lifetime. For carcinogens, the cancer slope factor (CSF) is the basis for determining human health effects; it is a measurement of risk per unit dose. The oral reference dose and cancer slope factor are chemical-specific and are obtained from the *Integrated Risk Information System* (IRIS) database (EPA 1991) or other sources as approved under WAC 173-340-708(7). Health-based levels will be based on values that are current at the time of approval of this closure plan. If an analyte does not have an RfD or CSF (e.g. lead) the clean up value was taken from the Method A Tables for soil.

Since there are multiple constituents of concern, individual hazard quotients are also calculated and summed for the total hazard index (Table B-12) as required by WAC 173-340-700(3)(b). A hazard index of ≥ 1 is considered to be an indication of a hazardous condition or effect. The calculation used to determine the hazard quotient (HQ) is as follows:

$$HQ = \frac{dose}{RfD} \qquad dose = \frac{soil\ concentration\ mg/kg \times SIR\ mg/day}{ABW\ kg \times UCF\ mg/kg}$$

Where: SIR = soil ingestion rate in mg soil/day (50)
ABW = average body weight in kg (70)
UCF = units conversion factor in mg/kg (1,000,000)
RfD = oral reference dose in mg analyte/kg body weight in a day
and,
soil concentration is in mg analyte/kg soil
dose is in mg analyte/kg body weight in a day

The carcinogenicity values obtained using WAC 173-340-745(4)(a)(iii)(B) calculations are presented in Table B-13.

B-5g(2). Summary of Results

The results of these assessments indicate that the concentration of constituents found to be present in the pond pose no threat to human health. The noncarcinogenic evaluation (Table B-11 and B-12) shows all analyte concentrations to be below the Method C clean up levels. In addition, the

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Table B-11. Noncarcinogenic Soil Cleanup Levels.

Analyte	Maximum concentration	Oral RfD	Industrial method C	Residential method B
Acetone	0.25	0.1[a]	350,000	8,000
Aroclor 1242	0.42	N/A	10[d]	1[d]
Aroclor 1254	1.1	N/A	10[d]	1[d]
Benzo(a)anthracene	1.8	N/A	20[d]	1[d]
Benzo(ghi)perylene	2.1	0.03[a]	105,000	2,400
Benzo(a)pyrene	1.9	N/A	20[d]	1[d]
Bis(2-ethylhexyl)phthalate	16.0	0.02[a]	70,000	1,600
Butanoic Acid	2.2E	N/A		
2-Butanone	21.0	0.05[b]	175,000	4,000
Cadmium	2.7	0.001[a]	3,500	80
Chromium	33.0	III 1.0[a] VI 0.005[a]	3,500,000 17,500	80,000 400
Chrysene	2.1	N/A	20[d]	1[d]
Copper	2500.0	0.04[c]	140,000	3,200
Fluoranthene	1.1	0.04[a]	140,000	3,200
Indeno(1,2,3-cd)pyrene	2.4	N/A	20[d]	1[d]
Lead	160.0	N/A	1,000[d]	250[d]
Manganese	600.0	0.14[a]	490,000	11,200
Pyrene	1.7	0.03[a]	105,000	2,400
Silver	32.0	0.005[a]	17,500	400
Thallium	50.0	0.0009[b]	3,150	72
Toluene	0.0023	0.2[a]	700,000	16,000
Zinc	360.0	0.2[a]	700,000	16,000
2,4-D	0.015	0.01[a]	35,000	800
4,4-DDE	0.0007	N/A		
2,4,5-T	0.003	0.01[a]	35,000	800
2,4,5-TP	0.003	0.008[a]	28,000	640

UNITS: Concentration = mg analyte/kg soil, Oral RfD = mg analyte/kg body weight-day,
Method B and C = mg analyte/kg soil.
N/A = [a]Not Available (at that time).
[b]from IRIS.
[c]from HEAST.
[d]from Superfund Technical Support Center.
Clean up value taken from Method A Tables for soil.

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Table B-12. Hazard Index for Multiple Constituents.

Analyte	Daily dose	RfD	Hazard quotient
Acetone	1.78×10^{-7}	0.1	2.00×10^{-6}
Aroclor 1242	3.00×10^{-7}	N/A	
Aroclor 1254	7.86×10^{-7}	N/A	
Benzo(a)anthracene	1.28×10^{-6}	N/A	
Benzo(ghi)perylene	1.50×10^{-6}	0.03	1.00×10^{-4}
Benzo(a)pyrene	1.36×10^{-6}	N/A	
Bis(2-ethylhexyl)phthalate	1.14×10^{-5}	0.02	6.00×10^{-4}
Butanoic Acid	1.57×10^{-6}	N/A	
2-Butanone	1.50×10^{-5}	0.05	3.00×10^{-4}
Cadmium	1.93×10^{-6}	0.001	0.002
Chromium III	2.36×10^{-5}	1.0	2.00×10^{-5}
VI	2.36×10^{-5}	0.005	0.005
Chrysene	1.50×10^{-6}	N/A	
Copper	0.0018	0.04	0.045
Fluoranthene	7.86×10^{-7}	0.04	1.96×10^{-5}
Indeno(1,2,3-cd)pyrene	1.71×10^{-6}	N/A	
Lead	1.00×10^{-4}	N/A	
Manganese	4.00×10^{-4}	0.14	0.003
Pyrene	1.21×10^{-6}	0.03	4.00×10^{-5}
Silver	2.28×10^{-5}	0.005	0.005
Thallium	3.57×10^{-5}	0.0009	0.04
Toluene	1.64×10^{-9}	0.2	8.00×10^{-9}
Zinc	3.00×10^{-4}	0.2	0.001
2,4-D	1.07×10^{-8}	0.01	1.00×10^{-6}
4,4-DDE	5.00×10^{-10}	N/A	
2,4,5-T	2.14×10^{-9}	0.01	2.00×10^{-7}
2,4,5-TP	2.14×10^{-9}	0.008	3.00×10^{-7}
TOTAL HAZARD INDEX			**0.5**

NOTE: Hazard Index assumes using most conservative HQ (copper) where HQs were not calculated, also uses chromium VI HQ
UNITS: Daily Dose = mg analyte/kg soil-day, ORAL RfD = mg analyte/kg body weight-day, HAZARD QUOTIENT = dimentionless

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Table B-13. Carcinogenic Soil Cleanup Levels.

Analyte	Maximum concentration	CSF	Industrial method C
Aroclor 1242	0.42	7.7[a]	17.0
Aroclor 1254	1.1	7.7[a]	17.0
Benzo(a)anthracene	1.8	N/A	20.0[b]
Benzo(a)pyrene	1.9	7.3[a]	17.9
Bis(2-ethylhexyl)phthalate	16.0	0.014[a]	9,375.0
Cadmium	2.7	N/A	10.0
Chromium VI	33.0	N/A	500.0
Chrysene	2.1	N/A	20.0[b]
Indeno(1,2,3-cd)pyrene	2.4	N/A	20.0[b]
Lead	160.0	N/A	1,000.0[b]
4,4-DDE	0.0007	0.34[a]	386.0

NOTES: Only EPA Carcinogenic Classifications A, B, and C are included in the Table
UNITS: Concentration = mg analyte/kg soil, CSF = risk (mg analyte/kg body weight-day)$^{-1}$, Method C = mg analyte/kg soil
[a]IRIS.
[b]Cleanup value from Method A Table for Industrial Soils.
N/A = not available.

evaluation shows the analyte concentrations found in the pond soil to be below the Method B clean up levels with the exception of some of the polycyclic aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene). The clean up level for these constituents were taken from the Method A Table (WAC 173-340-740, Table 2) because there are no RfDs available for them. It should be noted that for those PAHs (benzo(ghi)perylene, flouranthene, and pyrene) that did have RfDs, the clean up levels under Method B is well over the maximum concentration found in the soil. The reason for the low clean up level is due to assumed carcinogenicity for these constituents. For that reason these particular analytes are discussed in more detail in the results of the carcinogenic evaluation.

The carcinogenic evaluation (Table B-13) shows all analyte concentrations to be below the Method C clean up levels. There are some analytes that exceed the Method B clean up levels. These are the PAHs (benzo(a)anthracene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene), and the polychlorinated biphenyls (PCBs) (arochlor 1242, and arochlor 1254) listed in Table B-13.

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The PAHs are not considered to be a problem due to several reasons. These particular compounds occur at low concentrations (1.8 to 2.4 mg/kg) near the detection limit of the analysis method. The closer a value is to the detection limit there is more probability for error in the reported value. These compounds are all documented to occur naturally in soils, and are a widespread product of fossil fuel combustion. Finally, no PAHs were ever handled at the facility. Due to these facts it is proposed these PAHs not be considered in the closure of the 2101-M Pond.

The PCBs are also not considered to be a problem due to the very low concentrations in the soil. The maximum value for PCBs detected in the soil falls well below the clean up standards of the Toxic Substances Control Act. The soil clean up standard is 10 parts per million by weight. Clean soil is defined as containing less than one part per million by weight PCBs. WAC 173-303-071 contains an exemption for PCBs if the concentration is below 1 or 2 parts per million. For these reasons PCBs do not constitute a problem for clean closure.

Based on the calculations and the facts presented, there is no need for remediation of the 2101-M Pond soil. In fact, the calculations indicate that there is no reason why the pond should not be considered clean closed in its present condition.

The sum of all HQ using the 'maximum' contaminant value measured for each constituent in the soil, is less (0.5) than the threshold value of 1.0.

B-6. GROUNDWATER MONITORING

The Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1992) (referred to as the Tri-Party Agreement) requires all treatment, storage, or disposal (TSD) facilities undergoing clean closure to do so in accordance with WAC 133-303-610, irrespective of permit status, and to demonstrate that the groundwater and soils have not been adversely impacted by the TSD unit, as described in WAC 173-303-645. To demonstrate this a groundwater monitoring system has been established at the 2101-M Pond site. The network consists of four monitoring wells. One well is positioned upgradient and three are positioned downgradient of the pond. These wells were installed with the intent to satisfy interim status facility groundwater monitoring requirements in force at the time of well installation (40 CFR 265, Subpart F) (EPA 1988a). While the monitoring system and monitoring parameters were developed using the interim status regulations the intent of this section is to assess the impact of 2101-M Pond on the groundwater relative to WAC 173-303-645. The groundwater monitoring system and analyses are discussed in the following sections.

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B-6a. Groundwater Monitoring Activities

The interim status regulations in force during well installation (40 CFR 265, Subpart F) provided the objectives for the groundwater monitoring system. The objectives were to determine the following.

- Whether the groundwater meets DWS [40 CFR 265.92(b)(1)] (EPA 1988a).
- The quality of the groundwater [40 CFR 265.92(b)(2)] (EPA 1988a).
- Whether indicators of contamination are present in the groundwater [40 CFR 265.92(b)(3)] (EPA 1988a).
- Whether any contaminants or indicators originated from possible discharges of dangerous wastes to the 2101-M Pond.

To accomplish these objectives, four monitoring wells (Figure B-6) have been constructed to measure groundwater levels and to obtain groundwater samples from the uppermost aquifer. The wells were installed according to an interim status groundwater monitoring plan (Chamness et al. 1989). These wells are used to establish the groundwater gradient, evaluate the aquifer parameters, and to determine the groundwater quality. Analyses of groundwater data from wells not affected by the activities at the 2101-M Pond are compared with 2101-M Pond monitoring well results. This comparison is to demonstrate the effects of 2101-M Pond discharges to the groundwater quality. The baseline data will be compared with groundwater quality data from the 2101-M Pond downgradient monitoring wells to determine whether: (1) contaminants are present in the groundwater and, (2) contaminants disposed of to the 2101-M Pond have contributed to the degradation of groundwater quality below acceptable limits. Data from the analysis of pond soil will be compared with the groundwater quality data to determine whether constituents in the soil (considered as the source) have been transported through the vadose zone to groundwater (see Section B-6f).

Five quarters of groundwater samples were collected and analyzed to assess the background groundwater quality beneath 2101-M Pond. Semiannual sampling began in November 1989 and will continue through closure. Results from the quarterly and semiannual sampling events are reported to Ecology in quarterly reports for the Hanford Site. These data are presented also in Appendix E-1.

The results from monitoring well installation hydrogeologic and hydrochemical characterization activities are presented in the following sections.

B-6b. Hydrogeologic Characterization

This section provides information on the geology and hydrology of the Hanford Site and 2101-M Pond.

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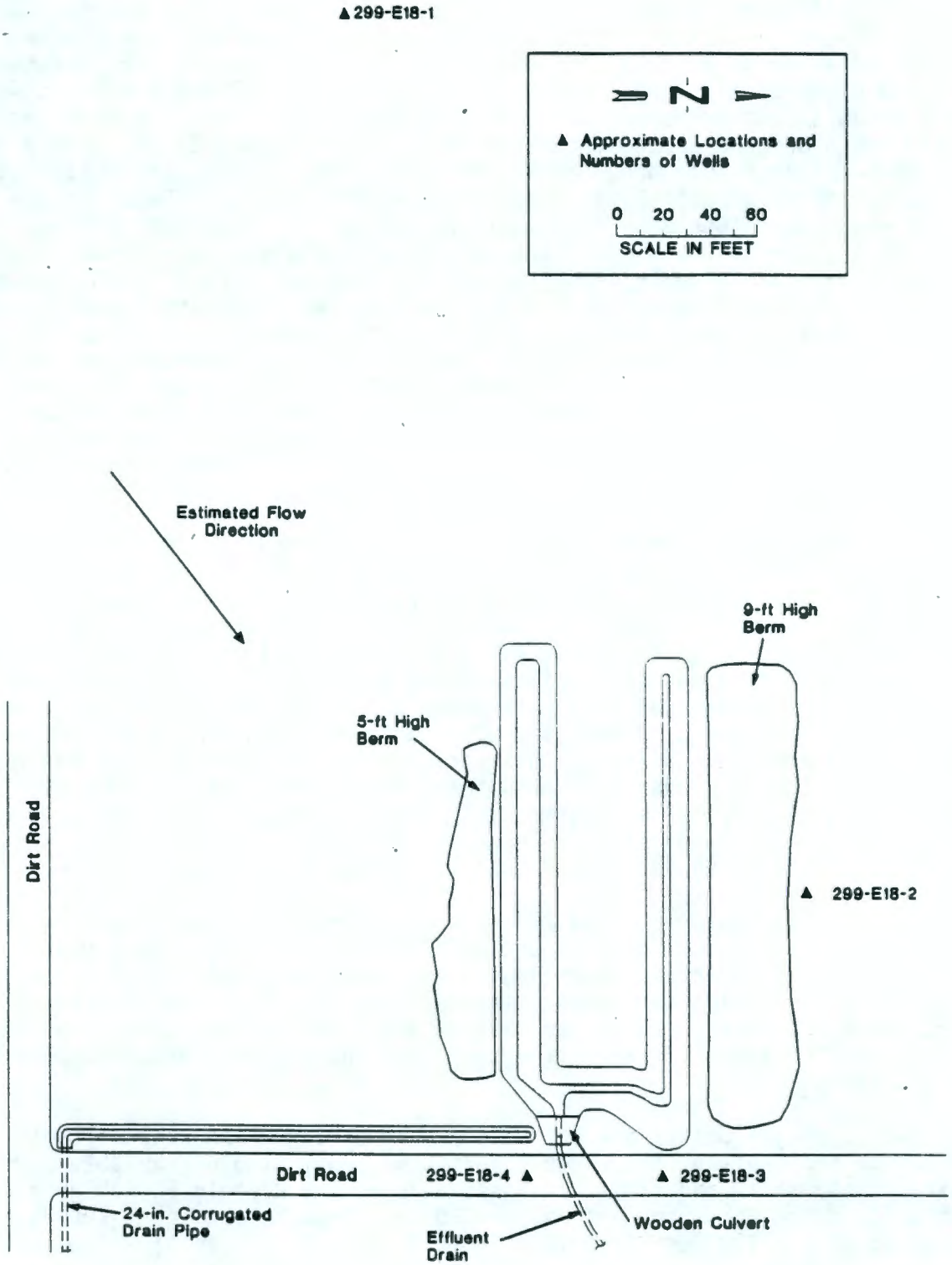

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1 Figure B-6. Location of Groundwater Monitoring Wells for 2101-M Pond.

B-6b(1). Geologic Regional Setting. The Hanford Site is located in the Pasco Basin, a topographic and structural basin in the Columbia Plateau. The Columbia Plateau is underlain by extensive tholeiitic basalt flows of the Columbia River Basalt Group that were erupted between 17 and 6 million years ago from northwest-trending linear vent systems in southeastern Washington, northeastern Oregon, and west central Idaho (Myers et al. 1979). These flows have been deformed into broad structural and topographic basins separated by narrow asymmetrical anticlinal ridges that border the Pasco Basin to the north, west, and southwest. Sediments partially fill the Pasco Basin. In the Pasco Basin, the Columbia River basalt consists of three formations totaling as much as 15,000 ft in thickness. Each flow typically consists of one or more entablature and colonnade units (the dense interior) and a rubbly flow top. If the flow top is sufficiently thick and extensive, it can yield extensive quantities of groundwater. Individual flows range from a few feet to over 300 ft in thickness. The basalt stratigraphic sequence is generally one of aquitards (the dense interior of flows) separated by thinner aquifers (the sedimentary interbeds and primary flow top breccias). Some sedimentary interbeds developed during episodes of stream drainage between basalt flows, and range from a few inches to several tens of feet in thickness.

Overlying the basalt is a sequence of fluvial and lacustrine sand, gravel, and silt of Miocene to Quaternary age (Figure B-7). The Ringold Formation consists of sand, gravel, clay, and silt that were deposited in Miocene and Pliocene streams and lakes. The Ringold Formation is overlain by the Plio-Pleistocene unit and the early 'Palouse' soil (Pleistocene). The overlying Hanford formation consists of two facies, the Touchet beds and the Pasco gravels. These sediments were deposited by cataclysmic floods draining across the north-central Washington plateau from ice-dammed lakes in northwestern Montana and Idaho, that catastrophically failed. The Pasco gravels mark the main channels through the Pasco Basin; the Touchet beds were deposited in slack water environments in water hydraulically impounded north of the flow constriction at Wallula Gap. The 200 Areas 'plateau' on which the 2101-M Pond is located is a bar deposited during the cataclysmic flooding.

B-6b(1.1). Geology of the 200 Areas. A generalized stratigraphic column for the 200 Areas is given in Figure B-7. Surrounding and plunging into the structural Pasco Basin are anticlinal ridges and synclinal valleys. The crest of one of these anticlinal ridges, the Umtanum-Gable Mountain structure, lies north of the 200 Areas, while the axis of the Cold Creek syncline lies to the south. The 200 Areas lie above the south-dipping basalt surface between these two fold axes.

Overlying the basalt are the slightly to strongly indurated fluvial and lacustrine sediments of the Ringold Formation consisting of variable strata of gravel, sand, silt, and clay. The thickness of the Ringold Formation ranges from 0 ft in the northern part of the 200 East Area to more than 700 ft southwest of the 200 West Area (DOE 1988; Tallman et al. 1979). The formation thickens substantially south of the 200 Areas near the axis of the Cold Creek syncline.

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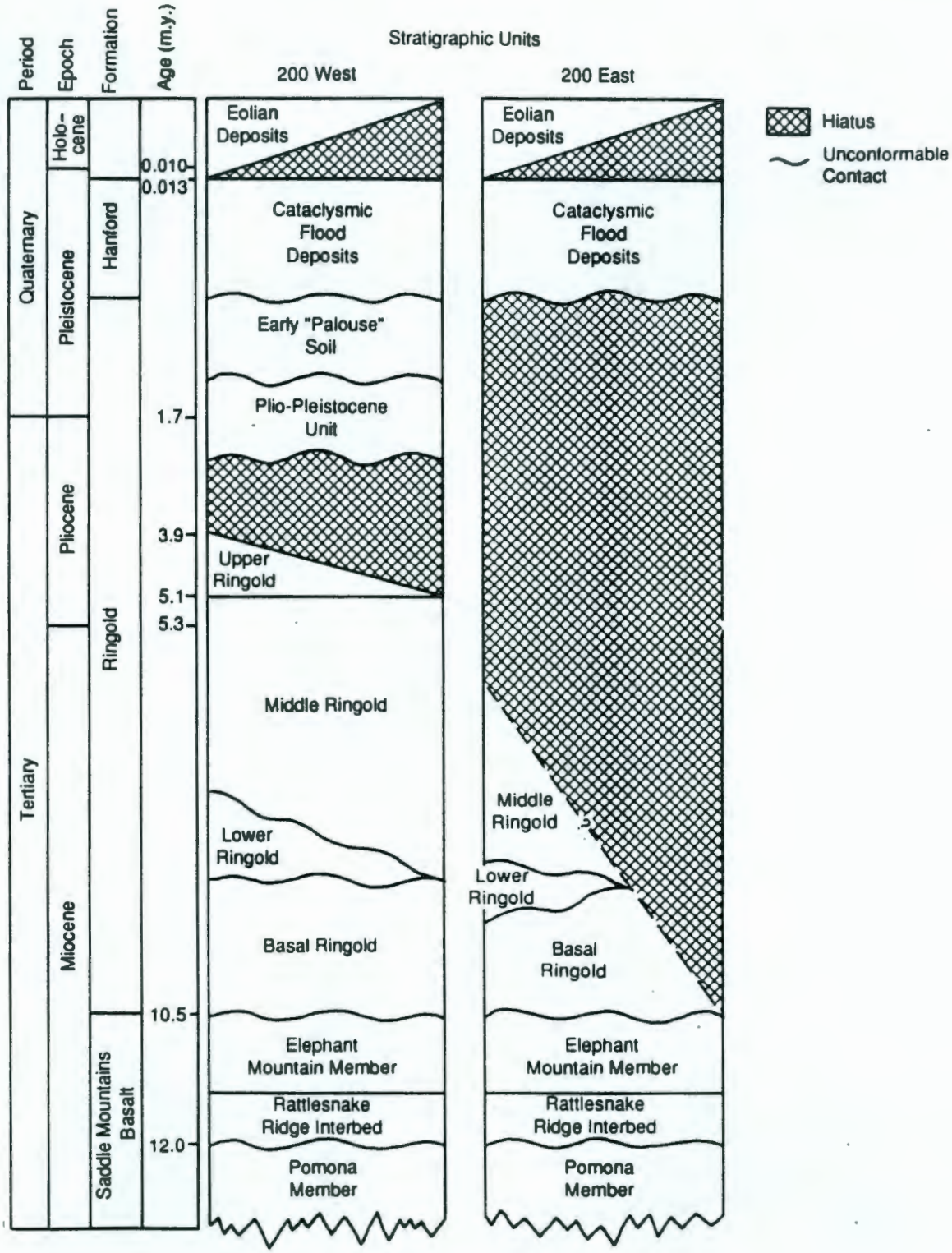

Figure B-7. Generalized Stratigraphic Column for the 200 Areas.

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The Ringold Formation is divided into four stratigraphic units: basal, lower, middle, and upper. The basal Ringold unit, consists of silty sandy gravel overlain by fine-grained sand, silt, or clay. Overlying the basal Ringold is the lower Ringold unit, consisting of silty coarse- to medium-grained sand, sandy silt, and clay. Sediments of the lower Ringold unit are often indurated and have been recognized as a potential confining layer in places. The fine-grained portion of the basal Ringold can be difficult to distinguish from the lower Ringold.

The Ringold Formation is dominated by the middle unit throughout the 200 Areas. The predominant lithology consists of well-rounded sandy gravel with some sand and silty sand lenses. The gravels typically range from pebble to cobble in size; however, boulders are locally common (Tallman et al. 1979). The coarse-grained basal and middle Ringold units are difficult to distinguish from each other because of their similar textures. Where present, the fine-grained sediments of the lower and/or upper basal Ringold separate the basal and middle units and aid in their distinction. The uppermost unit, the upper Ringold, is another sequence of thinly bedded, well-sorted sands, silts, and silty clay.

Not all of the units of the Ringold Formation are present throughout the 200 Areas. Uplift along the flanks of the anticlinal ridges, along with erosion by the ancestral Columbia River and catastrophic flooding during the Pleistocene Epoch, have removed or prevented deposition of some or all of the Ringold Formation in areas (Bjornstad 1984; Tallman et al. 1979). All four units are currently identified only in the western and southern portion of the 200 West Area, while no units of the Ringold Formation are present in the northeastern part of the 200 East Area.

A well-developed caliche horizon and/or locally derived basaltic gravel, informally called the Plio-Pleistocene unit, is found on the uppermost surface of the eroded Ringold sediments in the western portion of the Pasco Basin. This unit can be up to 80 ft thick (Bjornstad 1984). In places, the Plio-Pleistocene unit is overlain by the early 'Palouse' soil, an eolian deposit of fine-grained sand and silt. Both of these units are found only in the 200 West Area, having either been eroded or not deposited in the 200 East Area.

The catastrophic flooding that helped erode the Ringold Formation also deposited a sequence of unconsolidated silts, sands, and gravels informally named the Hanford formation. The fine-grained sands and silts, called Touchet beds, were deposited in protected areas, while the Pasco gravels were deposited in and near the floodwater channels. Thickness of the formation ranges from approximately 70 ft in part of the 200 West Area to a maximum of about 350 ft east of the 200 East Area (Tallman et al. 1979). Within much of the southern portion of the 200 Areas the Hanford formation consists of sand. Locally, the Hanford formation is overlain by a thin (0- to 10-ft) veneer of fine-grained eolian sand.

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Typically, the sediments in the 200 East Area contain little calcium carbonate and, to date, no caliche horizons have been identified. Where present, cementation of the Ringold Formation is generally by siliceous material.

B-6b(1.2). Stratigraphy Beneath the 2101-M Pond. The stratigraphy beneath the 2101-M Pond has been interpreted from field and laboratory analyses of cable tool borehole samples collected during the installation of the four monitoring wells and from previously drilled boreholes near the 2101-M Pond site. The following provides a summary of the site geology. More detailed discussions of the stratigraphy may be found in the 2101-M Pond Hydrogeologic Characterization Report (Chamness et al. 1990).

The upper three geologic units present beneath the 2101-M Pond area are: (1) the Saddle Mountains Basalt (Elephant Mountain Member), (2) the Ringold Formation, and (3) the Hanford formation. The early 'Palouse' soil and the Plio-Pleistocene units have not been identified in the 200-East Area. Cross sections and a fence diagram through the 2101-M Pond site are presented in Figures B-8, B-9, and B-10. Figure B-11 shows the locations of these cross sections and the fence diagram.

The new monitoring wells penetrated only the upper 20 ft of the unconfined aquifer. Therefore, stratigraphic knowledge of the underlying units is uncertain. In particular, the depth to the basalt and the lower/basal Ringold units is known only by interpolation from two nearby wells 299-E23-2 and 299-E19-1. The depth to basalt beneath the 2101-M Pond is approximately 480-ft (Chamness et al. 1990).

The lower Ringold Formation section is variable across the site. In well 299-E19-1, the basalt is overlain by 1 ft of muddy sandy gravel to sandy gravel. Above the gravel is 15 ft of clayey sand grading into gray clay. This unit may correlate with the fine grained basal Ringold unit. This clay is overlain by 40 ft of blue-gray clay, which likely correlates with the lower Ringold unit. These clays form a sharp contact with the overlying middle Ringold unit, which consists of muddy sandy gravel to sandy gravel.

The Ringold Formation northeast of the 2101-M Pond site is penetrated by well 299-E23-2. The basalt here is overlain by 180-ft of muddy sandy gravel to sandy gravel, which correlates to the middle Ringold unit. There is no fine-grained basal/lower Ringold present and the coarse grained basal unit is in contact with the middle Ringold unit.

Where present, the fine-grained basal/lower Ringold units form a lower confining layer within the Ringold Formation. If the basal/lower unit is present beneath the 2101-M Pond site, the unconfined aquifer could be approximately 40-ft thick. If absent, the unconfined aquifer would be approximately 150-ft thick.

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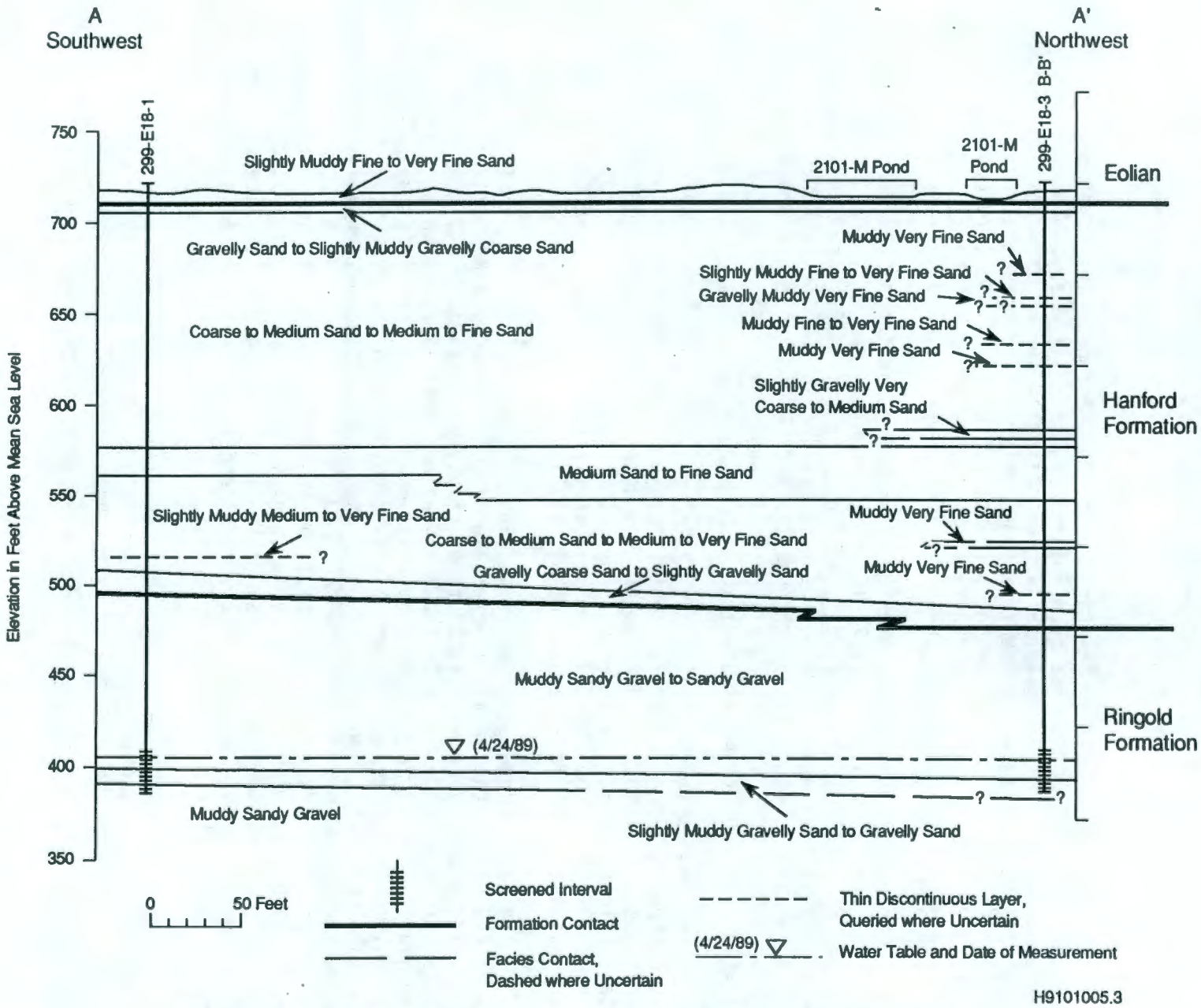

Figure B-8. Cross Section A-A' with no Vertical Exaggeration (Chamness et al. 1990).

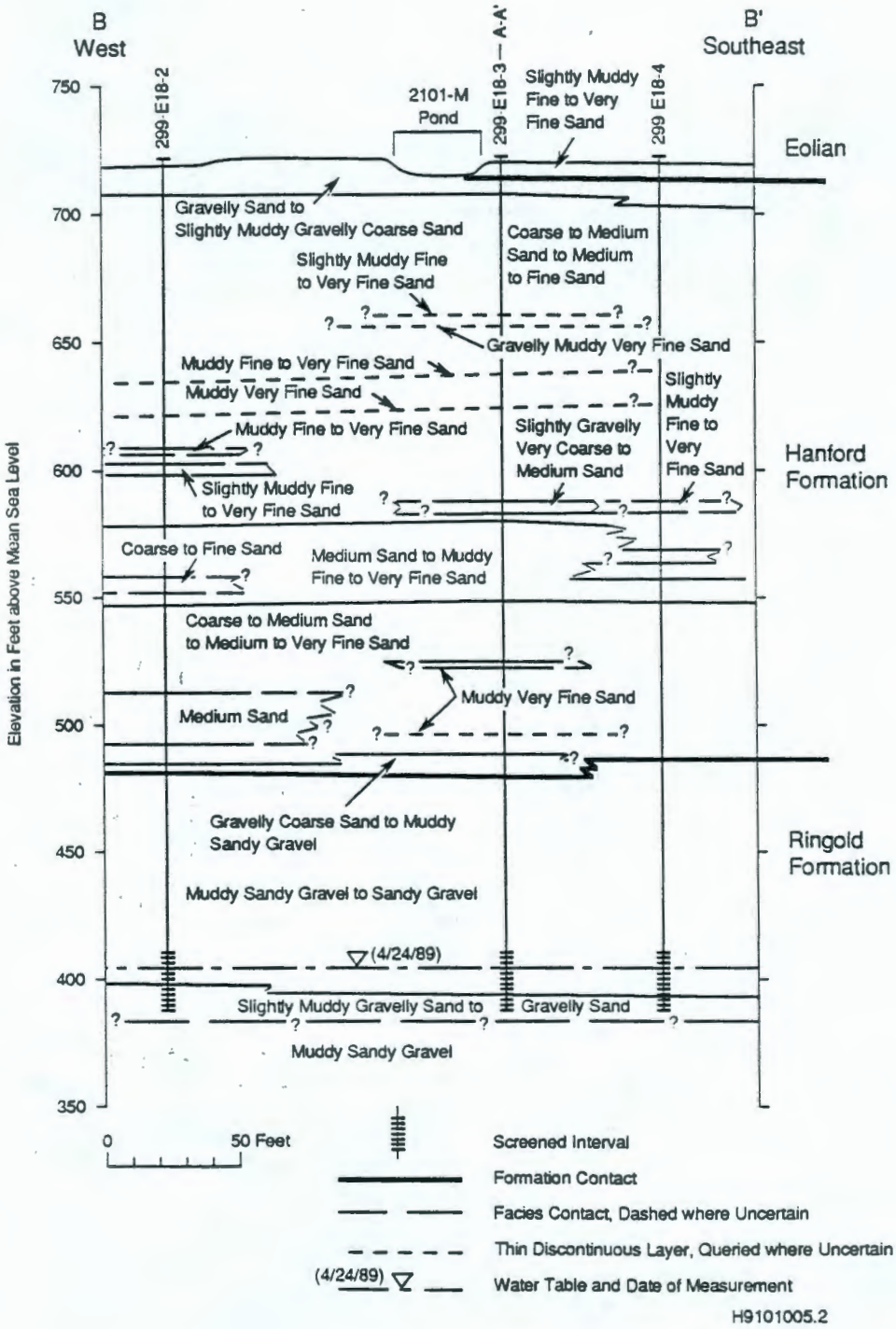

Figure B-9. Cross Section B-B' with no Vertical Exaggeration (Chamness et al. 1990).

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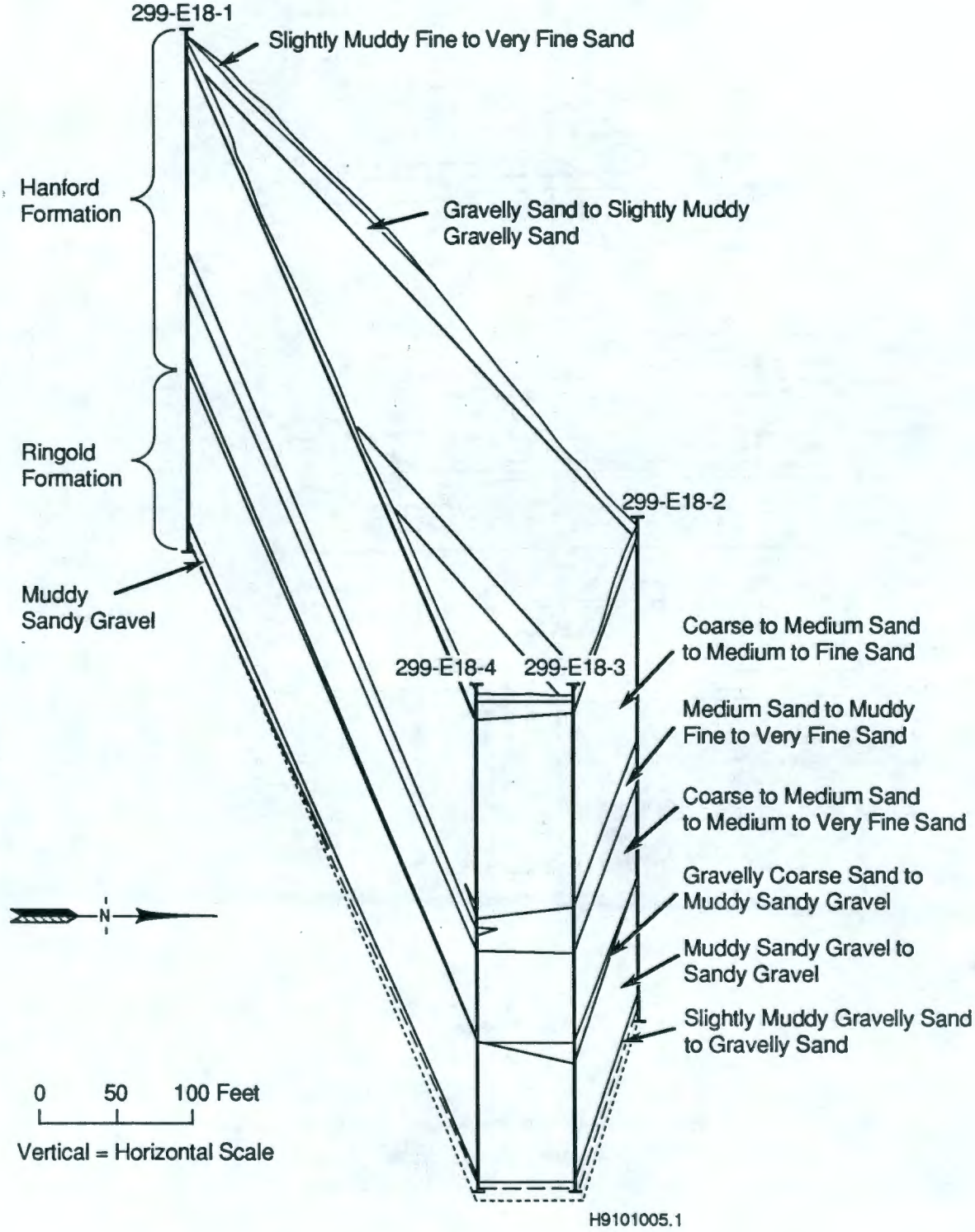

Figure B-10. Fence Diagram (Chamness et al. 1990).

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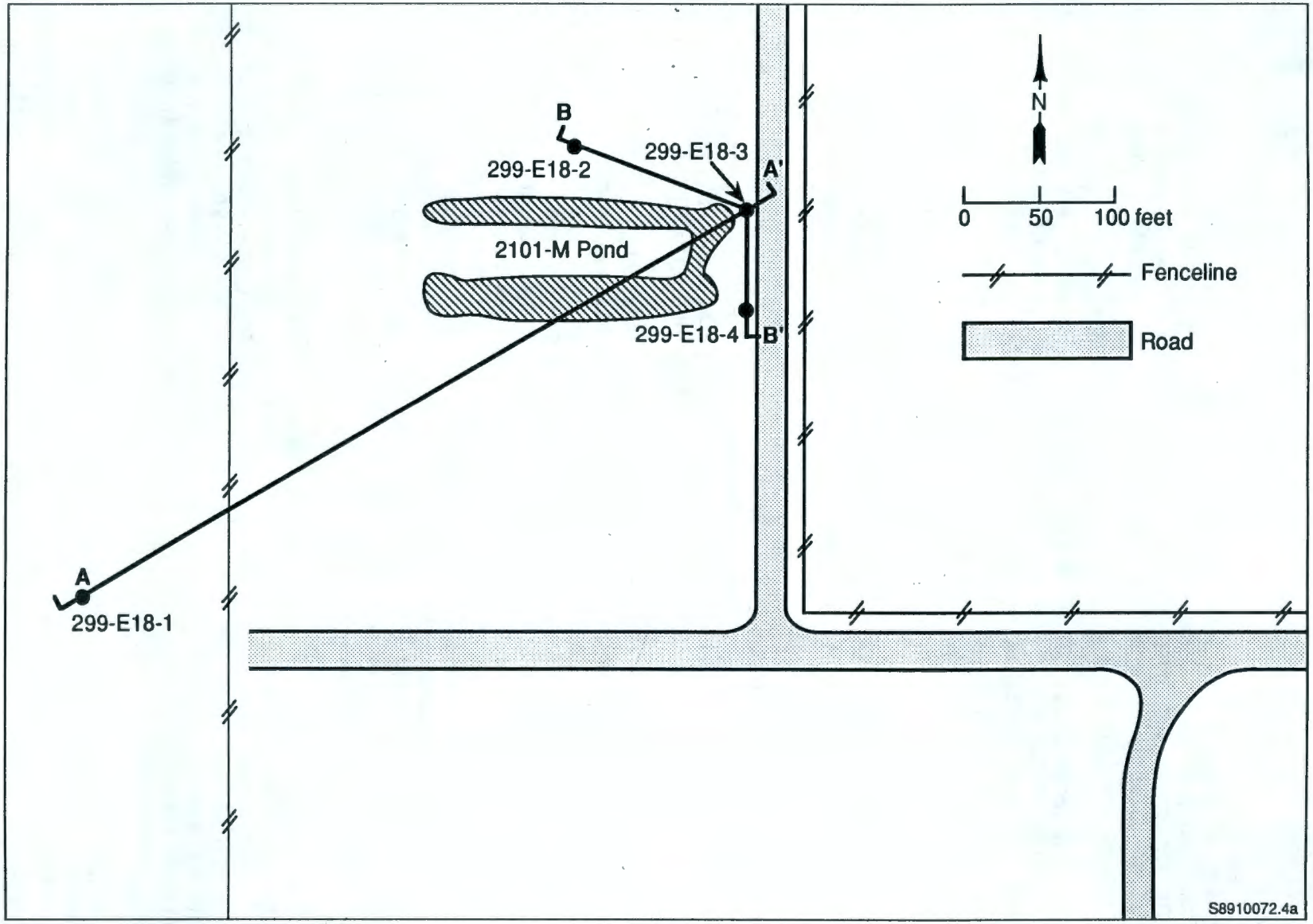

Figure B-11. Cross Section and Fence Diagram Location Map.

The four new monitoring wells penetrated nearly 100 ft of middle Ringold sediments and approximately 235 ft of the overlying Hanford formation. The middle Ringold unit in the area is dominated by unconsolidated to slightly consolidated muddy sandy gravels to sandy gravel. A 5 to 10-ft thick layer of slightly muddy gravelly sand to gravelly sand was found at the bottom of each well in the saturated zone. The overlying Hanford formation sediments consist of moderately to well sorted sand with minor gravelly sand and muddy sand lenses and layers.

B-6b(2). Hydrogeology. This section provides background information on the hydrogeology of the Hanford Site. Detailed descriptions of Hanford Site hydrogeology are available in reports by DOE (1988), Gephart et al. (1979), Graham et al. (1981), Graham et al. (1984), and Law et al. (1987), and reports on water-level data collected and reported semiannually, such as in Kasza (1990).

The Hanford Site has an arid climate and receives an average of 6.25 in. of precipitation a year. Evapotranspiration rates are expected to far exceed this (DOE 1988); therefore, most precipitation likely is transpired or evaporated back to the atmosphere (Graham et al. 1981). Recharge rates range from near zero (Routson et al. 1988) to more than 4 in. each year, depending on surface conditions (Gee 1987). Small recharge rates generally occur where fine-textured sediments and deep-rooted plants occur. The larger values are associated with areas having a coarse gravelly surface and no vegetative cover. The Hanford Site is drained by the Yakima and Columbia Rivers.

Groundwater beneath the Hanford Site occurs under both unconfined and confined conditions. The unconfined aquifer is contained primarily within the middle unit of the Ringold Formation and extends up into the Hanford formation in areas. The base of the unconfined aquifer is the uppermost basalt flow of the Columbia River Basalt Group or, in some areas, the clay of the lower Ringold Formation (Figure B-7). The confined aquifers beneath the Hanford Site generally consist of sedimentary interbeds and interflow zones that occur between dense basalt flows of the Columbia River Basalt Group. Because the Elephant Mountain Basalt is assumed to be an effective confining layer between the unconfined and confined aquifers in most of the 200 Areas, this discussion is limited to the hydrologic properties of the uppermost portion of the unconfined aquifer contained in the Hanford and Ringold Formations.

The source of natural recharge to the unconfined aquifer and some of the confined aquifers is rainfall from areas of high relief west of the Hanford Site and ephemeral streams in the Cold Creek and Dry Creek valleys. Discharge from the unconfined aquifer is primarily to the Columbia River, with lesser amounts of discharge to the Yakima River (Graham et al. 1981). In the 200 Areas, the head of the confined aquifers is greater than that in the unconfined aquifer.

B-6b(2.1). Groundwater Hydrology of the 200 Areas. The unconfined aquifer receives artificial recharge from liquid disposal areas. This artificial recharge is estimated to be 10 times greater than natural recharge (Graham et al. 1981). The major sources of artificial recharge in the northern Hanford Site have been three waste ponds designated U Pond, Gable

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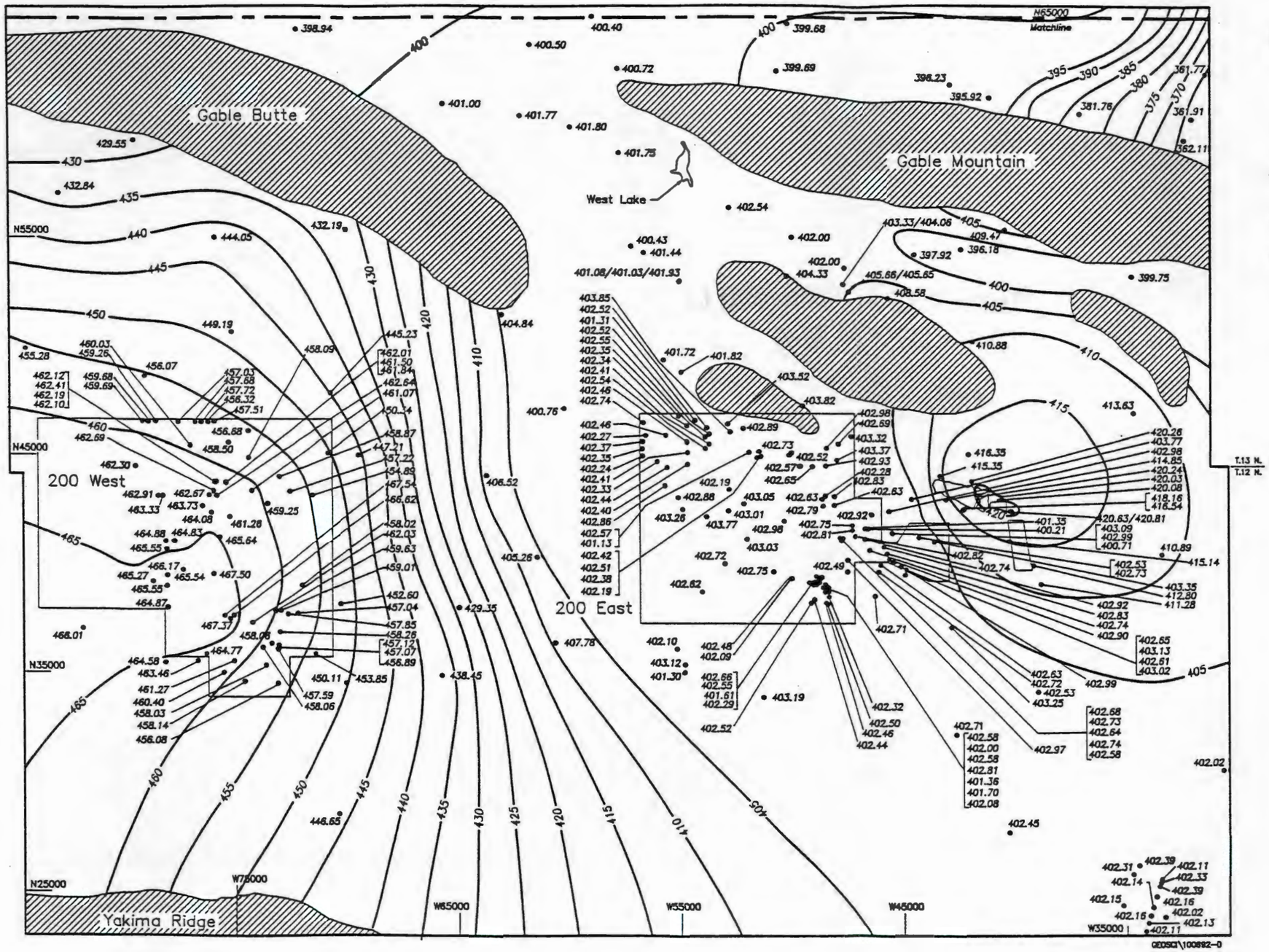

200 Areas Water Table Elevation June 1992

411.49 • Water table elevation (feet above mean sea level)

400 Groundwater table elevation contour interval = 5ft

Ponds

Areas where the basalt surface is generally above the water table

The 200 Areas water table elevation map has been prepared by the Geosciences Group, Environmental Division, of Westinghouse Hanford Company.

Note: To convert to metric, multiply elevation (ft) by 0.3048 to obtain elevation (m).

0 1 Mile

0 1 Kilometer

N

Figure B-12. 200 Area Water Table Map for 1989.

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Mountain Pond, and B Pond, all located near or in the 200 Areas. These areas of artificial recharge have had a major effect on the flow system of the unconfined aquifer. Both U Pond and Gable Mountain Pond were decommissioned within the past 8 yr. The B Pond is scheduled for decommissioning in the 1990's.

The depth to water of the unconfined aquifer within the 200 Areas ranges from approximately 190 ft beneath the former U Pond to approximately 340 ft west of the 200 East Area. The thickness of the unconfined aquifer ranges from 0 ft at the north edge of the 200 East Area to more than 250 ft in the northwest part of the 200 West Area.

Groundwater elevation contours for June 1992 (Kasza et al. 1992) for the unconfined aquifer in the 200 Areas are shown in Figure B-12. The regional flow direction in the 200 Areas is from west to east, but is affected by the two groundwater mounds that have resulted from discharges to U Pond and B Pond. Groundwater flow beneath the 200 West Area is generally toward the north and the east, away from the mound created by past discharges to U Pond. Partly because of this mound, the horizontal hydraulic gradient in the 200 West Area is sufficiently high to determine flow directions with a large degree of certainty. A vertical hydraulic gradient also is present within the unconfined aquifer in the 200 West Area as a result of the groundwater mound. As these mounds dissipate because of the cessation of discharges to U and B Ponds, the horizontal hydraulic gradients will decrease and shift to a more easterly direction, comparable to the original gradient in the unconfined aquifer before Hanford Site operations (Figure B-13). Vertical gradients should also decrease.

Groundwater flow beneath the 200 East Area is complex because flow converges from the west and east and then diverges, with one component flowing northward between Gable Butte and Gable Mountain and another component flowing southeast toward the Columbia River. In addition, the high transmissivity beneath most of the 200 East Area results in very small hydraulic gradients, ranging from 10^{-4} to 10^{-5} ft/ft. Flow directions shift because of changing rates of water discharged into B Pond and other disposal sites such as the 2101-M Pond. Therefore, it is often difficult to define flow directions at specific sites.

Dissipation of the groundwater mound beneath B Pond is anticipated after cessation of most discharges to B Pond in 1995. With time, this will lead to reestablishment of an eastward groundwater gradient.

The principal geologic units controlling the groundwater flow in the 200 Areas are, in ascending order, the Elephant Mountain Basalt, which generally forms the base of the unconfined aquifer, and the Hanford and Ringold Formations, which contain the unconfined aquifer (Figure B-7).

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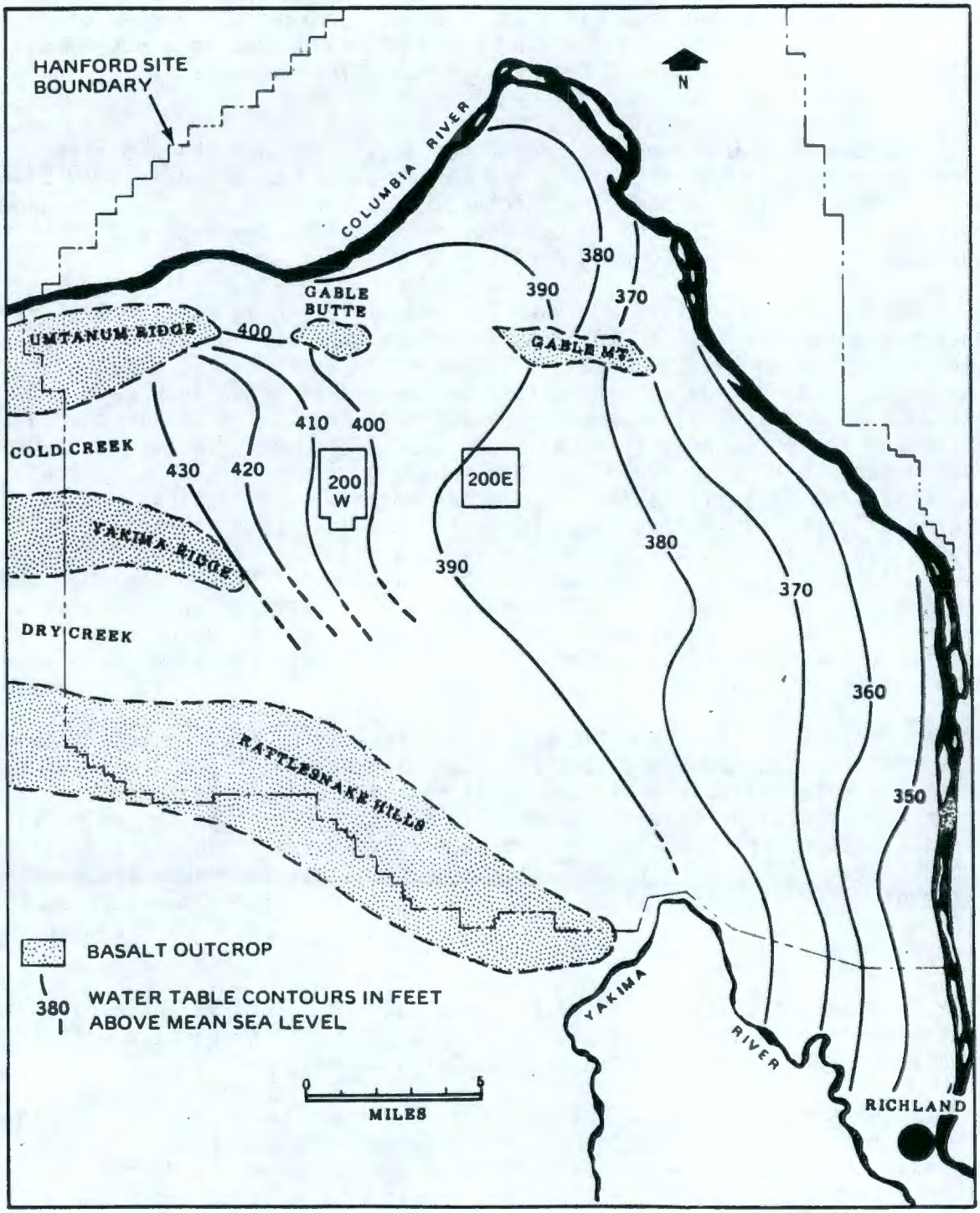

RCP 8001-286

Figure B-13. 1944 Water Table Map for the Hanford Site.

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The Ringold Formation exhibits a variety of hydrologic characteristics including hydraulic conditions ranging from confined to unconfined. In some areas, the lower Ringold unit is the base of the unconfined aquifer. In the southern portion of the 200 East Area and much of the 200 West Area, the basal Ringold unit is locally confined by the overlying lower Ringold unit (Graham et al. 1984). In other areas, the lower Ringold unit is missing, and only the basal and middle Ringold units contain the unconfined aquifer. Textural changes, vertically between formations and laterally within them, cause the unconfined aquifer to exhibit widely varying hydraulic properties (Table B-14). The values given in this table are generalizations. In some locations, hydraulic properties lie outside the values given.

Table B-14. Hydraulic Properties in the 200 Areas.

Interval tested	Hydraulic conductivity (m/d)	(ft/d)	Storativity	Porosity (%)
Hanford formation	600-3,000	2,000-10,000	0.07	30
Middle Ringold unit	3-70	9-230	----	--
Lower Ringold unit	1-3.6	1-12	0.002	10

From Graham et al. (1981).

In general, the Hanford formation contains only the upper portion of the unconfined aquifer, but in the northeastern part of the 200 East Area where the Ringold Formation is missing, the unconfined aquifer is totally within the Hanford formation.

In the 200 West Area, the unconfined aquifer occurs within the middle Ringold unit, which is often partially cemented. Transmissivities range from 300 to 5,400 ft^2/d. In the 200 East Area, the aquifer is in either the unconsolidated Hanford formation or the middle Ringold unit or both, leading to the wide range of transmissivities from 5 to 135,000 ft^2/d (Graham et al. 1981).

B-6b(2.2) Groundwater Hydrology Beneath the 2101-M Pond. Previous hydrologic investigations in the 200 East Area have focused on areas to the north and east of the 2101-M Pond. The impetus for conducting hydrologic investigations in those areas has been an evaluation of B Pond, Gable Mountain Pond, and other liquid waste disposal facilities in and near the 200 East Area. Very little data were available on hydrologic properties near the 2101-M Pond, before monitoring well installation.

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B-6b(3). Unconfined Aquifer. The unconfined aquifer is considered to be the uppermost aquifer, and is, therefore, of primary interest for groundwater monitoring.

Data collected from the monitoring wells installed at the site show that the upper portion of the unconfined aquifer is within the middle Ringold Formation. Sediment samples obtained during drilling show that the upper 15 ft of the saturated zone consists of unconsolidated to slightly consolidated muddy sandy gravel to sandy gravel. A 5 to 10-ft thick layer of slightly muddy gravelly sand was present at the base of each well (Chamness et at. 1990).

The base of the unconfined aquifer is uncertain beneath the 2101-M Pond. The four monitoring wells installed extended only 20 ft into the aquifer. The aquifer base is known only from data available for wells 299-E19-1 and 299-E23-2. As was discussed earlier in Section B-6b(1.2), the base of the unconfined aquifer in 299-E19-1 is the basal/lower Ringold clay layer while in 299-E23-2 it is the basalt units (Elephant Mountain Member). The unconfined aquifer thickness is estimated to range between 45 and 175 ft, depending on which unit acts as the base for the aquifer.

Because the 2101-M Pond is located in the vicinity of a groundwater divide, it is difficult to predict with confidence the direction of groundwater flow. In addition, the hydraulic gradient is so small that measurement error could be responsible for incorrectly determining the water levels, and thus, the direction of groundwater flow beneath the pond. Water levels obtained from the 2101-M Pond monitoring network confirm the flat water table (Table B-15). No useful water-level data are available from well 299-E19-1, located southwest to the 2101-M Pond, because it is currently plugged with drilling mud. Water-level data from the U.S. Ecology commercial waste disposal site, located less than 1 mi southwest of the pond (Figure I-1), indicate a flow direction to the northeast (Figures B-14 and B-15). Based on these data, the Hanford Site water-level measurements (Figure B-12), and the contaminant plumes (Law et al. 1987), the groundwater is interpreted to flow towards the northeast. However, it is recognized because of the low gradient that changes in discharges to nearby Hanford Site wastewater disposal facilities, other than 2101-M Pond, could influence the groundwater flow direction.

The effects of recharge from 2101-M Pond on the groundwater were evaluated to predict the amount of mounding that could occur. During the monitoring well design stage, before well installation, a preliminary numerical model simulation was considered (Chamness et al. 1989) to examine the effects of recharge from 2101-M Pond. This simulation assumed a transmissivity of 20,000 ft^2/d beneath the site. This value is more characteristic of the Hanford formation than the middle Ringold, which is the unit that contains the aquifer. The result of the preliminary model indicated a mound of only 0.0033 ft, which is insignificant.

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Table B-15. Water-Level Measurements and Elevation Data. (sheet 1 of 6)

Well Number	Top of Casing Elevation (ft)	Correction Factor[a]	Measurement Date	Depth to Water (ft)	Water-Level Elevation(ft)
2-E18-1	720.24	+0.06	8/16/88(c,e)	----	----
			10/6/88	314.29	406.01
			10/14/88	314.24	406.06
			10/26/88	314.32	405.98
			11/10/88(e)	314.61	405.69
			11/14/88	314.49	405.81
			12/8/88	314.21	406.09
			2/9/89	314.47	405.83
			2/15/89(e)	----	----
			2/21/89	314.56	405.74
			4/24/89	314.70	405.60
			7/13/89	315.10	405.20
			10/13/89	315.25	405.05
			10/31/89(e)	315.90	404.40
			11/29/89(e)	315.33	404.97
			2/12/90	315.57	404.73
			5/31/90	315.94	404.36
			9/6/90	316.24	404.06
			12/15/90	315.81	404.49
			7/9/91	315.75	404.55
			9/5/91(c)	----	----
			9/6/91(e)	316.75	403.55
			11/21/91	317.05	403.25
			12/12/91	317.01	403.29
			1/24/92(e)	317.05	403.25
			1/30/92	317.09	403.21
			2/13/92	317.18	403.12
			3/13/92	317.27	403.03
			4/21/92	317.07	403.23
			5/28/92	317.44	402.86
			6/03/92(e)	317.12	403.18
			6/30/92	317.53	402.77
			7/20/92	317.58	402.72
			8/14/92	317.63	402.67
			9/14/92	317.60	402.70
			10/19/92	317.65	402.65
			11/3/92(e)	317.98	402.32
			11/11/92	317.83	402.47
			12/15/92	317.97	402.33
			12/16/92(e)	317.22	403.08
			1/11/93	318.12	402.18
			2/22/93	318.26	402.04
			3/29/93	318.03	402.27

Table B-15. Water-Level Measurements and Elevation Data. (sheet 2 of 6)

Well Number	Top of Casing Elevation (ft)	Correction Factor[a]	Measurement Date	Depth to Water (ft)	Water-Level Elevation(ft)
2-E18-2	721.21	+0.22	8/16/88(c,e)	----	----
			10/6/88	315.52	405.91
			10/14/88	315.52	405.91
			10/26/88	315.55	405.88
			11/10/88(e)	316.33	405.10
			11/14/88(b)	315.69	405.74
			12/8/88	315.47	405.96
			2/9/89	315.75	405.68
			2/15/89(e)	----	----
			2/21/89	315.84	405.59
			4/24/89	316.01	405.42
			7/13/89	316.37	405.06
			10/13/89	316.51	404.92
			11/27/30(e)	316.72	404.71
			2/12/90	316.85	404.58
			3/13/90(e)	318.68	402.75
			5/31/90	317.22	404.21
			9/6/90	317.48	403.95
			9/5/91(c)	----	----
			9/6/91(e)	317.85	403.58
			11/21/91	318.38	403.05
			12/12/91	318.26	403.17
			1/30/92	318.54	402.89
			2/13/92	318.47	402.96
			3/13/92	318.52	402.91
			4/21/92	318.49	402.94
			5/28/92	318.62	402.81
			7/10/92(e)	318.85	402.58
			7/20/92	318.86	402.57
			8/14/92	318.86	402.57
			9/14/92	318.97	402.46
			10/19/92	318.93	402.50
			11/03/92(e)	319.28	402.15
			11/11/92	319.14	402.29
			12/15/92	319.21	402.22
			12/16/92(e)	319.05	402.38
			1/11/93	319.30	402.13
			2/22/93	319.38	402.05
			3/29/93	319.31	402.12
2-E18-3	722.04	+0.03	8/16/88(c,e)	----	----
			10/6/88(c)	----	----
			10/14/88	316.13	405.94
			10/26/88	316.10	405.97
			11/10/89(e)	316.16	405.91
			11/14/88	316.21	405.86
			12/8/88(b)	316.02	406.05

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Table B-15. Water-Level Measurements and Elevation Data. (sheet 3 of 6)

Well Number	Top of Casing Elevation (ft)	Correction Factor[a]	Measurement Date	Depth to Water (ft)	Water-Level Elevation(ft)
			2/9/89(b)	316.31	405.76
			2/15/89(e)	----	----
			2/21/89	316.39	405.68
			4/24/89	316.58	405.49
			7/13/89	316.91	405.16
			10/13/89	317.06	405.01
			11/27/89(e)	317.30	404.77
			2/12/90	317.44	404.63
			3/13/90(e)	317.65	404.42
			5/31/90	317.74	404.33
			9/6/90	318.01	404.06
			12/12/90	318.27	403.80
			9/5/91	318.44	403.63
			9/6/91(e)	318.48	403.59
			11/21/91	318.84	403.23
			12/12/91	318.86	403.21
			1/30/92	319.02	403.05
			2/13/92	319.10	402.97
			3/13/92	319.18	402.89
			4/21/92	319.09	402.98
			5/28/92	319.29	402.78
			6/03/92(e)	319.27	402.80
			6/30/92	319.42	402.65
			7/20/92	319.41	402.66
			8/14/92	319.42	402.65
			9/14/92	319.59	402.48
			10/19/92	319.58	402.49
			11/3/92(e)	320.10	401.97
			11/11/92	319.69	402.38
			12/15/92	319.82	402.25
			12/16/92(e)	320.01	402.06
			1/11/93	319.87	402.20
			2/22/93	319.92	402.15
			3/29/93	319.88	402.19
2-E18-4	721.57	+0.0	8/16/88(c,e)	----	----
			10/6/88	315.59	405.98
			10/14/88	315.66	405.91
			10/26/88	315.62	405.95
			11/9/89(e)	315.69	405.88
			11/14/88	315.74	405.83
			12/8/88	315.53	406.04
			2/9/89	315.81	405.76
			2/15/89(e)	----	----
			2/21/89	315.91	405.66
			4/24/89	316.08	405.49
			7/13/89	316.43	405.14

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Table B-15. Water-Level Measurements and Elevation Data. (sheet 4 of 6)

Well Number	Top of Casing Elevation (ft)	Correction Factor[a]	Measurement Date	Depth to Water (ft)	Water-Level Elevation(ft)
			10/13/89	316.57	405.00
			11/21/89(e)	317.45	404.12
			2/12/90	316.92	404.65
			5/31/90	317.25	404.32
			9/6/90	317.50	404.07
			9/5/91	317.91	403.66
			9/6/91(e)	317.99	403.58
			11/21/91	318.26	403.31
			12/12/91	318.37	403.20
			1/30/92	318.50	403.07
			2/13/92	318.56	403.01
			3/13/92	318.66	402.91
			4/21/92	318.58	402.99
			5/28/92	318.73	402.84
			6/03/92(e)	318.78	402.79
			6/30/92	318.81	402.76
			7/20/92	318.87	402.70
			8/14/92	318.90	402.67
			9/14/92	319.10	402.47
			10/19/92	319.04	402.53
			11/3/92(e)	319.48	402.09
			11/11/92	319.12	402.45
			12/15/92	319.26	402.31
			12/16/92(e)	319.15	402.42
			1/11/93	319.31	402.26
			2/22/93	319.39	402.18
			3/29/93	319.36	402.21
2-E13-10	738.84	---	6/8/88	333.51	405.33
			10/6/88	332.82	406.02
			11/14/88	333.29	405.55
			12/8/88	332.78	406.06
			2/9/89	332.87	405.97
			2/21/89	333.05	405.79
			4/24/89	333.18	405.66
			7/13/89	333.54	405.30
			10/13/89	333.69	405.15
			2/12/90	333.91	404.93
			5/31/90	334.30	404.54
			9/6/90	334.62	404.22
			9/5/91	334.90	403.94
			12/5/91	335.17	403.67
			6/11/92	335.72	403.12
			12/13/92	336.48	402.36

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Table B-15. Water-Level Measurements and Elevation Data. (sheet 5 of 6)

Well Number	Top of Casing Elevation (ft)	Correction Factor[a]	Measurement Date	Depth to Water (ft)	Water-Level Elevation(ft)
299-E13-14	745.15	---	7/29/88	340.08	405.07
			11/11/88	339.39	405.76
			12/12/88	340.00	405.15
			5/14/90	340.45	404.70
			6/19/90	340.65	404.50
			12/11/90	341.10	404.05
			6/6/91	341.42	403.73
			6/11/91	341.45	403.70
			12/5/91	341.38	403.77
			3/16/92	341.81	403.34
			6/11/92	343.05	402.10
			12/3/92	343.78	401.37
299-E23-2(0)	720.91	---	6/8/88	315.80	405.11
			10/6/88	315.12	405.79
			11/14/88	315.21	405.70
			12/8/88	314.92	405.99
			2/9/89	315.31	405.60
			2/21/89	315.35	405.56
			4/24/89	315.58	405.33
			7/13/89	315.91	405.00
			10/13/89	316.06	404.85
			2/12/90	316.40	404.51
			5/31/90	316.82	404.09
			9/6/90	317.07	403.84
			9/5/91	317.38	403.53
			12/4/91	317.69	403.22
			6/8/92	317.92	402.99
			12/3/92	318.61	402.03
2-E24-7	716.32	---	6/8/88	310.81	405.51
			10/6/88	310.09	406.23
			10/26/88	310.17	406.15
			12/8/88	309.93	406.39
			7/13/89	310.98	405.34
			10/13/89	311.09	405.23
			2/12/90	311.46	404.86
			5/31/90	311.89	404.43
			9/6/90	312.08	404.24
			9/5/91	312.46	403.86
			12/4/91	313.10	403.22
			6/8/92	313.26	402.75
			12/3/92	313/9	402.11
MW-10 (699-36-58A)	735.96	---	6/8/88	330.54	405.42
			10/6/88	329.86	406.10
			12/8/88	329.67	406.29

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Table B-15. Water-Level Measurements and Elevation Data. (sheet 6 of 6)

Well Number	Top of Casing Elevation (ft)	Correction Factor[a]	Measurement Date	Depth to Water (ft)	Water-Level Elevation(ft)
			2/21/89(d)	----	----
			7/13/89	330.33	405.63
			2/12/90	330.88	405.08
			5/31/90	331.21	404.75
			9/6/90	331.61	404.35
			9/5/91	331.73	404.23
MW-13	724.10	---	10/6/88	315.57	408.53
(699-35-59)			12/8/88	315.40	408.70
			2/21/89	315.92	408.18
			7/13/89	315.71	408.39
			2/12/90(d)	------	------
			5/31/90	316.07	408.03
			9/6/90	316.33	407.77
			9/5/91	316.34	407.76

(a) Based on inclinometer measurements. This has already been calculated into the water-level elevation.
(b) Measured only once.
(c) Unable to make measurements.
(d) Could not get two measurements within 0.02 ft.
(e) Measurements taken at time of sampling.

A second simulation was completed (Chamness et al. 1990) using transmissivity values obtained from aquifer tests in 2101-M Pond monitoring wells. The value used was 4,000 ft^2/d. A two-dimensional model was used (McDonald and Harbaugh 1984) for the simulation. The model simulated a single 50-ft layer on a 50- x 50-node grid with a 20-ft node spacing. A hydraulic gradient of 5×10^{-4} ft/ft was used by the model. Constant-head upgradient and downgradient boundaries were established. A recharge rate of 18,000 gal/d was induced on an 80 x 120-ft area in the grid center. The model was run to steady state. The model simulated a mound beneath the region of recharge. At its highest point, the simulated mound was approximately 0.3 ft above the pre-recharge level.

B-6b(3.1). Historical Groundwater Data. Historical groundwater data are available from two existing wells within 2,000 ft of the 2101-M Pond. A summary of the status of these wells and their locations are given in Table B-16.

B-6b(3.2). Water Levels. Water level data for wells near the 2101-M Pond are provided in Table B-15. A hydrograph is presented for the four wells monitoring the pond in Figure B-16. Many other wells are regularly monitored in the general vicinity and provide information on the depth to groundwater and direction of groundwater flow reported in semiannual reports (e.g. Kasza et al. 1992).

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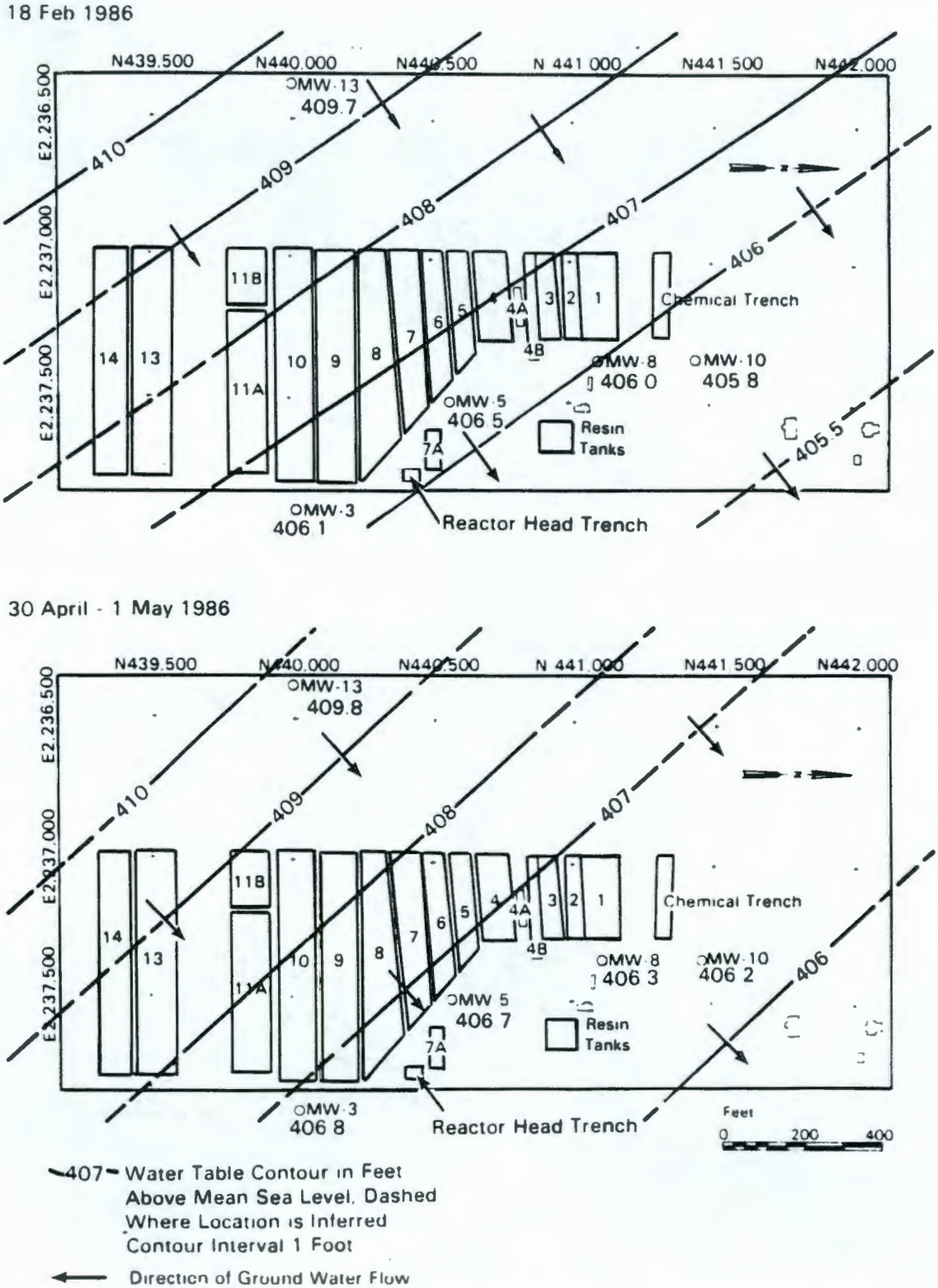

Figure B-14. Water Table Maps of the U.S. Ecology Site for February and April-May 1986 (from Bergeron et al. 1987).

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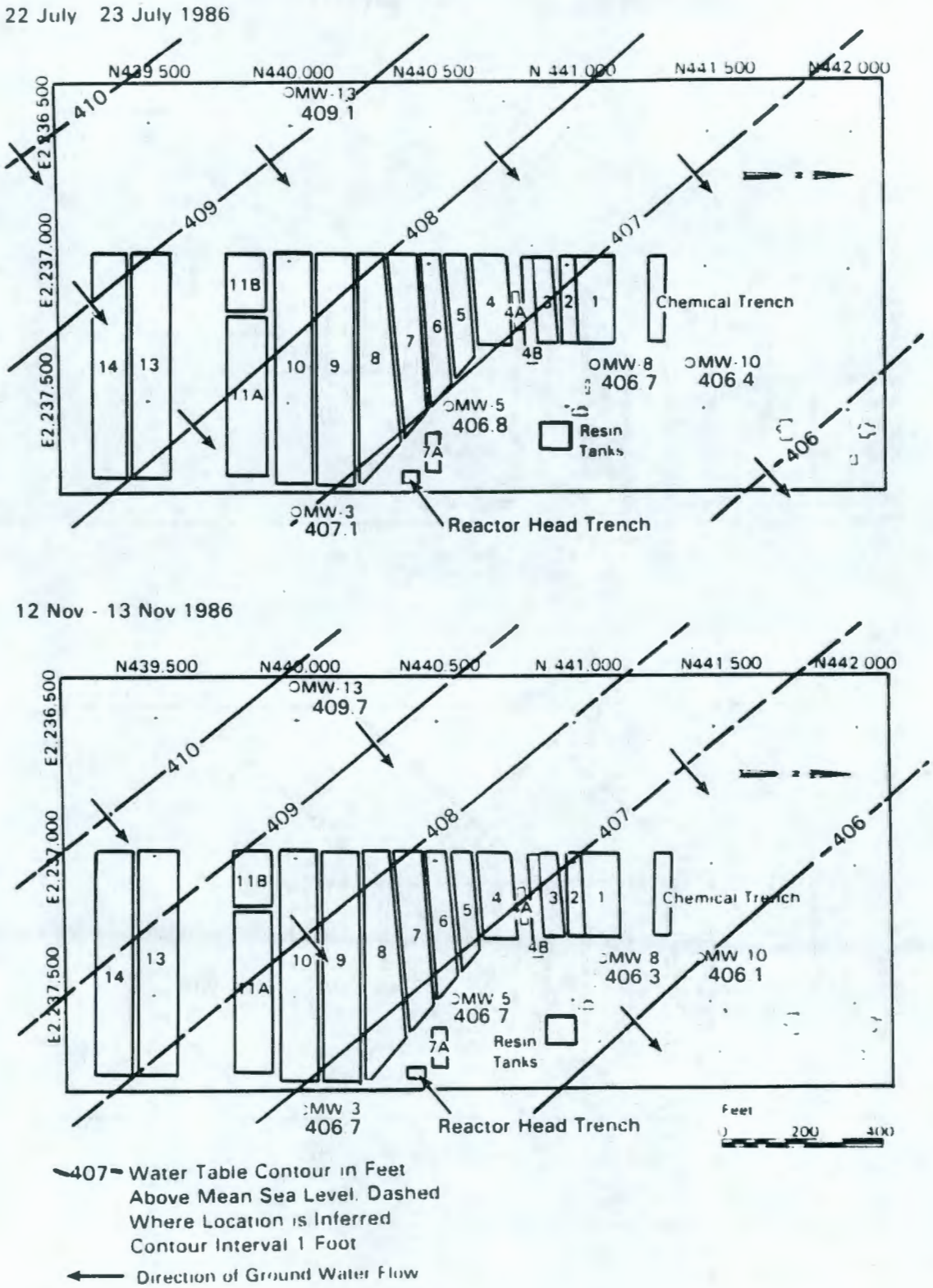

Figure B-15. Water Table Maps of the U.S. Ecology Site for July and November 1986 (from Bergeron et al. 1987).

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Table B-16. Status of Existing Wells in the Vicinity of the 2101-M Pond.

Well number (date completed)	Approximate distance and direction from site (ft)	Well status
299-E13-14	1,800 SW	Constructed of 8-in. carbon-steel casing perforated from 212 to 217 ft below ground surface.
299-E23-2	1,700 NE	Constructed of 8-in. carbon-steel casing perforated from 320 to 340 ft below ground surface. It has three piezometers set at depths of 340, 400, and 456 ft. Problems with the piezometers have prevented sample collection since October 1987.

Water level measurements for the monitoring wells and four nearby wells show a decline in water-level elevation beginning in December 1989. A hydrograph for the four monitoring wells illustrates this trend (Figure B-16). This trend is repeated in wells throughout the 200 East Area. Water levels have declined an average of 3.68 ft in the four wells monitoring the 2101-M Pond since measurements were started in 1988. This is due to the decreased discharges to various waste water disposal sites in the 200 East and 200 West Areas, as indicated by similar water level drops throughout the 200 Areas. There is no indication that discharges to the 2101-M Pond have decreased and are causing the drop in water levels.

B-6b(3.3). Groundwater Gradient and Quality. The regional groundwater gradient in the vicinity of the 2101-M Pond is from the west/southwest toward the east/northeast (Figure B-12). Near the 2101-M Pond, the water table is nearly flat, with less than a foot of difference between 299-E18-1 and 299-E18-2. The gradient beneath the pond has been calculated using an average of 1992 water level data for the two 2101-M Pond monitoring wells consistently showing the greatest difference, 299-E18-1 and 299-E18-2. This calculation estimates a gradient of 4×10^{-4} ft/ft. Water levels in Figure B-17 were measured in December 1992. Water level contours are not shown, because differences between some wells are within the measurement error.

The numerical model discussed previously suggests that a 0.3-ft mound could be present beneath the 2101-M Pond. Water level data do not support this. However, because of the relatively flat water table, it is not possible to delineate whether a smaller mound is present.

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Table B-17. Water-Level Residuals for Interwell Comparisons of 299-E18-1 vs. 299-E18-2, 299-E18-3, and 299-E18-4.

Measurement date	299-E18-1 vs. 299-E18-2	299-E18-1 vs. 299-E18-3	299-E18-1 vs. 299-E18-4
10/6/88	0.10	--	0.03
10/14/88	0.15	0.12	0.15
10/26/88	0.10	0.01	0.03
11/14/88	0.07	-0.05	-0.02
12/8/88	0.13	0.04	0.05
2/9/89	0.15	0.07	0.07
2/21/89	0.18	0.06	0.08
4/24/89	0.18	0.11	0.11
7/13/89	0.14	0.04	0.06
10/13/89	0.13	0.04	0.05
2/12/90	0.27	0.22	0.22
5/31/90	0.15	0.03	0.04
9/6/90	0.11	0.00	-0.01
11/21/91	0.20	0.20	-0.06
12/12/91	0.12	0.08	0.09
1/30/92	0.32	0.16	0.14
2/13/92	0.16	0.15	0.11
3/13/92	0.12	0.14	0.12
4/21/92	0.29	0.25	0.24
5/28/92	0.05	0.08	0.02
6/30/92	--	0.12	0.01
7/20/92	0.15	0.06	0.02
8/14/92	0.10	0.02	0.00
9/14/92	0.24	0.22	0.23
10/19/92	0.15	0.16	0.12
11/11/92	0.18	0.09	0.02
12/15/92	0.11	0.08	0.02
1/11/93	0.05	-0.02	-0.08
2/22/93	-0.01	-0.11	-0.14
3/29/93	0.15	0.08	0.06
Mean	0.14	0.08	0.06
Standard deviation	0.07	0.08	0.09

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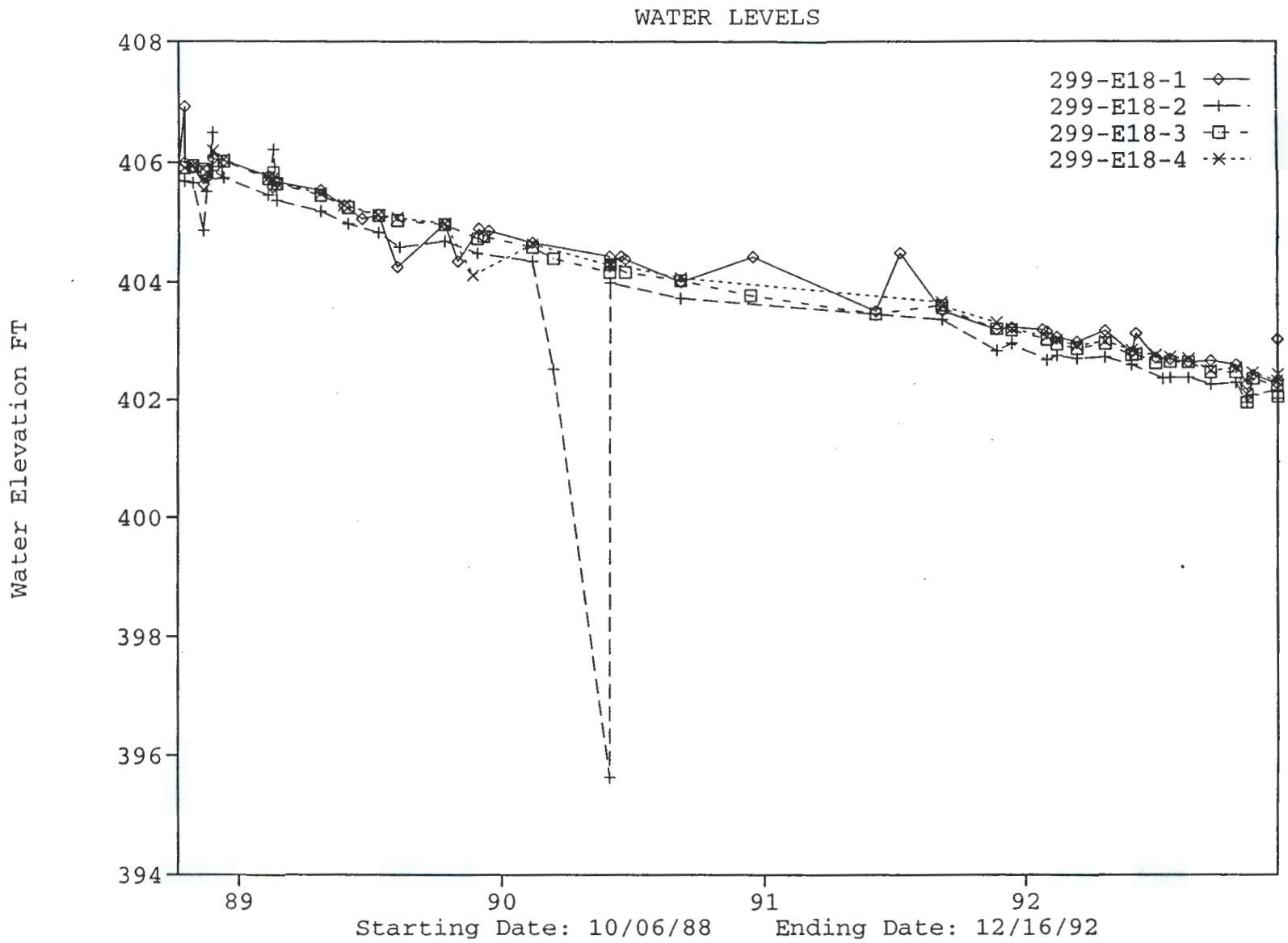

Figure B-16. Hydrograph for the Four 2101-M Pond Monitoring Wells.

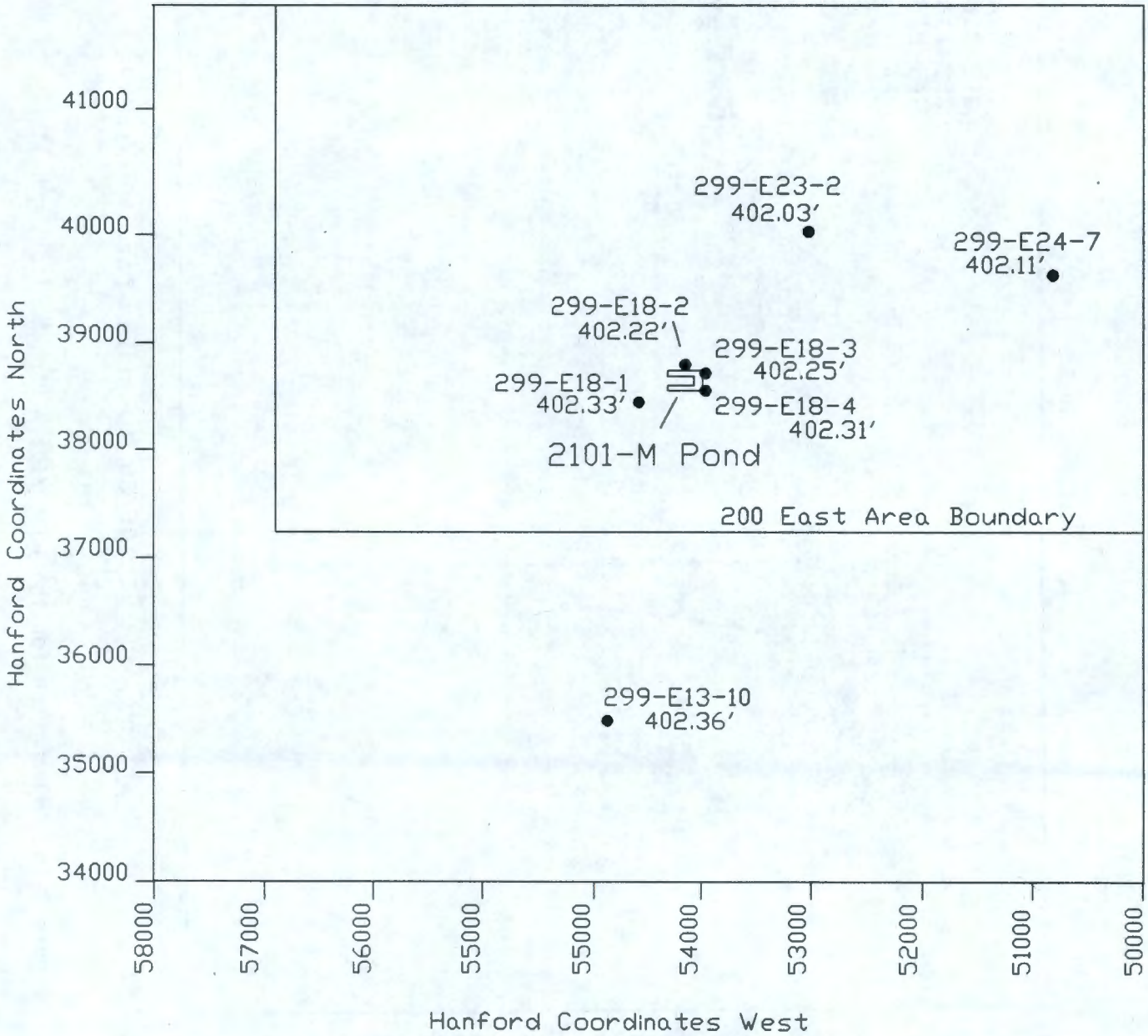

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Figure B-17. The 2101-M Pond and Vicinity Water Table Elevation, December 1992.

The water level differences have remained relatively consistent for the four wells monitoring the 2101-M Pond (Table B-17). The differences between well 299-E18-1 and the other three wells is generally greater than the surveying error of +/- 0.02 ft, and for wells 299-E18-3 and 299-E18-4 is usually less than the estimated total measurement error of +/- 0.15 ft (Chamness et al. 1990). If measurement error was the only reason for the difference between wells 299-E18-1 and 299-E18-2, it would be expected that the standard deviation of the mean would be larger than 0.07 ft. These results indicate well 299-E18-1 is upgradient of 299-E18-2, 299-E18-3, and 299-E18-4.

Water quality at well 299-E18-1 is different from wells 299-E18-2, 299-E18-3, and 299-E18-4. Well 299-E18-1 has significantly higher conductivity, calcium, magnesium, nitrate, sulfate and lower barium concentrations (Appendix D-2).

Current discharges to the 2101-M Pond appear to be influencing the groundwater quality beneath the site. Figure B-18 is a series of plots including water quality parameters indicating the influence of the pond on the groundwater. Plotted are average concentrations for well 299-E18-1, average concentrations for the three monitoring wells, and the average concentration observed from sampling of 1988 discharges to the 2101-M Pond. The plots illustrate that groundwater quality near the pond is generally intermediate to that found in well 299-E18-1 and the pond influent. This indicates that the current discharges are improving the groundwater quality relative to 299-E18-1.

Quarterly water quality samples were collected for 1 yr from all four 2101-M Pond monitoring wells. Semiannual groundwater sampling was initiated in November 1989 and will continue through certification of closure. Results of the groundwater sampling are discussed in sections B-6d and B-6e.

B-6b(3.4). Uppermost Aquifer. The uppermost aquifer beneath the 2101-M Pond is the unconfined aquifer, which is estimated to range from approximately 45- to 175-ft thick, depending on whether the lower/basal Ringold Formation or basalt forms the base of the unconfined aquifer. Where it has not been eroded, the Elephant Mountain Member basalt is typically dense, relatively impervious, and thick enough to prevent communication between the unconfined and deeper confined aquifers. The available geologic data for the 200 Areas (Tallman et al. 1979) suggest that the cataclysmic floods that eroded the Ringold Formation and the Elephant Mountain Member north of the 200 East Area did not erode these units beneath the 2101-M Pond. Groundwater flow beneath the 2101-M Pond is estimated to be to the northeast. It is assumed that there is an insignificant or minor vertical flow component based on the numerical modeling.

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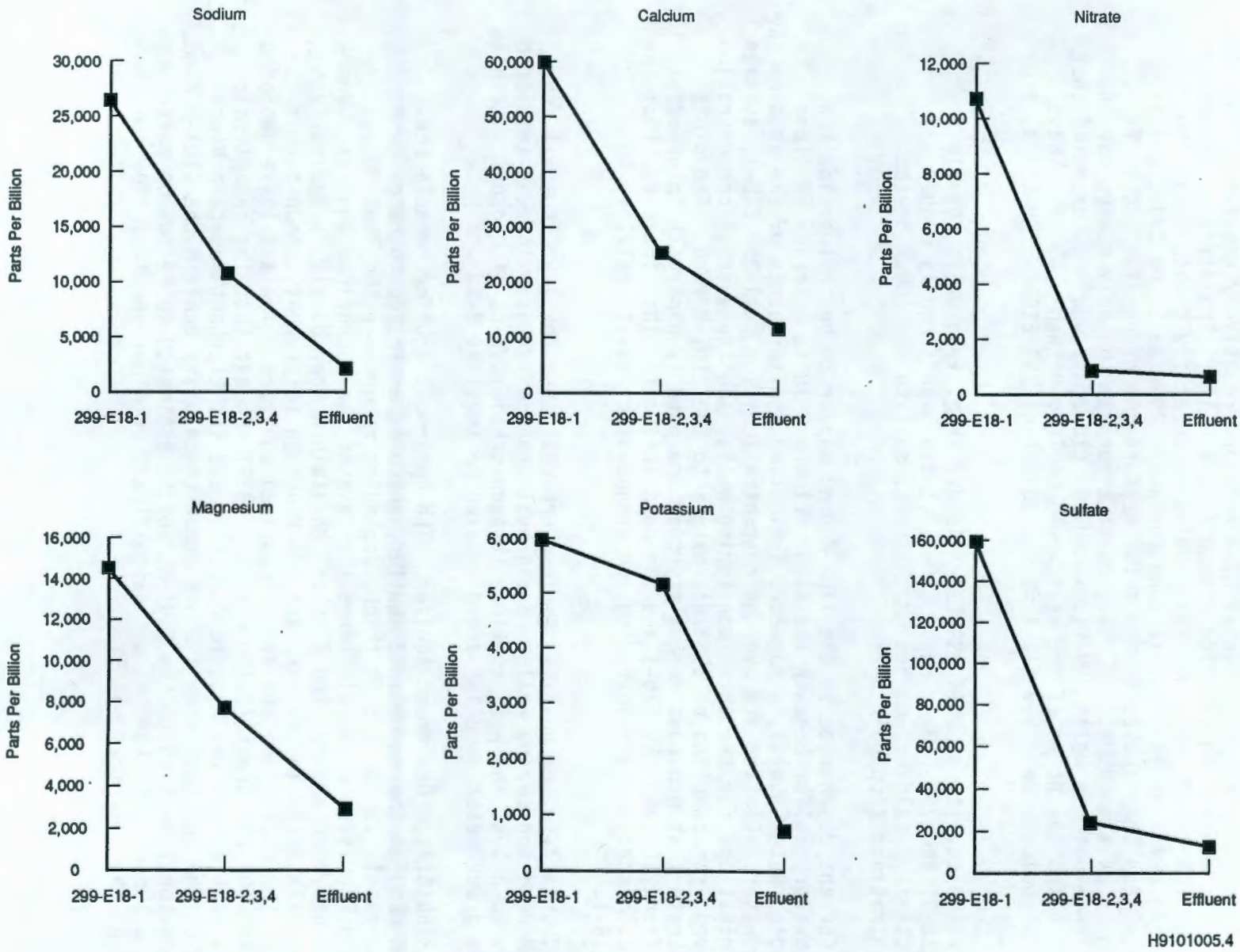

Figure B-18. Plots Comparing Average Groundwater Compositions for Wells 299-E18-1, 299-E18-2, -3, -4 and Average Composition for 2101-M Pond Effluent Water.

B-6b(4). Characterization/Monitoring Wells. The four monitoring wells installed around 2101-M Pond are shown in Figure B-6. The wells were located to provide one monitoring well upgradient and three monitoring wells downgradient of the pond. These wells perform the following functions.

1. Provide water level data to determine the groundwater flow direction beneath the site.

2. Provide up- and down-gradient groundwater quality information from the upper portion of the unconfined aquifer.

3. Provide a means to evaluate the hydraulic properties of the upper part of the aquifer.

4. Define the subsurface stratigraphy beneath the site.

5. Determine the moisture content of the unsaturated zone.

The wells are constructed of nominal 4-in.-dia stainless-steel casings with nominal 4-in.-dia 20-slot continuous-wound stainless-steel screens. The screens extend from approximately 2 ft above to 18 ft below the water table. A 20-40 mesh sand filter pack surrounds the screens within the annular space. The 4-in.-dia materials are constructed within 8-in.-dia boreholes. Eight-inch-diameter telescoping 10-slot continuous-wound stainless-steel screens were set in the bottom of the borehole before final completion. The 8-in.-dia screens extend from approximately the water table to 20 ft below the water table.

B-6b(4.1). Justification for Locations. Groundwater flow in the southwestern corner of the 200 East Area is estimated to be to the northeast. The background well (299-E18-1) was located approximately 280 ft southwest of the southwestern corner of the 2101-M Pond at sufficient distance from the pond to be unaffected by discharges to the pond. The background well will provide information on the groundwater quality upgradient of the pond (Figure B-6).

The three downgradient wells were located at the edge of the pond, on the southeast and northeast corners and halfway along the north side [299-E18-4, 299-E18-3, and 299-E18-2, respectively, (Figure B-6)]. These wells are close enough to the pond to monitor any contaminants in the groundwater originating from the pond.

B-6b(4.2). Drilling and Well Installation. The wells were drilled by the cable-tool method for the following reasons.

- Drill cuttings are easily contained (important in contaminated material).

- Representative geologic samples can be collected.

- Moisture samples can be collected from above the water table using core-barrel techniques.

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- Disturbance to the borehole wall is minimized.

- A relatively straight and plumb borehole is produced.

- No drilling additives other than water are used.

Temporary carbon-steel casing was driven the total depth of the well. After reaching the desired depth, installing the 8-in. telescoping screen, and developing the well, groundwater samples were taken. The following groundwater contamination indicator parameters were analyzed as soon as possible after sampling to determine if water could be discharged to the ground:

- Volatile organic constituents

- Metals (analyzed by the ICP method)

- Gamma scan

- Gross alpha

- Gross beta

- Iodine-129 (one well only).

No levels exceeding standards were found, enabling purge water to be discharged to the ground.

At the completion of aquifer testing, the telescoping well screen was left in the hole. The nominal inside diameter of the temporary casing and/or telescoping screen at the bottom of the borehole was 8 in., so that a 4-in.-dia monitoring well could be installed with an adequate annular seal.

A schematic diagram of a completed well is presented in Figure B-19 and as-built diagrams are shown in Appendix E-1. Final wells were constructed of 4-in.-inside diameter (ID) 304 or 316 stainless-steel casing and a 0.20-in. continuous-slot stainless-steel well screen. Final well screen lengths were 20 ft with approximately 2 ft of screen extending above the water table to allow for possible future fluctuations of the unconfined aquifer. This configuration ensures that samples were from the upper portion of the aquifer and that any immiscible constituents floating on the surface of the water were sampled.

The annular seal was emplaced between the borehole wall and the stainless-steel casing, while pulling back the temporary carbon-steel casing. Figure B-19 shows the general thicknesses and positions of each of the different types of materials used for the annular seal. The materials and methods of installation meet the WAC 173-160 requirements for resource protection wells.

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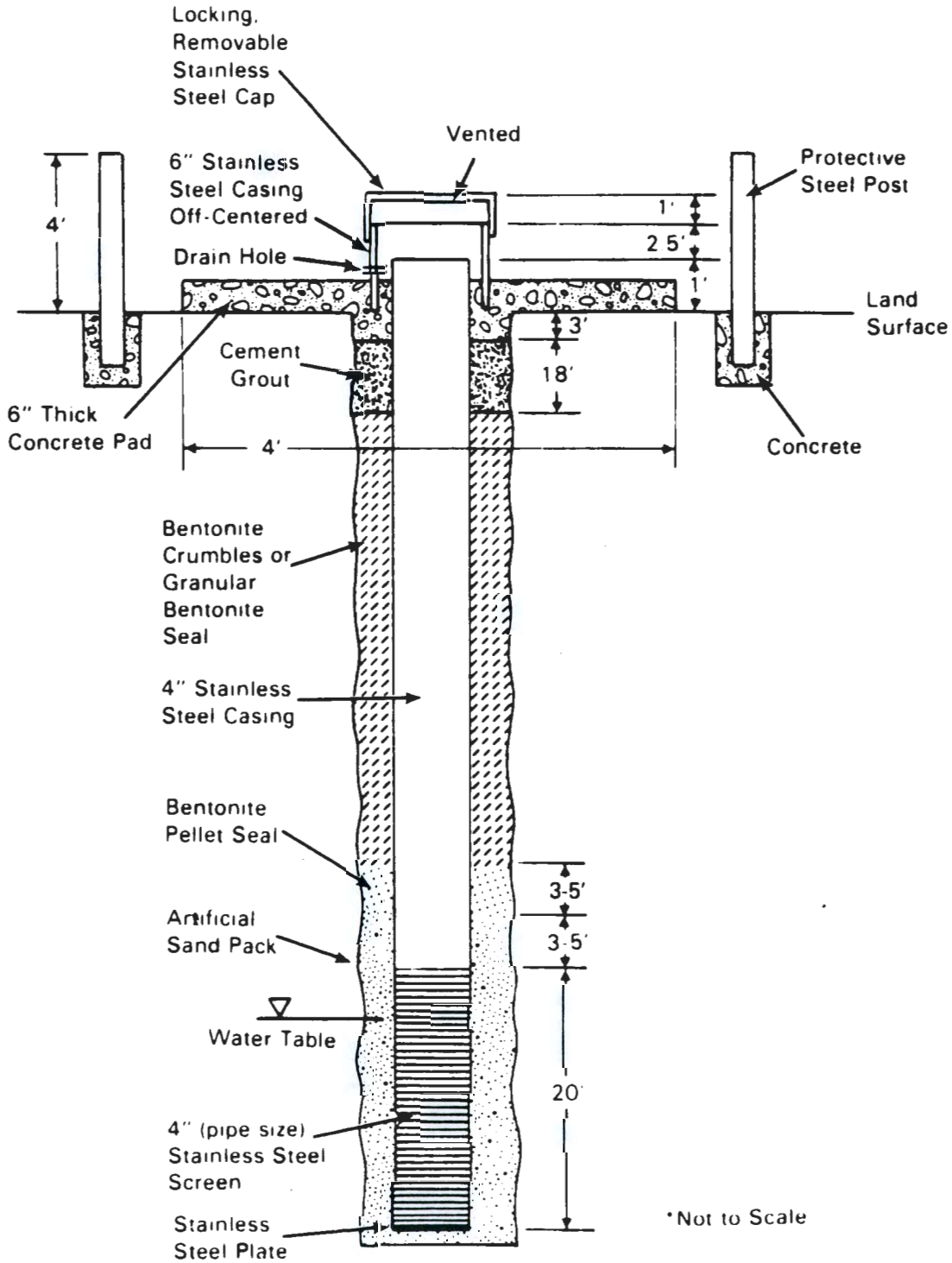

1 Figure B-19. Schematic Diagram of a Completed Groundwater Monitoring Well.

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The 4-in.-well casing extends approximately 1 ft above ground surface. To protect the 4-in. well and provide shelter for data loggers, a piece of 6-in. stainless-steel casing was set into the concrete pad. A drain hole was drilled approximately 1/2 in. above the concrete pad for drainage of water from inside the protective casing. The protective casings were banded and permanently marked with well identification numbers. This information also was stamped on brass plaques in the concrete pads. At least three guard posts were cemented into place around each well pad and painted safety yellow. After completion, all monitoring wells were surveyed for location and elevation. The elevation of the top of the stainless-steel casing was determined to the nearest 0.02 ft. A mark was placed on the casing to indicate the location that was surveyed. The areal location was determined to the nearest 0.5 ft. All measurements were referenced to a common datum. The wells were developed after completion of well construction and before installation of the sampling pumps. Well development proceeded until turbidity was less than 5 nephelometric turbidity units.

B-6b(4.3). Monitoring Parameters. Quarterly samples were collected for 1 yr from the four groundwater monitoring wells for chemical analysis of the constituents listed in Table B-18. These constituents were required by 40 CFR 265, Subpart F, which was in force at the time of quarterly groundwater sampling. Constituents included in the DW constituents list (WAC 173-303-9905) were analyzed during the second quarter (November 1988) and the first semiannual sampling period (November 1989). The samples were analyzed by U.S. Testing. The results of these analyses are given in Appendix E-1. Groundwater sampling began on June 6, 1991 after a 1-yr hiatus. Semi-annual samples are generally analyzed for most of the constituents identified in Table B-18. As time goes on, the list is being reduced to only those constituents either (1) detected in the past, (2) thought to have been discharged to the pond, (3) detected in the soil, or (4) are groundwater contamination indicator parameters. These analyses are also given in Appendix E-1.

B-6b(5). Geologic Sampling. Geologic samples were collected during drilling at 5-ft intervals or at changes in lithology. Samples were collected with a drive barrel in the unsaturated sediments whenever possible. When hard-tool drilling was necessary, a bailer was used to collect the sediment samples. No drilling water or other material was added to the borehole during drive-barrel drilling unless necessary and approved by the well-site geologist. This was done so that perched water zones could be detected and representative moisture samples could be taken, although none were encountered.

Moisture samples were collected in the unsaturated sediments at 5-ft intervals when possible and at unusually moist or wet zones. The samples collected were described as hand specimens in the field and documented on geologic field forms.

B-6b(5.1). Sample Analyses. Selected samples were collected for laboratory analyses, including (1) sieve, (2) moisture content, (3) calcium carbonate content, (4) saturated hydraulic conductivity, (5) water retention, (6) petrographic description of mineral content, and (7) chemical analyses for dangerous constituents. The first three analyses were run on all of the

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Table B-18. Groundwater Monitoring Parameters.

Parameter	Maximum level[a]
Interim primary drinking water standards	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4 to 2.4
Lead	0.05
Mercury	0.002
Nitrate (as N)	10
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
2,4-D	0.1
2,4,5-TP silvex	0.01
Radium	5 (pCi/L)
Gross alpha	15 (pCi/L)
Gross beta	4 (millirem/yr)
Turbidity (surface water only)	1 (TU)
Coliform bacteria	1/100 (mL
Groundwater quality parameters	
Chloride	
Iron	
Manganese	
Phenols	
Sodium	
Sulfate	
Groundwater contamination indicator parameters	
pH	
Specific conductance	
Total organic carbon	
Total organic halogen	

NOTE: From 40 CFR 265, Subpart F.
[a]Concentrations are in mg/L unless otherwise noted.
TU = turbidity units.

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samples in the vadose zone; sieve and calcium carbonate analyses also were run on the samples that may have reached the saturated zone. At least one representative sample was collected for the second three analyses from each major stratigraphic unit encountered during drilling. Sixteen sediment samples were analyzed for metals and nine for volatile organics; no contamination was found in these samples. The latter analyses were performed by U.S. Testing following procedures given in SW-846 (EPA 1982b), when possible.

B-6b(5.2). Borehole Logging. Each well was geophysically logged with natural gamma, density, and neutron probes. Logs will be included in the characterization report and have been submitted to Ecology in quarterly reports on monitoring wells used for RCRA on the Hanford Site.

B-6b(5.3). Data Interpretation and Presentation. All geologic and geophysical data will be presented in cross sections and tables following RCRA groundwater monitoring technical enforcement guidance (EPA 1986d) and will be placed in the characterization report. Aquifer testing is reported in Section B-6c.

B-6b(6). Sampling and Analysis. Each well is equipped with a dedicated HydroStar* pump, capable of pumping 3 to 5 gal/min. Groundwater sampling is being conducted by trained personnel from PNL following established procedures. The samples are delivered to the analytical laboratory for analysis following chain-of-custody procedures. Analyses at the analytical laboratory are performed following EPA-recommended procedures.

B-6b(6.1). Statistical Analysis of Detection-Level Monitoring Data. The WAC 173-303-645 (8)(h) establishes the requirement that a statistical analysis will be completed to determine if contamination is occurring at a facility. The regulation requires the Cochran's Approximation to the Behrens-Fisher Student's t-test (CABF) to be used for normally distributed data, or an alternate statistical method may be used.

An alternate statistical method, the tolerance interval method, was chosen. This method was chosen for several reasons: (1) the CABF method is not applicable if the replicate analyses are not independent; (2) the number of analyses available for statistical evaluation during the compliance monitoring period is inadequate; (3) the tolerance interval method is one of several methods recommended by EPA (1989b) and in 40 CFR 264, Subpart F; (4) the tolerance interval method is easily applied; and (5) the tolerance interval method accommodates analyses that are less than detection limits.

The quarterly sampling completed at the 2101-M Pond site was based on the interim status requirements that were in place at the time of sampling. Therefore, only the indicator parameters conductivity, pH, TOC, and TOX had replicate analyses collected. However, the replicates were not independent but splits from the same sample. Because of this, the CABF method is not applicable.

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*HydroStar is a trademark of Instrumentation Northwest, Inc.

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The tolerance interval approach provides concentration limits representing reasonable upper limits using data on background wells. For pH, both the upper and lower limits are constructed. If the compliance concentrations do not fall in the tolerance interval, it is interpreted as statistically significant evidence of contamination. Normal tolerance intervals are constructed (if data are normally or lognormally distributed) by the following formula:

$$T.I. = X_b + KS_b \text{ (one-sided)}$$

or

$$T.I. = X_b \pm KS_b \text{ (two-sided)}$$

where:

X_b denotes the background mean; S_b denotes the background standard deviation; and K is a normal tolerance factor [obtained from Table 5 of EPA (1989b)] which depends on sample size (n), coverage (P%), and confidence level (Y). A coverage of 95% and confidence level of 95% are recommended (EPA 1989b).

If data are not normally or lognormally distributed or there are too many nondetects, nonparametric tolerance intervals are calculated. A two-sided nonparametric tolerance interval is the range (largest minus smallest datum) of the observed data. An upper one-sided nonparametric tolerance limit is the largest observation.

When all of the background values are less than detection limit (e.g., cadmium), the background threshold value is determined to be the limit of quantitation (LOQ) using applicable laboratory QC data obtained from Appendix E-1. The use of LOQ to establish a threshold criterion, in such a case, is recommended by EPA (EPA 1986a, page 123).

B-6b(6.2). Establishing Baseline. Establishing a groundwater constituent baseline for the 2101-M Pond facility requires the answering of two questions: (1) is well 299-E18-1 truly an upgradient well to the 2101-M Pond facility; and (2) if well 299-E18-1 is not upgradient, WAC 173-303-645(8)(g)(iii) allows for water quality comparisons to be made with nonupgradient wells. Data presented in Section B-6b(3.3) does not conclusively show that well 299-E18-1 is upgradient from the 2101-M Pond.

To establish a groundwater quality baseline to be used for comparison, additional wells were chosen to establish groundwater baseline conditions for the 2101-M Pond site. Initially, nine wells were selected on the basis that they are most probably unaffected by Hanford Site operations. The list was reduced to six following a review of borehole completion summaries and the amount of representative groundwater data. The locations of the six wells

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chosen are shown in Figure B-20. These wells transect the Hanford Site and should encompass the spatial variability necessary to establish baseline concentrations.

Data used to establish constituent baseline concentrations for the six baseline wells are from data collected after January 1985 and are listed in Appendix E-1. The first quarter of data collected for the 2101-M Pond will not be used as there is a question of whether the wells were fully developed before sampling. Well 299-E18-1 shows concentrations above DWS for unfiltered manganese, iron, and selenium and filtered manganese and selenium. Specific conductivity also was elevated above the following four quarters of data. Concentration of the above constituents dropped below DWS following additional well development before the November 1988 sampling event.

Following selection of baseline wells, each constituent of concern was checked to determine if the data were normal, log-normal or nonnormally distributed. The normality assumption of data distribution was examined or checked by a normal probability plot.

Tolerance intervals were developed for general contamination indicator parameters specific conductance, pH, TOC, and TOX; water quality parameters: chloride, manganese, sodium, sulfate, and nitrate; and for metals: arsenic, barium, cadmium, chromium, lead, selenium, mercury, silver, and copper. Tolerance intervals developed for the 2101-M Site are listed on Table B-19.

B-6b(6.3). Data Evaluation. Following the initial year of quarterly sampling, semiannual sampling was initiated in November 1989. Semiannual sampling will continue through certification of clean closure. Results from semiannual analyses are compared to the individual constituent tolerance interval. If an analysis exceeds the tolerance interval the following steps will be taken.

- Ecology will be notified in writing within 7 days with a report summarizing the compliance well indicator parameters that have shown a statistically significant increase over the baseline tolerance intervals.

- All monitoring wells will be immediately sampled and analyzed for all constituents listed in 40 CFR Part 264, Appendix IX.

- Following the review and validation of the Appendix IX analytical data, resample and reanalyze the compliance wells for all of the compounds detected.

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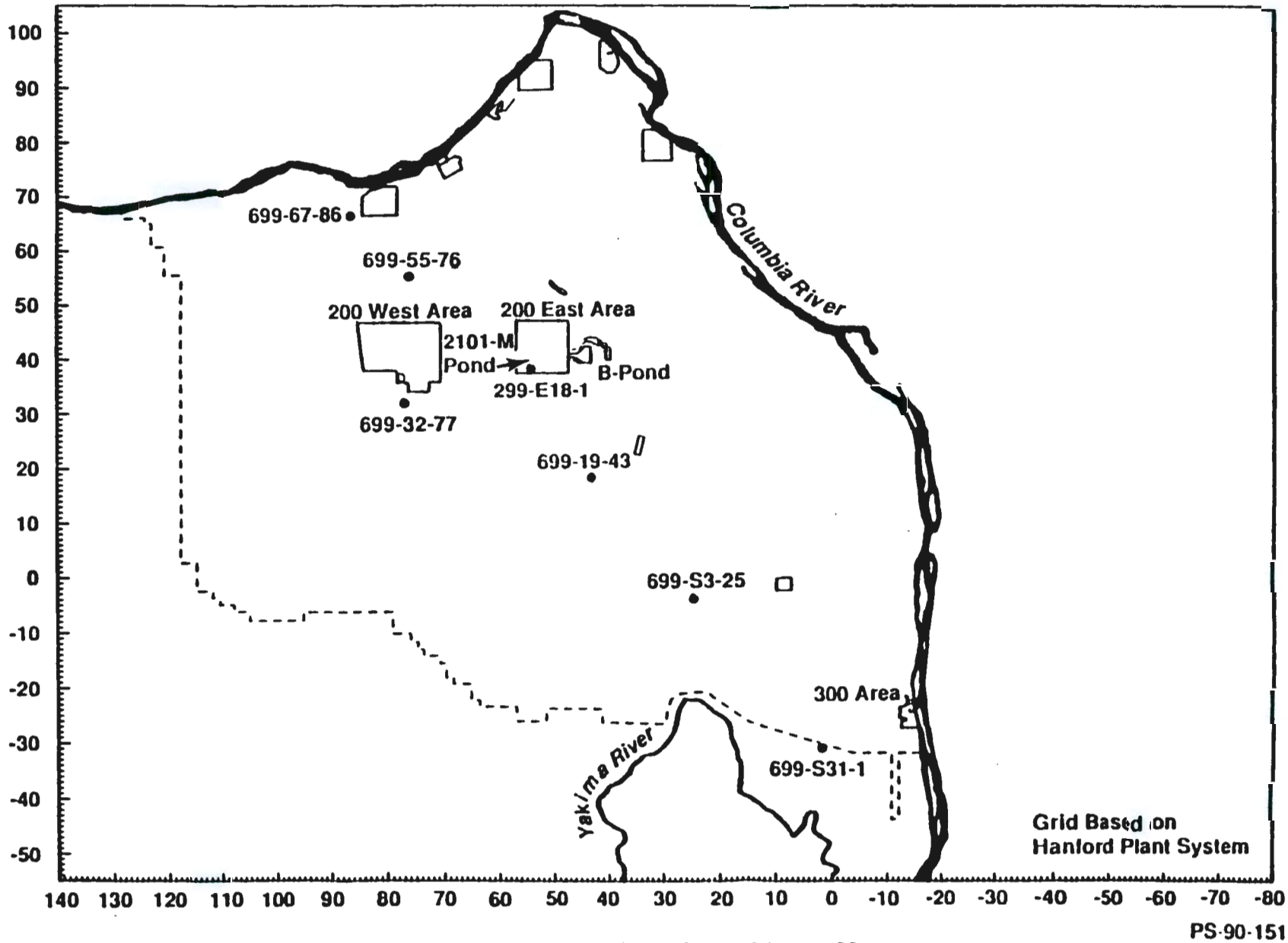

Figure B-20. Location of Baseline Wells.

Table B-19. Upper Tolerance Interval Values for 2101-M Pond Baseline. (sheet 1 of 3)

	Average	Standard deviation	Number of samples above detection limits Total	GT	LT	Upper tolerance interval value
Indicator parameters						
Conductivity 1/700[a] µS/cm	299	77	25	25	0	475
pH 0.1/6.5-8.5[g]	7.6	0.40	26	26	0	(6.3 8.2)[d]
TOC 1,000 ppb/none	450	376	26	4	22	1,500[d]
TOX 20 ppb/none	10	14.9	20	2	18	61[d]
Water quality parameters						
Chloride 500/250,000[g] ppb	6,046	1,198	18[b]	18[b]	0[b]	9,093[c]
Manganese 5/50[g] ppb	N/A	N/A	5	1	4	21[d]
Filtered manganese 5/50[g] ppb	N/A	N/A	19	5	14	47[d]
Sodium 200 ppb/none	N/A	N/A	5	5	0	21,500[d]
Filtered sodium 200 ppb/none	15,856	5,253	21	21	0	28,311[c]
Sulfate 500/250,000[g] ppb	38,238	19,202	24	24	0	82,400[d]
Selenium 5/10 ppb	<5	N/A	5	0	5	8.6[g]

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Table B-19. Upper Tolerance Interval Values for 2101-M Pond Baseline.
(sheet 2 of 3)

	Average	Standard deviation	Number of samples above detection limits Total	GT	LT	Upper tolerance interval value
Filtered selenium 5/10 ppb	<5	N/A	17	0	17	7.7[g]
ICP Metals						
Arsenic 5/50 ppb	N/A	N/A	5	1	4	6[d]
Filtered arsenic 5/50 ppb	N/A	N/A	17	2	15	6[d]
Barium 6/1,000 ppb	24	18	5	5	0	150[e]
Filtered barium 6/1,000 ppb	23	2	21	20	1	110[e]
Cadmium 2/10 ppb	<2	N/A	5	0	5	16.4[g]
Filtered cadmium 2/10 ppb	<2	N/A	21	0	21	16.4[g]
Chromium 10/50 ppb	<10	N/A	5	0	5	28.8[g]
Filtered chromium 10/50/ ppb	N/A	N/A	21	5	16	26[d]
Copper 10/100[g] ppb	<10	N/A	5	0	5	39[f]
Filter copper 10/100[g] ppb	N/A	N/A	21	1	20	12[d]

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Table B-19. Upper Tolerance Interval Values for 2101-M Pond Baseline. (sheet 3 of 3)

	Average	Standard deviation	Number of samples above detection limits			Upper tolerance interval value
			Total	GT	LT	
Lead 5/50 ppb	<5	N/A	1	0	1	10.0[g]
Filtered lead 5/50 ppb	<5	N/A	17	0	17	5.0[g]
Mercury 0.1/2 ppb	<0.1	N/A	5	0	5	2.7[g]
Filtered mercury 0.1/2 ppb	<0.1	N/A	17	0	17	2.7[g]
Silver 10[c]/50 ppb	<10	NA	5	0	5	25.3[g]
Filtered silver 10[c]/50 ppb	<10	N/A	21	0	21	25.3[g]

NOTES:
[a]Detection limit/regulatory standard.
[b]Excluding data from well 299-E55-76 and well 299-E53-25.
[c]Normal distribution.
[d]Maximum value reported. For pH, range reported.
[e]Log-Normal distribution.
[f]Based on limit of quantitation (LOQ).
[g]Secondary drinking water standard.
D.L. = detection limit
TOC = total organic carbon
TOX = total organic halogen
GT = greater than
LT = less than.

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- Following review and validation of the reanalysis data, establish a background value for each valid detected constituent identified in the Appendix IX analysis.

- Within 45 days, submit to Ecology a plan to establish a compliance monitoring program meeting the requirements of WAC 173-303-645(10) if the reanalysis data confirm that background was exceeded, or submit to Ecology the data necessary to justify that a compliance monitoring program is not required.

Discussion of the results for the first semiannual sampling event are presented in Section B-6e(1).

B-6c. Well Development and Aquifer Testing

Before sampling the unconfined aquifer beneath the 2101-M Pond, the wells were developed to eliminate any water and/or contaminants that may have been added during well construction. Wells are generally considered adequately developed when turbidity is below 5 nephelometric turbidity units.

Hydrologic tests (aquifer pumping tests) were conducted in wells near the 2101-M Pond in August and November 1988 to determine the transmissivity of the uppermost portion of the aquifer beneath the 2101-M Pond and, if possible, the storativity of the uppermost portion of the aquifer beneath the pond. The tests were conducted in wells installed near the pond for groundwater monitoring. The tests are considered to be opportunistic because the wells were not designed for aquifer testing. Results obtained from the tests must be considered in this perspective.

Tests were initially planned in wells 299-E18-1 and 299-E18-3 (Chamness et al. 1989). Four tests were eventually conducted, one at each well. The third and fourth tests were conducted in wells 299-E18-2 and 299-E18-4 when these wells were redeveloped with submersible pumps. Initial plans were for the tests to be conducted with 8-in.-dia telescoping screens set in the wells. Development tests indicated that transmissivity was actually much lower than anticipated. Wells were developed before conducting constant-discharge aquifer tests. The discharge rate was initially low, with steps of increasing discharge rate. While developing well 299-E18-3 with a 50-hp pump, the aquifer yielded much less water than expected. A 25-hp pump then was installed in the well, which also was too large for the aquifer yield. Therefore, a much smaller pump with a lower discharge rate was required. To prevent construction schedule delays, the tests were conducted after the wells had been completed with a 4-in. casing and screen.

About 4,000 gal were removed during these development periods. It was then decided to complete the well before conducting the constant-discharge aquifer test. After the well was completed, it was developed and tested with a 1 1/2-hp pump, and approximately 1,200 gal were removed during this development period.

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Well 299-E18-1 was developed with a 1 1/2-hp pump after final completion. Approximately 1,500 gal were removed during development. The aquifer test was performed using the 1 1/2-hp pump.

Distribution of transmissivity across the site was determined by conducting tests in wells 299-E18-1 and 299-E18-3 (Figure B-6). Responses were measured in wells 299-E18-2 and 299-E18-4, while pumping from well 299-E18-3. Redevelopment at wells 299-E18-2 and 299-E18-4 provided an opportunity for the collection of corroborative information.

B-6c(1). Data Analysis. The solutions used to analyze the data include the Cooper-Jacob (1946) straight-line method (where greater than or equal to 0.01) and the Theis (1935) type-curve fitting method, devised by Wenzel (1942). These methods are discussed in Lohman (1972). The following assumptions are inherent in these solutions.

- The aquifer is homogeneous and isotropic.
- The aquifer is of infinite areal extent.
- The well penetrates the entire thickness of the aquifer.
- The pumped well has an infinitesimal diameter.
- Water is instantaneously released from storage.

The pumping well drawdown data were evaluated to determine when borehole storage effects were no longer a factor, using the following equation by Hargis (1979):

$$t_c = 360{,}000 \times r_c^2 / T$$

where:

t_c = the time of pumping to dissipate borehole storage effects, in minutes

r_c = the radius of the well casing in the interval over which the water-level declines, in feet

T = the transmissivity of the aquifer, in square feet per day.

B-6c(2). Results and Limitations. The four site wells only partially penetrate the aquifer. This results in a violation of a major assumption in aquifer test analysis--that the wells fully penetrate the aquifer. Vertical movement can be induced in the vicinity of partially penetrating wells, affecting ideal drawdown responses. In addition, insufficient stress was imposed, so that very little drawdown (a few hundredths of a foot), or even no drawdown, resulted in some cases. Aquifer heterogeneity also appeared to affect some of the data.

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For these reasons, the resulting values for transmissivity are not considered to be quantitative; however, they are indicative of the range of transmissivity values beneath the 2101-M Pond. Results of the analyses, as well as the drawdown data trends, indicate that heterogeneous aquifer materials underlie the 2101-M Pond. Drawdown recovery curves and data from drawdown and recovery during pumping will be included in the site characterization report. A summary of the test results is presented in Table B-20. These data are within the expected range of values presented in Table B-14, using estimated aquifer thickness values.

Table B-20. Summary of Aquifer Test Results for Wells Tested at the 2101-M Pond.

	Transmissivity (ft^2/d)		
Well no.	Pumping well	Observation well	Storativity
299-E18-1	700	--	--
299-E18-2	2,000	8,700	0.01
299-E18-3	800	--	--
299-E18-4	--	5,000 to 60,000	0.005 to 0.04

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B-6d. Quarterly Sampling Results

B-6d(1). Water Level Measurements. Water levels are now measured on a monthly basis separate from those taken when the groundwater is sampled. Water level data for wells monitoring the 2101-M Pond are listed in each quarterly report, and Hanford site water table maps are provided in semiannual reports (e.g., Kasza et al. 1992). These water level measurements are all obtained within a few hour period, thereby minimizing temporal effects on measurements. Data are collected using a calibrated steel tape. Measurements are taken until two measurements agree to within 0.02 ft. The measurements taken at times other than sampling events are generally used for interpretation of the gradient and groundwater flow direction.

Inclinometer surveys, using Sure Shot Technique*, were run on the four monitoring wells. Three of the wells depart slightly from vertical. The surveys were run at 50-ft intervals. Deviation was assumed to occur midway between measurements. Water levels and borehole deviations are listed in Table B-15.

*Sure Shot Technique is a trademark of Al Bit and Tool Company.

No correction is made for barometric or tidal effects. Informal barometric efficiency studies for the unconfined aquifer, in the 200 Areas, have shown unexpected high values. Values range from 0 to 80%. No studies have been done at the 2101-M Pond site.

B-6d(2). Water Quality Analyses. Before sampling, the wells were developed to remove water and particulates added during the drilling process. Initial sampling results indicate that well development may not have been adequate. Data from unfiltered analyses of first quarter sampling indicate that some residual particulate metals in concentrations above DWS and/or SMCL (chromium, manganese, and iron) may remain from the drilling process, but these are very close to or below DWS or SMCLs in filtered analyses. Similar elevated values for chromium in unfiltered analyses have been noted at other newly drilled RCRA monitoring wells in the 200 East Area.

After well development and purging, first quarter samples were obtained from all four monitoring wells. Samples were collected and analyzed in accordance with procedures given in Chamness et al. (1989). Samples were obtained using dedicated HydroStar pumps and were stored in the field and in transit as specified in Chamness et al. (1989). Analyses were conducted by U.S. Testing using the recommended analyses and methods specified by the EPA and contained in the sampling and analysis plan (Chamness et al. 1989).

Filtered analyses are considered to represent more valid indications of groundwater contamination than unfiltered analyses. Constituents detected in filtered analyses can be mobile solutes that can migrate more readily with groundwater to surface waters or to areas where groundwater is extracted for a drinking water supply. Unfiltered analyses indicate the presence of ions in solution, as well as those adhered to particulate matter or wear-abraded fragments of rock or drilling equipment, produced in the construction of a monitoring well. As such, the particulate constituents are unlikely to be mobile and to be transported to where they may become part of a drinking water supply. A considerable amount of turbidity is created in the aquifer at and in the vicinity of penetration by a monitoring well through activities associated with well construction, purging, pumping, and well development. If the well has not had a chance to stabilize after drilling, purging, and development, residual particulate matter may remain. If a well were to be used for drinking water supply, consideration of unfiltered analyses would be appropriate in assessing public health and safety because the total metals present in the water could potentially be consumed. However, for monitoring wells, "Any difference in concentration between the total and dissolved fractions may be attributed to the original metallic ion content of the particles and any sorption of ions to the particles" (EPA 1986d, p. 114). Unfiltered iron and chromium values for the five quarterly samples and the first semiannual sample are elevated. Concentrations are variable from quarter to quarter, (Appendix E-1) and no discernable pattern is apparent.

B-6d(2.1). First Quarter. First quarter samples were obtained August 16, 1988. Analytical data indicate concentrations above DWS for chromium, arsenic, selenium, and manganese in unfiltered samples. However, only selenium and manganese were slightly above DWS in filtered samples. Filtered selenium, at 10.7 parts per billion in well 299-E18-1, is barely

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above the 10 ppb primary drinking water standard. Filtered manganese, at 51 parts per billiom in well 299-E18-1, is barely above the SMCL of 50 parts per billion. Values from filtered samples for these analytes in all other wells are below the respective DWS.

To verify the elevated values of these metals during first quarter analyses, all four wells were resampled in September 1988. These groundwater samples were analyzed for metals only. The results of this resampling (Appendix E-1) generally verify the data from the first set of samples. However, manganese, selenium, and arsenic dropped to or below DWS in both filtered and unfiltered analyses.

B-6d(2.2). Second Quarter. Second quarter samples were taken on November 9 and 10, 1988. After purging, samples were taken from all four wells and submitted for analyses. Results obtained indicate that all analyzed constituents were below the DWS in the filtered samples (Appendix E-1). Results show that only iron was above the SMCL in unfiltered samples from two wells, but was below the SMCL in filtered analyses from all wells. Turbidity is the suspected cause of this difference. Results showed that manganese and selenium, which were above DWS during first quarter sampling in filtered and unfiltered analyses from well 299-E18-1, were below the DWS and SMCL limits for both filtered and unfiltered analyses for second quarter samples. Two values of field pH in well 299-E18-1 were 8.6; all others were 8.5 or lower.

No volatile organic compounds were found to exceed DWS with the exception of acetone. Acetone was detected at very low concentrations in almost all samples and the blank. Another set of samples (including a blank) were rerun, and the results indicated that three of the four wells and some of the blanks contained acetone at very low levels. Because in both instances the blanks contained the highest concentrations of acetone, all four wells were resampled and the samples were split and sent to different laboratories. Results from U.S. Testing indicated that groundwater only from well 299-E18-2 contained acetone, at 11 parts per billion; results obtained from PNL indicated no acetone in any of the samples from any of the wells. These results suggest that acetone was introduced during sample handling or analysis and is not a true constituent of groundwater.

B-6d(2.3). Third Quarter. Third quarter samples were collected on February 15 and 16, 1989. Results show that all analytes, except unfiltered chromium and iron, were below DWS. In addition, turbidity was slightly above the DWS in well 299-E18-1. Filtered iron and chromium were well below standards. Results are listed in Appendix E-1.

B-6d(2.4). Fourth Quarter. The fourth quarter samples were collected on May 26 and June 1, 1989. Results show that only unfiltered iron was above DWS in well 299-E18-1. Turbidity was above DWS in wells 299-E18-1, 299-E18-3, and 299-E18-4. All other constituents in well 299-E18-1 were below standards and the other three wells were below standards. Results are listed in Appendix E-1.

B-6d(2.5). Fifth Quarter. A fifth set of samples were collected between August 8 and 11, 1989. Unfiltered iron and chromium were higher than DWS in

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wells 299-E18-1, 299-E18-3, and 299-E18-4. Filtered iron and chromium were below or at detection limits. Turbidity was above DWS in wells 299-E18-1, 299-E18-2, 299-E18-3, and 299-E18-4. Results are listed in Appendix E-1.

B-6d(2.6). Discussion of Quarterly Sampling Results. Quarterly sampling results show consistent exceedance for unfiltered chromium. Filtered analyses for chromium is consistently at or slightly above detection limits. In addition to unfiltered chromium, unfiltered iron shows a high degree of variability over the five quarters of sampling. This variability is thought to be a 'near well' feature and does not represent a widespread problem.

The first quarter sampling data are not used in the development of tolerance intervals because of higher-than-expected values for conductivity, and certain metals, i.e., aluminum, chromium, iron, selenium, and manganese (Appendix E-1).

Comparison of quarterly sampling results with baseline tolerance intervals shows that the three monitoring wells exceed the upper tolerance interval for several constituents, for the quarters beginning in November 1988. The constituents, wells, and date of exceedance are as follows:

- Chloride (299-E18-4, 2/89 and 5/89)
- Arsenic (E18-2, 6/89; 299-E18-3, all quarters; 299-E18-4, all quarters)
- Filtered arsenic (E18-3, all quarters; 299-E18-4, all quarters).

The cause for this exceedance is uncertain and may be attributed to local concentration variability that is not incorporated into the calculated tolerance interval, due to turbidity in unfiltered samples, past discharges to the 2101-M Pond facility, or influence from other Hanford Site facilities.

Arsenic values, for both filtered and unfiltered samples, are consistently slightly above the tolerance interval of 6 parts per billion but well below the DWS of 50 parts per billion. This, in combination with the fact that no records of any arsenic compounds having been disposed of at the 2101-M Pond, indicates that the arsenic values measured are only part of the natural background for the site (Johnson 1993).

Exceedance for chromium and high iron content only occur in unfiltered samples. Elevated chromium and iron appear to be correlated with high turbidity in the unfiltered samples. This suggests that elevated chromium and iron are the result of particulate matter, most likely from the middle Ringold sediments. Columbia River basalts contain from approximately 10 to 110 parts per million chromium and 11 to 13% iron (Landon and Long 1989). Chamness et al. (1990) show that basalt gravels make up approximately from 20% to 60% of the total gravels in the middle Ringold. If this same ratio is applied to the fine grained sediments (silts and muds), the elevated chromium and iron could be the result of basaltic particles in the samples. The preferred explanation is that elevated iron and chromium is a result of particulates

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remaining from well construction which are slowly corroding, releasing metals into the groundwater adjacent to the well. Detection of higher chromium and iron concentrations in newly installed stainless steel wells than nearby carbon steel wells supports this theory. Because the exceedences are due to causes other than past discharges to the 2101-M Pond, no further action will be required. It is expected that exceedence for chromium, above the regulatory level and closure plan tolerance intervals, will continue through closure.

B-6e. Semiannual Sampling

Well 299-E18-1 is sampled by the 216-B-3 Pond RCRA project as an upgradient well. Early in the project, samples were taken independently of those collected for this project. Arrangements have now been made to sample at concurrently and save analytical costs. Additional samples for radioactive constituents monitored by the Environmental Surveillance Program are also collected on occasion. All results are included in Appendix E-1. Results from all four semiannual sampling events corroborate the first years quarterly results. The 2101-M Pond is affecting the groundwater primarily through dilution of the groundwater constituents found in the upgradient well. Elevated metals continue to show up in all four of the monitoring wells at least periodically, supporting the conclusion that they are related to well construction and not to contamination of the groundwater from 2101-M Pond.

B-6e(1). First Semiannual Sampling Event. The first semiannual samples were collected between October 31 and November 29, 1989. A breakdown of the constituent groups analyzed for are provided in Table B-21.

Concentrations for constituents of concern were all below their respective tolerance interval (Table B-19) except chloride (299-E18-4), arsenic (299-E18-2, 299-E18-3, and 299-E18-4), and iron (299-E18-4). In addition, the upgradient well 299 E18-1 exceeded the tolerance interval for specific conductance, sulfate, chromium, and selenium. All exceedances are consistent with those observed during quarterly sampling except selenium. However, selenium is only 1 part per billion over the tolerance interval of 5 parts per billion. This exceedance is considered insignificant and is well below DWS. All analytical results have been reported in the appropriate quarterly and annual reports (Smith et al. 1990; DOE 1991a).

Results from the expanded list of analytes based on WAC 173-303-9905 and 40 CFR 264, Appendix IX show all values to be below detection limits except for chloroform and methylene chloride. Replicate samples were taken for well 299-E18-3. For both of these analytes, one replicate had concentrations above detection limits for chloroform and methylene chloride, and the second replicate was below detection limits. It is interpreted that the presence of these two constituents is due to contamination during sampling or in the laboratory and are not of concern to the 2101-M Pond facility.

B-6e(2). Second Semiannual Sampling Event. Samples were initially collected for the second semiannual sampling event on May 30, 1990. These samples were not analyzed because of contractual problems with the analytical

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laboratory. A new analytical contract was established in 1991, and samples for the second semiannual sampling event were collected on September 6, 1991. Table B-21 provides a breakdown of the constituent groups analyzed for. Appendix E-1 contains all analytical results.

Concentrations for constituents of concern were all below their respective tolerance interval (Table B-19) except unfiltered chromium (299-E18-1 and 299-E18-4), filtered copper (299-E18-2 and 299-E18-3), and unfiltered sodium (299-E18-1). This is the only semiannual sampling period that has ever detected filtered or unfiltered copper in any of the wells. Levels of copper detected are below drinking water standards and are consequently not of concern. As in the first semiannual results, the upgradient well, 299-E18-1, continued to exceed the tolerance intervals derived from the 6 background wells in specific conductivity. These analytical results have been previously reported in the appropriate quarterly and annual reports (DOE-RL 1991b and c; DOE-RL 1992a and b; DOE-RL 1992c).

B-6e(3). Third Semiannual Sampling Event. Samples were collected on June 3 and July 10, 1992 for the third semiannual sampling period. Table B-21 provides a breakdown of the constituent groups analyzed for. Appendix E-1 contains all analytical results. Samples were collected from 299-E18-1 on January 24, 1992 for the 216-B-3 Pond project. The analytical results are provided with the rest of the data, and are consistent with other data from the same well. These analytical results have been previously reported in the appropriate quarterly and annual reports (DOE 1992d and e; DOE-RL 1993).

Problems with the analysis of TOX were identified at this time. Samples collected from the three downgradient wells all showed levels of TOX above the established critical mean for the 2101-M Pond. The laboratory had noted some analytical problems, and duplicates also indicated a wide variability in the data. As a precaution, resampling of all 4 wells was requested and scheduled for November 3, 1992. The resampling results indicated all 4 wells were below the detection limit for TOX, which would also put them below the critical mean. All recent analytical TOX results are still under review until the problem has been resolved with the laboratory and are flagged in Appendix E-1 appropriately.

Concentrations for constituents of concern were all at or below their respective tolerance intervals (Table B-19) except filtered and unfiltered arsenic (299-E18-3 and 299-E18-4), filtered chromium (299-E18-4), unfiltered chromium (all 4 wells), and pH (299-E18-3). As before, well 299-E18-1 continued to show exceedance of the tolerance intervals for specific conductivity, sulfate, and unfiltered sodium. Uranium was detected at a somewhat higher concentration in well 299-E18-2 than previous samples, but did not exceed drinking water standards.

B-6e(4). Fourth Semiannual Sampling Event. Samples for the fourth semiannual period were collected on December 16, 1992. Table B-21 provides a breakdown of the constituent groups analyzed for. The present plan is to sample for all of the indicator parameters and most of the drinking water and groundwater quality parameters once a year. The alternate sampling period will analyze for a smaller list of constituents that consists of the

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Table B-21. Groundwater Sampling Parameters[a]

Parameter	Sampling Date 11/89	9/91	6/92	12/92
Interim primary drinking-water standards				
Arsenic	All[b]	-[c]	All	All
Barium	All	All	All	All
Cadmium	All	All	All	All
Chromium	All	All	All	All
Fluoride	All	All	All	All
Lead	All	-	All	1
Mercury	All	-	All	1
Nitrate (as N)	All	All	All	All
Selenium	All	-	All	All
Silver	All	All	All	All
Endrin	All	-	All	1
Lindane	All	-	All	1
Methoxychlor	All	-	All	1
2,4-D	All	-	All	1
2,4,5-TP silvex	All	-	All	1
Radium	All	All	All	1
Gross alpha	All	All	All	All
Gross beta	All	All	All	All
Turbidity (surface water only)	All	All	All	All
Coliform bacteria	1,3,4	-	All	All
Groundwater quality parameters				
Chloride	All	All	All	All
Iron	All	All	All	All
Manganese	All	All	All	All
Phenols	All	All	All	1
Sodium	All	All	All	All
Sulfate	All	All	All	All
Groundwater contamination indicator parameters				
pH	All	All	All	All
Specific conductance	All	All	All	All
Total organic carbon	All	All	All	All
Total organic halogen	All	All	All	All
Other constituents				
Volatile organics	All	All	All	All
Semivolatile organics	All	-	All	All
WAC 173-303-9905/40 CFR 264 App. IX	All	-	-	-
Radionuclides, additional	1	All	All	All

(a) Each well number was abbreviated in the following table to its last digit, e.g., 299-E18-1 becomes 1, 299-E18-2 becomes 2.
(b) All = Indicates all four monitoring wells were sampled for that constituent.
(c) Not analyzed.

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constituents of concern. Upgradient well 299-E18-1 was cosampled with the 216-B-3 Pond project and the results are provided with the others in Appendix E-1. These analytical results have been previously reported in the appropriate quarterly and annual reports (DOE 1993a; DOE 1993b).

Concentrations for constituents of concern were all at or below their respective tolerance intervals (Table B-19) except for filtered and unfiltered arsenic (299-E18-2, 299-E18-3, and 299-E8-14), chloride (299-E18-4), unfiltered chromium in all four wells, filtered chromium in one duplicate sample (299-E18-3),and pH (299-E18-3). Upgradient well 299-E18-1 continued to show specific conductivity, sodium, and sulfate at levels exceeding the tolerance intervals calculated from the 6 background wells. Uranium was requested again and was back to levels comparable to earlier results. Therefore the higher value reported in the third semiannual sample is considered to be anomalous.

B-6f. Comparison of Soil and Groundwater Analyses

To assess whether contaminants from the 2101-M Pond have entered the groundwater, soil analyses (Section B-5) and groundwater analyses were compared. Many of the metals that may have been discharged to the 2101-M Pond are indigenous to Hanford Site sediments and soils and may occur naturally in the groundwater. The mere presence of such elements in the groundwater is, thus, no indication that groundwater quality beneath the 2101-M Pond has been affected by discharges to the pond. Furthermore, most metals sorb or precipitate in Hanford Site soils and, thus, are not very mobile (see EP toxicity results and discussion in Section B-5).

For example, copper and chromium are found in Hanford Site soils as well as in the 2101-M Pond soil (Section B-5). Copper was discharged to the pond from dissolution of pipes within the 2101-M Building HVAC system as well as certain copper compounds that could have been disposed of down sink drains in the BWIP Laboratory. Dissolved copper from piping in the facility and the HVAC is the most likely source. These discharges may account for elevated values of copper in the 2101-M soil above those in background soils. However, values of copper in groundwater are well below values for copper in both background soils and the 2101-M Pond sediments. Concentrations of copper in groundwater (filtered and unfiltered analyses) are well below SMCLs for drinking water. The relative immobility of copper in sediments of the 2101-M Pond also is shown by the decline in concentrations of copper with depth in the upper 12 ft of pond sediments. An EP toxicity test was performed on copper-containing soil samples from the 2101-M Pond, and it was found that copper did not readily leach from the sample. Copper values from ICP analyses of soil samples far exceeded the copper that resulted from the EP toxicity test. Thus, little copper is likely to be leached from the soil and transported to groundwater.

Chromium may have been discharged to the pond from the BWIP Laboratory. Values for chromium are approximately the same in the 2101-M sediments and in background soils. Chromium is found in particulate form in groundwater as indicated by the difference in values between unfiltered and filtered

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analyses. As discussed earlier, chromium is thought to be related to well construction, and is probably not a result of any discharges to the pond.

Barium, a DW that was discharged to the 2101-M Pond, is attenuated rapidly with depth in 2101-M Pond sediments, similar to copper. Barium also is present in background soils at concentrations approximating those in most samples of 2101-M Pond sediments. Barium is present in ground water in presumed upgradient as well as downgradient wells, but in concentrations substantially lower (three orders of magnitude) than those in background soils and sediments of the 2101-M Pond and well below primary DWS. The EP toxicity tests were performed for barium on several samples from the 2101-M Pond, and it was found that barium was unlikely to leach out of the soil.

Not all metals form immobile solutes. Selenium, which was used in small quantities in dilute solution for waste package studies in the BWIP Laboratory, generally does not sorb well and is quite soluble in some soil systems. In calcareous soil systems such as at the Hanford Site, it is likely sorbed on the surface of calcium carbonate (Fujii et al. 1988). Selenium was below detection limits in all soil samples taken from the 2101-M Pond and from both the 'wet' and 'dry' background sample sites (Section B-5). Samples of vadose zone sediments were taken at selected intervals in the wells and were analyzed for metals using either XRF or ICP. One sample from a depth of 194 ft in well 299-E18-3 contained 1.14 parts per million selenium by XRF. All others were less than the detection limit of 1 part per million. Selenium values found in groundwater are at or near the detection limit of 5 parts per billion.

Volumes of liquid discharged to the 2101-M Pond have been estimated [Section B-3a(3)] at approximately 0.8 to about 1.5 Mgal/yr for 1982 to 1988. Liquid discharges may provide a driving force to transport soluble, unsorbed contaminants from the surface and near-surface sediments to groundwater. For the BWIP Laboratory, these volumes are significant only during and after the period of laboratory operation; i.e., the period from about 1981 to 1985 when contaminants may have been discharged down sink drains and up to the present. After 1985, administrative controls were imposed to restrict the nature of liquids poured down sink drains in the laboratory. Since 1953, when the 2101-M facility opened, the only other known discharge to the 2101-M Pond was water from the HVAC system and possibly some run-off from paved parking areas. This liquid effluent may have contained dilute quantities of copper dissolved by flow through copper pipes in the facility and HVAC units. Recent measurements of the waste stream discharged to the 2101-M Pond indicate copper concentrations of up to 530 parts per billion (Table B-2).

Analyses of filtered samples suggest that the groundwater beneath the 2101-M Pond meets DWS. The groundwater beneath 2101-M Pond is not a source of drinking water and is unlikely to be so in the immediate future. Furthermore, considerably more dilution will occur before groundwater beneath the 2101-M Pond reaches the Columbia River, more than 7 mi away. Drinking water supplies are extracted by communities along the Columbia River downstream from the Hanford Site.

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B-6g. Quality Assurance/Quality Control

Quality assurance procedures for the collection and analyses of groundwater samples are addressed in the Interim Status Ground-Water Monitoring Plan (Chamness et al. 1989). This section discusses the results of a review of the QA and QC for groundwater samples collected in August, September, and October 1988 at 2101-M Pond. The groundwater samples were analyzed using the 2nd edition of SW-846 (EPA 1982b) as guidance.

B-6g(1). Quality Assurance Review of Inorganic Analyses. Thirteen water samples were collected between August 16 and November 13, 1988 for analysis of inorganics by U.S. Testing. Four samples were collected for the first quarter on August 16. Four more samples were collected on September 23 and 28 as a check on the metals analyses. Five samples were collected on November 9, 10, and 22, with the four samples collected on November 9 and 10 being the second quarter samples. One of the wells was sampled on November 22 for another project. Inorganics discussed below include ICP metals, mercury, arsenic, selenium, lead, thallium, cyanide, anions, sulfide, total carbon, coliform bacteria, and radionuclides. These were all analyzed following SW-846 procedures (EPA 1982b), other EPA procedures (EPA 1984b; Kreiger and Whittaker 1980; Johns 1975), methods given in ASTM (1986) and APHA (1985), and/or modifications of these.

The following comments refer to the laboratory performance in meeting the QC specifications for each of the procedures in SW-846, 2nd edition (EPA 1982b).

1. Holding Times

   All holding times were within QC limits.

2. Instrument Detection Limits

   Detection limits provided by U.S. Testing were appropriate for the methods used.

3. Blanks

   The concentrations of analytes in the blanks were all below detection limits. All of the inorganic samples were seen with blanks.

4. Duplicate Analyses

   Duplicates have been run for all of the analytes. However, there is no duplicate for anions on November 22. Either no analysis was performed or the information was not provided.

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5. Matrix Spike Sample Analysis

All appropriate inorganic samples were run with matrix spike samples and duplicate matrix spikes, all with acceptable recovery percentages.

6. Overall Sample Analysis

The data are acceptable for the following reasons.

- EPA methods were used for analysis.
- Percent spike recoveries were within QC limits.
- Control samples were used for accuracy checks.
- The sample matrices were similar.

B-6g(2). Quality Assurance Review of Organic Analyses. Thirteen groundwater samples were collected between August and November 1988 for analysis of organics by U.S. Testing, Richland, Washington. On August 16, 1988, samples for pesticides, herbicides, and phenol were collected for compliance with 40 CFR 265. On November 9 and 10, 1988, samples were collected for the three groups above as well as for volatile organic compounds, and ABNs. On November 23, all four wells were sampled again for VOCs only. For this discussion, organic analyses include pesticides, herbicides, phenol, TOX, TOC, volatile organic constituents, ABNs, citrus red, and PCBs. Procedures used were from the 2nd edition of SW-846, methods given in ASTM (1986) and APHA (1985), or modifications of these.

The following comments refer to the laboratory performance in meeting the QC specifications for each of the procedures in SW-846, 2nd edition.

1. Holding Times

All holding times for organics were within the QC limits.

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2. Detection Limits

All detection limits were equal to or lower than drinking water (or other proposed EPA) standards except:

	EPA[a] (ppb)	U.S. Testing[b] (ppb)
1,1-dichloroethylene	7	10
Vinyl chloride	2	10
1,2-dichloroethane	5	10
1,2-dichloropropane	6[c]	10
Ethylbenzene	680[c]	
Styrene	140[c]	

[a]U.S. Environmental Protection Agency.
[b]U.S. Testing Company, Inc.
[c]Proposed standard.

Changes in procedures at the beginning of calendar year 1989 are such that the U.S. Testing detection limits are now equal to or less than the EPA standards for all but 1,1-dichloroethylene and vinyl chloride. U.S. Testing now has a detection limit of 5 parts per million for ethylbenzene and styrene.

3. Blanks

The concentrations of ABNs and pesticides in the method blanks were all below the EPA method detection limits. For the VOCs, acetone was detected at 18 parts per billion in the method blank run on November 9, 1988, which is above the method detection limit of 10 parts per billion. Another set of VOA samples were collected from all four wells and analyzed by both PNL and U.S. Testing laboratories, and the method blanks were all below the MDL. This is within the limits for acetone in method blanks specified in the EPA's Certified Laboratory Procedures.

4. Duplicates

Duplicates were run for most of the organics analyzed. The possible exceptions were: herbicides in August and both November 9 and 10 and November 22; phenols on November 22; ABNs on November 9 and 10; and citrus red and PCBs. Either these analyses did not have duplicates run, or the information has not been provided.

5. Surrogate Recoveries

Surrogate recoveries were all within the EPA limits, which are ±3 standard deviations (Appendix E-1).

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6. Matrix Spike Samples Analysis

Percent matrix spike and duplicate matrix spike recoveries were within the EPA limits. Matrix spikes were performed on all organic samples with the exception of citrus red and some semivolatile compounds analyzed by direct aqueous injection on November 9/10. Matrix spikes are not performed on citrus red samples because of difficulties with their insolubility. Either spikes were not performed for the semivolatiles or the data were not provided (Appendix E-1).

7. Overall Sample Analysis

The data are acceptable for the following reasons.

- EPA-approved methods were used for analysis.
- Percent spike recoveries were within QC limits.
- Control samples were used for accuracy checks.
- The sample matrices were similar.

B-6h. Groundwater Support of Closure Option

Available data from analyses of metals suggest that the constituents in filtered analyses of the groundwater beneath the 2101-M Pond do not exceed the DWS or SMCL. Constituents above DWS and SMCL in unfiltered analyses are assumed to result from turbidity arising during well purging. If these results are confirmed by continuing sampling and analyses of groundwater beneath the facility, the 2101-M Pond appears not to be a source of groundwater contamination. Nothing has been discovered to date that would appear to warrant closure of the 2101-M Pond in any manner but as a clean-closed facility. In summary, clean closure remains an option for the 2101-M Pond.

B-7. SCHEDULE FOR CLOSURE

In accordance with WAC 173-303-610(3)(a)(vii), this section outlines the schedule for final closure of the 2101-M Pond. Closure of the 2101-M Pond will begin upon notification of approval of the closure plan by Ecology. The activities to be completed during the final closure period will proceed according to the schedule presented in Figure B-21.

Phase II sampling was completed in June 1991, following Ecology's approval of the sampling plan.

The schedule in Figure B-21 is based on the removal of the entire pond area to a depth of 2 ft. This was done because the extent of remediation, if

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any, was not fully known. Based on the results of the Phase II sampling, no remediation is necessary and closure will be accomplished within 180 days of approval of the closure plan.

Closure of the 2101-M Pond as a landfill will be implemented only in the event that clean closure is not achieved.

Other final closure activities include continued groundwater monitoring through certification of closure/postclosure care period and the process of certification of closure by an independent registered professional engineer.

B-8. AMENDMENT OF PLAN

The preliminary closure plan for the 2101-M Pond was submitted to Ecology in April 1987. Revision 0 of the plan was submitted in September 1989 to provide the site characterization information and closure strategy. Revision 1 of the plan was submitted in April 1991 to provide the Phase II sampling plan and the contingency plan. Revision 2 of the plan is being submitted to present the results of the Phase II sampling and conclusions.

In accordance with WAC 173-303-610(3)(b), the closure plan for the 2101-M Pond will be amended whenever changes in operating plans or facility design affect the closure plan; or if, when conducting final closure activities, unexpected events (e.g., groundwater contamination) require a modification of the closure plan. This plan may be amended any time before certification of final closure of the 2101-M Pond.

If an amendment to the approved closure plan is required, DOE-RL will submit a written request to Ecology to authorize a change to the approved plan. The written request will include a copy of the closure plan amendment for approval.

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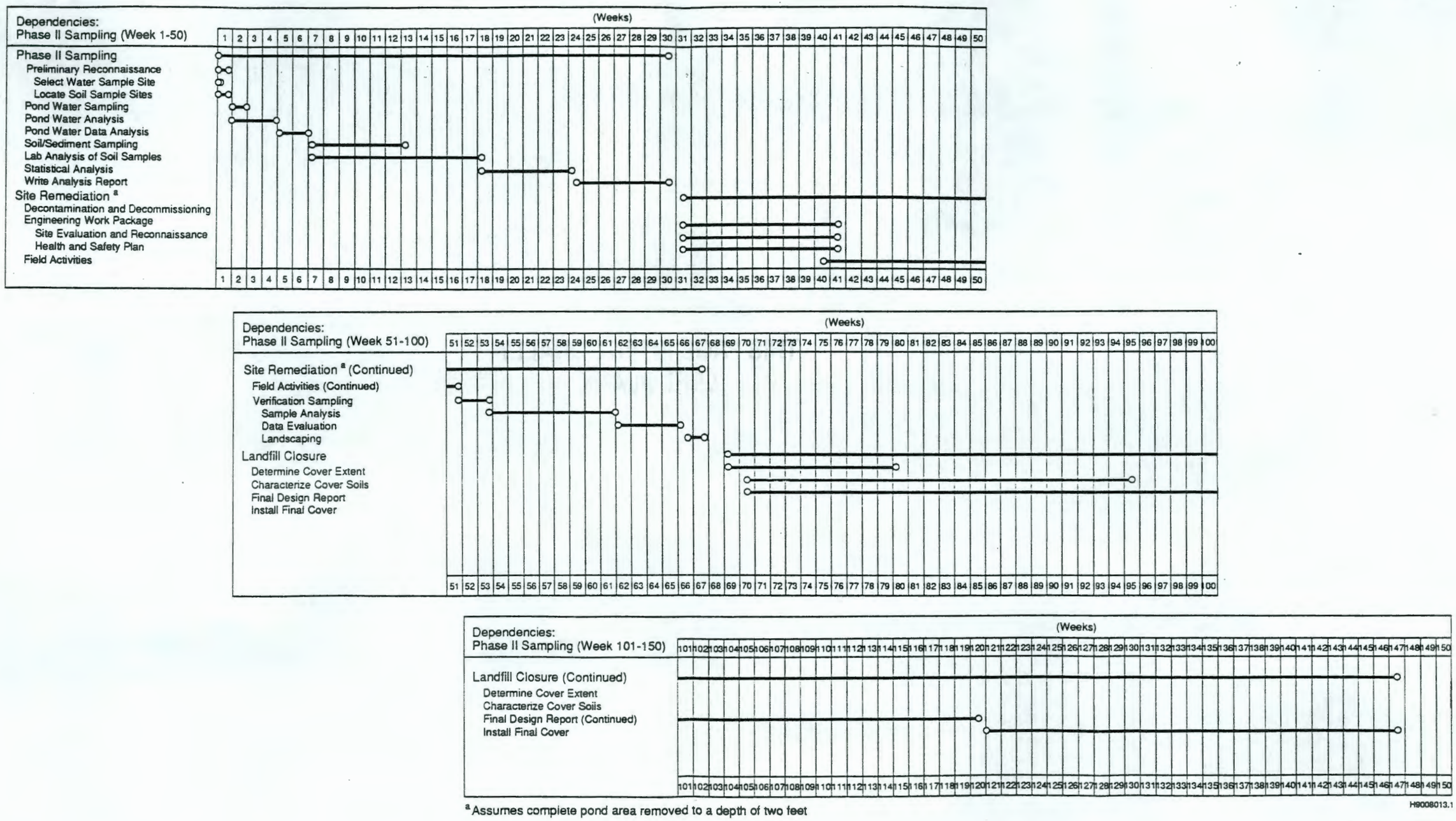

[a] Assumes complete pond area removed to a depth of two feet

Figure B-21. Closure Schedule Bar Graph.

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C. CERTIFICATION OF CLOSURE

Within 60 days of closure of the 2101-M Pond, the DOE-RL will submit to the Benton County Auditor and the lead regulatory agency a certification of closure. The certification of closure will be signed by both the DOE-RL and a registered independent professional engineer, stating that the unit has been closed in accordance with the approved closure plan. The certification will be submitted by registered mail or an equivalent delivery service. Documentation supporting the independent registered professional engineer's certification will be supplied upon request of the regulatory authority. The DOE-RL and the independent professional engineer will certify with a document similar to Figure C-1.

Official copies of the closure plan will be located at the following office:

Office of Environmental Assurance,
Permits, and Policy
U.S. Department of Energy
Richland Operations Office
Federal Building
825 Jadwin Avenue
P.O. Box 550
Richland, Washington 99352.

If clean closure is not attained, the owner or operator will submit to the local zoning authority, or to the authority with jurisdiction over local land use, a survey plat indicating the location and dimensions of the 2101-M Pond. The EPA will be provided with a survey plat. The plat will show the facility location with respect to permanently surveyed benchmarks and will be prepared and certified by a professional land surveyor. The plat will also contain a note, prominently displayed, stating the owner's obligation to restrict disturbance of the surveyed area.

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CLOSURE CERTIFICATION
FOR

_____

Hanford Site
U.S. Department of Energy, Richland Operations Office

We, the undersigned, hereby certify that all _____ _____ closure activities were performed in accordance with the specifications in the approved closure plan.

_____ _____
Owner/Operator Signature DOE-RL Representative Date
(Typed Name)

_____ P.E.#_____ State___ _____
Signature Independent Registered Professional Engineer Date
(Typed Name, Professional Engineer license number, state of issuance, and date of signature)

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1 Figure C-1. Closure Certification for the 2101-M Pond.

II. CONTINGENCY CLOSURE/POSTCLOSURE PLAN

This section discusses the requirements for closing the 2101-M Pond as a landfill (i.e., any contaminants will be left within the soil column and capped with an earthen cover to restrict contaminant migration). This postclosure plan will be implemented if clean closure is not accomplished.

This plan is divided into four sections, they are as follows:

- Summary
- Preliminary cover design
- Postclosure considerations
- Cover system permeability.

II-1. SUMMARY

The primary function of this cover system will be to minimize migration of surface water to the groundwater. This will be accomplished through the use of a cover system consisting of three layers:

- Foundation layer
- Low-permeability layer
- Topsoil layer.

Before the cover is constructed, a foundation layer will be placed. The purpose of the foundation layer is to establish a smooth, level grade upon which to construct the cover. After this foundation layer, a thick, low-permeability soil layer with an estimated hydraulic conductivity (K) of about 3×10^{-7} cm/s will be placed. This soil layer will consist of a compacted silt-to-silt-loam soil. Over the low-permeability layer will be the topsoil layer, which will be of sufficient thickness to help promote a vigorous stand of vegetation and provide storage of water for evapotranspiration. If there is need to build a cover, standard field verification test methods (e.g., sealed double-ring infiltrometer) will be specified as part of the QC for the final cover design. A final cover design will only be done in the event that the landfill contingency is necessary.

To determine the effectiveness of the cover design, the hydrologic evaluation of landfill performance (HELP) computer model (Version 2) was used. The model uses climatological data and daily precipitation data from 10 consecutive years at the Hanford Meteorological Station (HMS) to estimate annual and peak daily run-off, drainage, and percolation through the cover. These 10 yr have an average annual precipitation of approximately 1 in. above the average annual precipitation for the Hanford Site. For this reason, the output of the model is considered to be conservative.

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II-2. PRELIMINARY COVER DESIGN

The cover configuration has been developed and evaluated using EPA guidance and design manuals, and other technical references as stated herein. The cover design description explains how the cover will minimize the migration of liquids into the vadose zone. The design and configuration section discusses expectations for cover system permeability and freeze/thaw cycle effects, potentials for erosion and settlement, and describes the necessary maintenance requirements.

The primary objective of this cover system is to confine waste. The primary functions of the cover are to enhance moisture storage while minimizing water infiltration, erosion, and long-term maintenance requirements. Secondary functions are to preserve slope stability and minimize deterioration because of environmental conditions. All of the cover functions are met with this preliminary design.

As stated, this cover design is preliminary in nature. Because the 2101-M Pond closure strategy is clean closure, a definitive design will be completed should a decision be made that clean closure is not feasible.

For this preliminary design, data from McGee Ranch soil is used (DOE 1990). This is the only presently characterized silt deposit on the Hanford Site. Should for any reason a decision be made that McGee Ranch will not be used as a source for cover materials at 2101-M Pond, minimum design standards for the cover components are available from EPA design guidance documents. These documents (EPA 1979, 1982a, 1984a, 1985b, and 1986i) were used as a basis of information for this cover design. A listing of specific laboratory data and a schedule for obtaining such data are provided in Table II-1 and Table II-2, respectively.

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II-2a. Cover Materials Description

The use of soils native to the 2101-M Pond site and soils from the McGee Ranch site (Figure II-1) are planned for the cover. All soil components of the cover that require compaction will be compacted in maximum 6-in. lifts, ranging from 90 to 95% (or as high as reasonably achievable) of maximum density as determined by ASTM D 1557-78 [modified proctor (ASTM 1990c)]. Compaction will be accomplished using rubber-tired construction equipment, sheepsfoot rollers, or hand-operated vibratory tampers. The degree of compaction obtained will be measured periodically using ASTM D 2922-81 [nuclear density gage (ASTM 1990a)] or ASTM D 1556-82 [sand cone method (ASTM 1990b)], or their approved equivalent. Material that does not meet specifications will be recompacted and/or removed and replaced as necessary.

1. Foundation soil--In order to provide a flat, homogeneous bottom surface to the pond, the arms of the pond will have to be brought up to level with the center portion of the pond. This will be the function of the foundation soil. This fill will be compacted as described above, to provide a stable level foundation for the

Table II-1. Laboratory Testing Requirements for Cover Materials.

Cover layer	Atterburg limits	Moisture/density (compaction)	Consolidation	Water retention	Permeability	Gradation curves	pH
Foundation	X	X	X	X	X	X	
Low-permeability	X	X	X	X	X	X	
Topsoil				X	X		X

Table II-2. Schedule for Testing of Cover Materials.

Activity	Duration (months)	1	2	3	4	5	6	7	8	9	10	11	12
Identify soil property testing laboratory		XXXXXXXX											
Identify potential material sources		XXXX											
Field sampling (quality and quantity)				XXXXXXXXXXXX									
Obtain laboratory samples						XXXXXXXX							
Perform laboratory test						XXXXXXXXXXXXXXXX							
Modify design based on laboratory tests									XXXXXXXX				

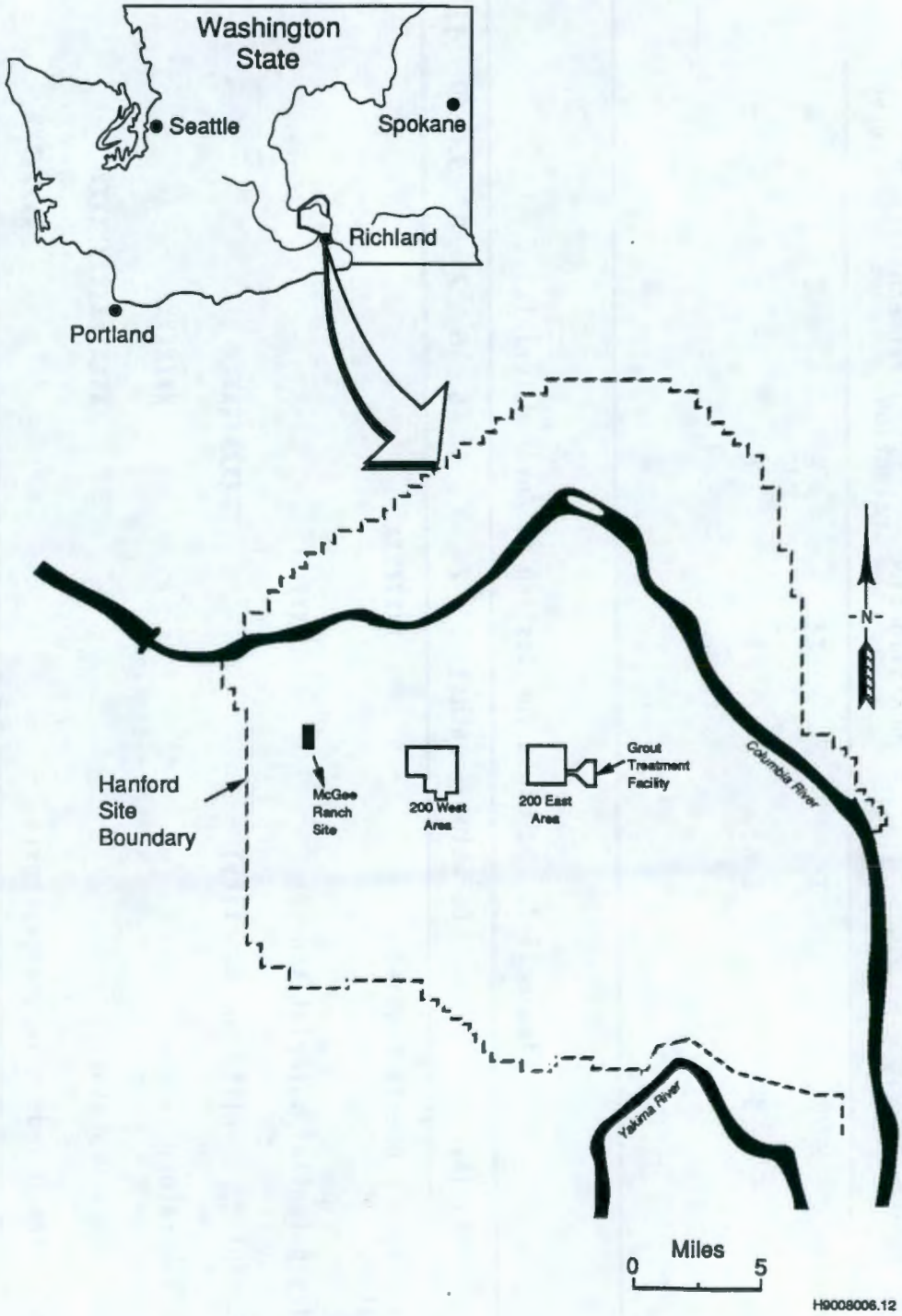

Figure II-1. Location Map, McGee Ranch Site.

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remainder of the cover. A native sandy or silty sand will be selected for the foundation soil. The most likely source for this material is the berms located along the north and south arms of the pond (Figures II-2 and II-3). This material was originally removed from the site in the development of the pond itself.

The soil will be classified and moisture/density relationships (compaction curves) will be developed for preparation of construction specifications and field construction procedures. Along with this, the upper 6 to 12 in. of the center section of the pond will be removed, mixed with the soil from the berms, and then used as the final layer(s) of the foundation soil (Figure II-4). Lifts will be placed until an unbroken, flat, smooth, level surface of a minimum 6-in. thickness is obtained. No standard for soil permeability is assigned to this layer, though it is assumed that it will be consistent with, or less than, that of the native soil on the site. It is estimated that it will take a minimum of 10 lifts to bring the entire foundation layer to a level grade. If any excess soil from the berms remains after the foundation layer is complete, it will be placed in an approved spoils area in the vicinity of the 2101-M Pond. The estimated volume of foundation fill required is 1,600 yd^3.

2. Low-permeability soil--The function of the low-permeability soil is to minimize the long-term infiltration of water by acting primarily as a capillary barrier. This barrier is caused by the abrupt transition from the fine-textured silt to the coarser textured sand. The break causes an effect similar in nature to a perched water table because the soil moisture at the lower boundary of the silt layer must reach nearly atmospheric pressure before it will move into the sand (Richards 1950).

   This layer also will store water for evapotranspiration back to the atmosphere. The low-permeability soil will most likely consist of a silt-to-silt-loam soil.

   This layer will be installed in a maximum of 6-in. lifts and compacted to the density standards and test methods identified above. Enough lifts will be placed so that a level, compacted thickness of at least 12 in. is achieved . This layer will have an estimated hydraulic conductivity of 3×10^{-7} cm/s. The estimated volume of this material is 850 yd^3.

3. Topsoil layer--The topsoil primarily must provide an adequate environment for plant growth. In doing so, it will be effective in retaining precipitation for evaporation and transpiration back to the atmosphere. Secondly, the topsoil must be adequately resistant to water and wind erosion.

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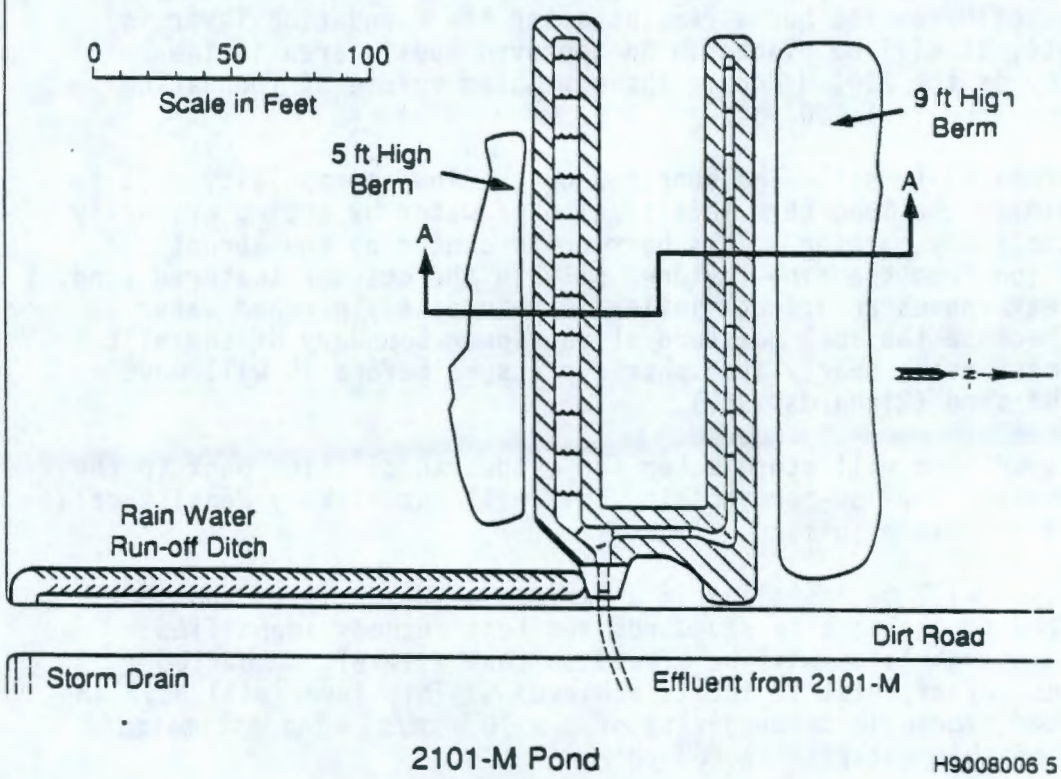
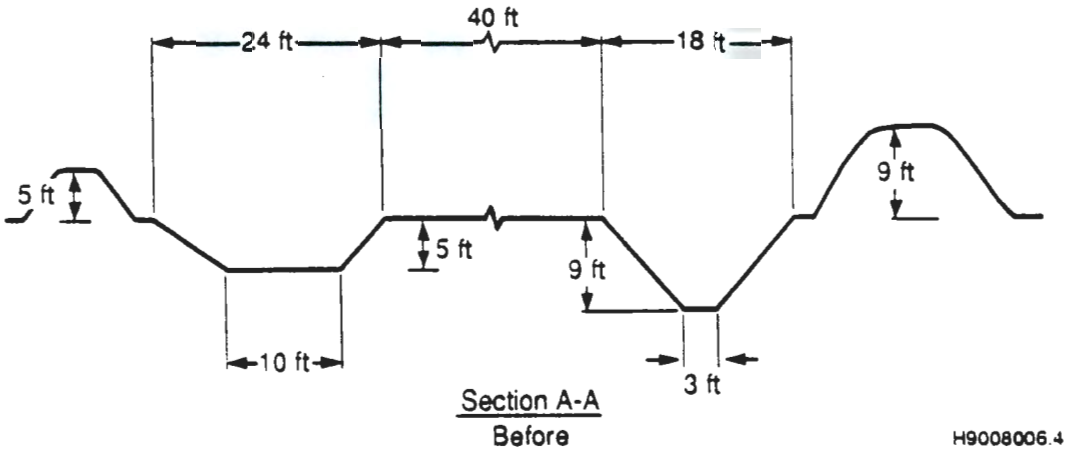


Figure II-2. Schematic Aerial of 2101-M Pond.



1 Figure II-3. Cross-Section A-A.

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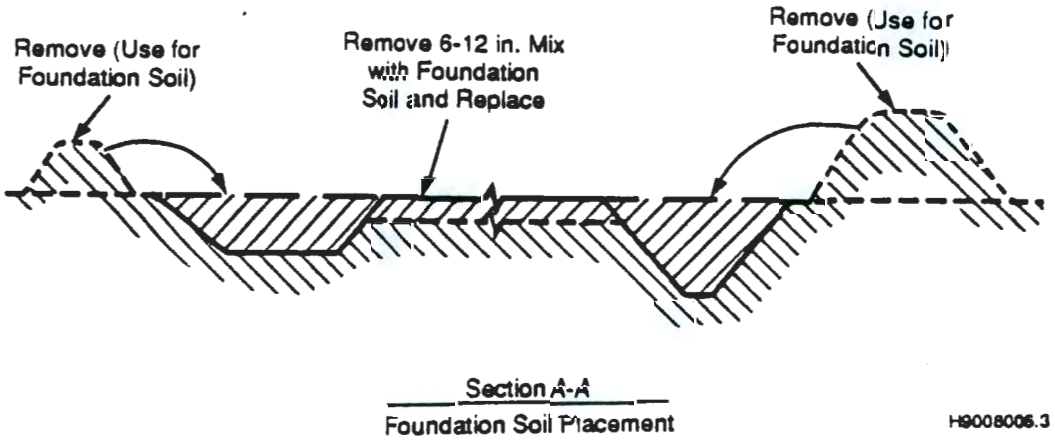

2 Figure II-4. Cross-Section A-A, Foundation Soil Placement.

The topsoil borrow area will be most likely the same as the low-permeability layer. Characteristics for McGee Ranch silt have been determined (Table II-3), and used as a basis for input to the HELP model, Version 2. The HELP model results are discussed in Appendix B-5. An estimated 1,700 yd^3 of topsoil are required. Fertilizers and herbicides may need to be applied to the topsoil to help establish the desired vegetative cover. Calculations for water and wind erosion are provided in Appendix B-5. As stated, the topsoil most likely will consist of the same material as the low-permeability layer. The only difference between the two layers will be in the degree of compaction. The topsoil layer will be placed in a 6-in. lifts to a minimum depth of 24 in. with minimal compaction to allow for the establishment of the vegetative cover.

4. Vegetative cover--The vegetative cover plays a significant role in the overall cover function and has two primary functions. First, the vegetation acts to transpire water that has been stored in the topsoil back to the atmosphere. Second, the vegetation helps to reduce the erosion caused by wind and water. A thickspike wheatgrass (Agropyron dasytachyum) and a Siberian wheatgrass (Agropyron sibericum), Indian Ricegrass (Oryzhopsis hymenoides), Bottlebrush squireltail (Sitanion hystrix), Sheep fescue (Festuca ovina), arid tolerant bluegrass species (Poa), and perennial Rye species (Secale) will be seeded into the topsoil. The topsoil should be laid with care taken to prevent compaction (i.e., <.79 oz/in^3 dry density), but with enough compaction to provide and adequate seedbed preparation (i.e., >7.68 oz/in^3 dry density). Thickspike wheatgrass is a rhizomatous native grass of the Pasco Basin and is well-suited for wind erosion control on deep sandy soils (Brown and Wiesner 1984). Siberian wheatgrass is the most abundant of the perennial grasses seeded on Hanford Site waste burial grounds and may limit cheatgrass competitively where seeded. On blowout areas where other grass species do not germinate or succeed, it will be necessary to reseed with a species hardy to dune sand areas such as Indian Ricegrass (Oryzhopsis hymenoides) or Bottlebrush squirreltail (Sitanion hystrix).

It has been shown that effectively timed herbicide control of Russian thistle (Salsola kali) is crucial to a successful establishment of any perennial grass species on the Hanford Site. All perennial grasses should be planted in the fall with proper seedbed preparation. A pea gravel mulch or veneer, or an alfalfa grass hay mulch, will help increase soil moisture, tilth, and fertility. If, because of scheduling, the cover construction requires a spring planting, an annual cereal grain (such as winter wheat or barley) is recommended to quickly stabilize the cover followed by planting of the perennial wheatgrasses the following fall.

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Table II-3. Preliminary Information on Moisture/Density Relations and Hydraulic Conductivity for McGee Ranch Soil[a]. (sheet 1 of 2)

In-Place Density	No. Tests	Range	Mean
Moist density (corresponding unit weight)	3	1.38 - 1.39 g/cm^3 (86.1 - 86.7 lb/ft^3)	1.38 g/cm^3 (86.3 lb/ft^3)
Moisture content	3	6.2 - 7.4%	7.0%
Dry density (corresponding unit weight)	3	1.28 - 1.30 g/cm^3 (79.8 - 81.1 lb/ft^3)	1.29 g/cm^3 (80.7 lb/ft^3)
Porosity	3	0.512 - 0.517	0.514
Compacted Density (25-Blow Proctor Test) ASTM D698-78	**No. Tests**	**Range**	**Mean**
Maximum density (moist) (corresponding unit weight)	3	1.99 - 2.05 g/cm^3 (124.1 - 127.9 lb/ft^3)	2.03 g/cm^3 (126.6 lb/ft^3)
Moisture content at maximum density	3	16.0 - 17.9%	16.9%
Maximum density (dry) (corresponding unit weight)	3	1.74 - 1.77 g/cm^3 (108.5 - 110.4 lb/ft^3)	1.75 g/cm^3 (109.4 lb/ft^3)
Porosity	3	0.340 - 0.355	0.347
Hydraulic conductivity	1	--	3.0 x 10^{-7} cm/s
Compacted Density (15-Blow Proctor Test) Modified ASTM D698-78			
Maximum density (moist) (corresponding unit weight)	3	2.03 - 2.05 g/cm^3 (126.6 - 127.9 lb/ft^3)	2.04 g/cm^3 (127.0 lb/ft^3)
Moisture content at maximum density	3	16.8 - 17.8%	17.3%

Table II-3. Preliminary Information on Moisture/Density Relations and Hydraulic Conductivity for McGee Ranch Soil[a]. (sheet 2 of 2)

Compacted Density (cont) (15-Blow Proctor Test) Modified ASTM D698-78	No. Tests	Range	Mean
Maximum density (dry) (corresponding unit weight)	3	1.73 - 1.74 g/cm^3 (107.9 - 108.5 lb/ft^3)	1.74 g/cm^3 (108.3 lb/ft^3)
Porosity	3	0.346 - 0.349	0.347
Hydraulic conductivity	1	--	1.3×10^{-6} cm/s
Compacted Density (5-Blow Proctor Test) Modified ASTM D698-78	**No. Tests**	**Range**	**Mean**
Maximum density (moist) (corresponding unit weight)	3	2.00 - 2.04 g/cm^3 (124.7 - 127.2 lb/ft^3)	2.01 g/cm^3 (125.6 lb/ft^3)
Moisture content at maximum density	3	18.7 - 19.9%	19.4%
Maximum density (dry) (corresponding unit weight)	3	1.67 - 1.70 g/cm^3 (104.2 - 106.0 lb/ft^3)	1.69 g/cm^3 (105.2 lb/ft^3)
Porosity	3	0.359 - 0.373	0.366
Hydraulic conductivity	1	--	1.6×10^{-6} cm/s

NOTES:
g/cm^3 = grams per cubic centimeters
lb/ft^3 = pounds per cubic foot
cm/s = centimeters per second.
[a]Specific gravity of solids (G_s) for all determinations is 2.66.

With the completion of the placement of these four components, an engineered cover, which will allow for the storage of water to be used for evapotranspiration purposes, will be in place. Figures II-5 and II-6 show a cross section of the final cover and a plan view of the finished cover.

II-2b. Construction Quality Assurance Plan Outline

A construction QA plan will be prepared that will address in sufficient detail activities that pertain to the areas outlined below. This plan will provide verification that the cover will conform to or exceed the design specifications. The construction QA plan cannot be prepared until specific construction materials data are known. This plan will provide documentation that field data, obtained during construction, meets the design specifications. The construction QA plan will incorporate, by reference, those Westinghouse Hanford procedures pertinent to the construction QA plan, and address the following areas as a minimum:

- Responsibility and authority of the organizations and key personnel involved with implementation of the construction QA plan

- Personnel qualifications and documentation of training and experience related to respective responsibilities

- Monitoring activities listed in detail, including observations and tests conducted to ensure the quality of each installed component

- Sampling requirements, including a description of sampling and testing activities to determine the quality of materials installed during construction. These include the following:

  - Types of sampling activities
  - Types of samples
  - Number and location of samples
  - Frequency of testing
  - Data evaluation procedures
  - Acceptance and rejection criteria
  - Corrective action plans
  - Handling of testing errors

- A description of procedures to document construction QA activities. Documentation must include the following items as a minimum:

  - Daily summary reports
  - Monitoring data sheets
  - Change orders
  - Meeting memoranda
  - Photographs

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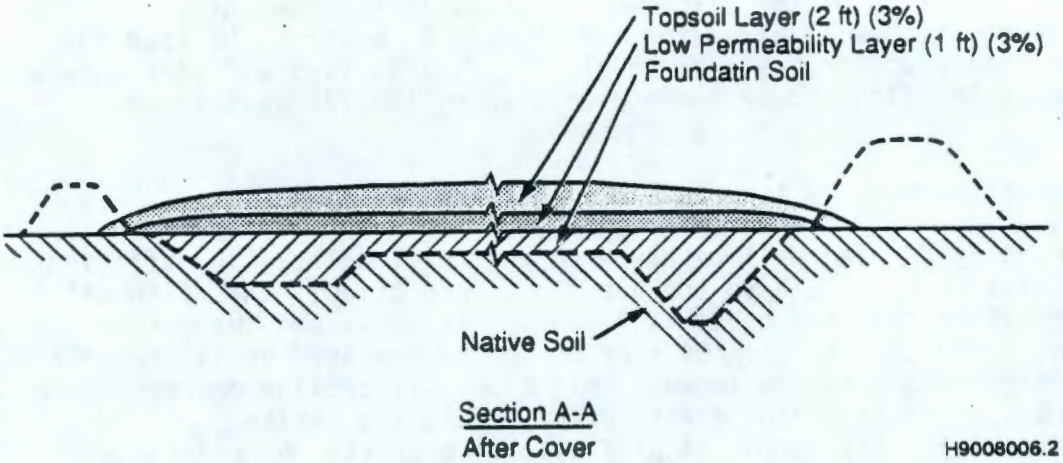

Figure II-5. Cross-Section A-A, Cover.

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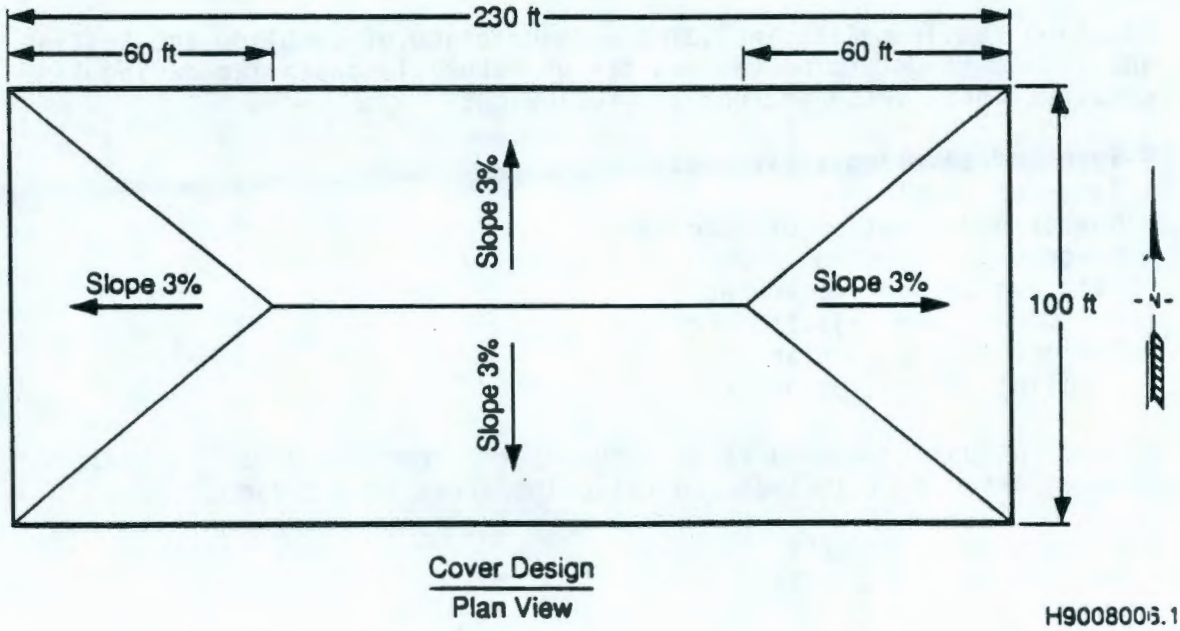

Figure II-6. 2101-M Pond Cover Plan View.

- Problem identification and reports on corrective measures
- Design acceptance reports
- Final documentation including record drawings

- The construction QA plan must address all the following cover components:

  - Foundation soil
  - Low-permeability soil
  - Topsoil
  - Vegetative cover

- Some elements of consideration for the cover components include the following:

  - Method of compaction
  - Storing and handling of materials
  - Adverse weather
  - Improper materials and techniques.

II-3. POSTCLOSURE CONSIDERATIONS

The following sections summarize the postclosure criteria to be considered when designing a cover.

II-3a. Maintenance Needs

As required by WAC-173-303, this section describes how maintenance during the postclosure care period will be minimized by the design and construction of the final cover.

Stabilization projects conducted at the Hanford Site since 1978 have shown that very little site maintenance is required following the successful establishment of a vegetative cover. Of primary concern during the postclosure period will be repair of any damage to the cover because of erosion. In addition, periodic maintenance of the vegetative cover and the groundwater monitoring wells and pumps will be necessary during the postclosure period.

Erosion damage to the cover may occur as a result of precipitation or wind. The potential for sheet erosion will be offset by the use of low slope angles, short slope lengths, and a vegetative cover. The potential for erosion from wind will be offset by mulching practices and the establishment of a perennial grass cover.

Successful establishment of a hearty vegetative cover on the Hanford Site may require from 2 to 5 yr. During this establishment period, a mulch applied for initial stabilization and the natural emergence of cheatgrass (Bromus tectorum) combine to protect the soil from erosion by wind. Periodic observations by trained personnel will be made to evaluate seedling progress

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and to recommend necessary corrective actions. Spot applications of herbicides may be used in the spring to selectively control annual broadleaf species that compete for available moisture and nutrients. Herbicide applications will end following successful perennial grass establishment. Fertilizer applications after closure may be needed to stimulate plant vigor during the second or third year. Deep-rooting plants such as sagebrush, with root systems extending into the vadose zone, are common to the region. Manual removal of such vegetation starting on the cover will be required during the postclosure period.

Slopes created by the installation of the cover during closure and the channeling of run-off water may lead to localized increases in erosion. Although run-off damage is expected to be minimal, regular inspections of areas that could be subject to erosion will be necessary. Should there be any major erosion damage, repairs will be made using grading equipment and fill soils.

Settlement and displacement are not expected to be problems at the 2101-M Pond. Careful placement and compaction of the soil during construction will greatly reduce settlement. Differential settlement is not expected, and only a very small and insignificant amount of uniform compression and consolidation is expected to occur over time. Refer to Section II-3c(1) for further discussion.

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II-3b. Erosion and Abrasion

The 2101-M Pond cover design has been evaluated for erosion because of water and wind. The erosion rates for water and wind erosion are calculated using the Universal Soil Loss Equation (USLE) and the Wind Erosion Equation (WEQ), respectively. Using the conservative erosion estimates, the erosion rate for the 2101-M Pond cover is 1.59 tons/acre/yr. This is the erosion rate that would be expected for the first few years of the cover's life, assuming that poor vegetative conditions exist and mulching practices do not remain effective beyond 1 yr. Detailed calculations for erosion potential are provided in Appendix B-5.

II-3c. Settlement and Displacement

This section addresses technical accommodations for any potential settling or displacement of the facility's engineered cover. Settlement or displacement are not anticipated to be problems at the 2101-M Pond. Accurate characterization of existing subgrade conditions and of both soil and cover engineering properties are necessary to adequately predict settlement.

II-3c(1). Consolidation-Related Settlement. There are two types of consolidation in soils; primary and secondary. Primary consolidation is the expulsion of pore fluids under excessive hydrostatic pore pressure. Secondary consolidation is the long-term deformation of the skeleton of the soil mass

and compression of gases in the voids. Minimal foundation compression is anticipated because the loads that will be imposed by the cover materials or surface activities will be insignificant at 2101-M Pond.

Consolidation of the low-permeability soil layer also is assumed to be insignificant for the same reasons. Laboratory analysis of consolidation potential of the low-permeability soil are expected to verify this assumption. Secondary consolidation takes place slowly over time and is generally insignificant when compared to primary consolidation. Secondary consolidation is not specifically significant for the types of soils underlying the site or for the proposed cover construction materials.

No waste has been buried in containers or by any other method below the 2101-M Pond. Therefore, consolidation and compression cannot occur because of dewatering of waste. Because the Hanford Site is located in an arid-steppe environment, sand dominates the near-surface soil profile. The potential for biological oxidation occurring in this soil cover is insufficient to cause consolidation or compression of the cover.

II-3c(2). Cavity-Related Settlement. Cavities are large voids within a soil or rock mass that cause settlement at the ground surface (EPA 1985b). Cavity-related settlement has been documented as related to mining, natural karstic (solution cavity) areas, and landfills. Mining has not occurred near the 2101-M Pond. A review of the subsurface strata indicates that no water-soluble rock (such as limestone) exists beneath the 2101-M Pond. Cavity-related settlement in landfills is caused by waste consolidation, decomposition of organic waste, and collapse into cavities created by random dumping of waste. These settlement features have been documented to lead to cracks in cover surfaces, collapse of portions of the cover, and ponding of water in depressions in the cap caused by settlement of portions of the cover. The potential for any of these occurrences does not exist at the 2101-M Pond site.

II-3c(3). Embankment-Related Displacement. Embankments generally fail because of inadequate strength of soils of either the embankment materials, the foundation materials, or both. Also, seepage, inadequate drainage, freeze/thaw, and dry and soak phenomena affect slope stability.

II-3c(3.1). Freeze/Thaw Displacement. Freeze/thaw phenomena will not cause stability problems for the cover. Subsurface soil temperatures have been recorded at the HMS since 1952. The lowest temperature recorded at 36-in. below the surface was 32 °F, which occurred once over the monitoring period (Stone et al. 1983). Therefore, the zone of frost penetration does not exceed 3 ft below grade. Therefore, the top 3 ft of the cover design can be assumed to be potentially affected by freeze/thaw and dry and soak cycles.

Freeze/thaw cycling affects on the cover also have been considered in the 2101-M Pond design. The maximum frost penetration depth, as stated previously, is 3 ft below grade. The average number of annual freeze/thaw cycles is 93 with a range of 25 to 168 d (Stone et al. 1983). A freeze/thaw cycle is defined as a day in which the minimum temperature is below freezing and the maximum temperature is above freezing.

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The water table is approximately 315 ft below grade. This depth, coupled with the subsurface soils of the Hanford formation, indicates that capillary rise from the water table to the cover will not occur.

A small level of ice lens formation could occur in the silty topsoil component. However, the only water available for such ice lens formation is that stored in the silty soil matrix of the cover. The interface between the native soils and the silty soils acts as a capillary break, thus preventing the upward movement of water. In summary, considerations of freeze/thaw cycling effects on the cover have been evaluated, and have been determined to not be a concern.

II-3c(3.2). Dry and Soak Effects. A dry and soak cycle is not considered to be of concern for this environment. Examination of the HELP mode simulation of water movement in the cover design indicates the wetting front will not extend into the subcover soils (Appendix B-5). The arid climate of the region, a relatively cohesionless, high water-holding capacity soil, along with the establishment of a vegetative cover eliminate the need for concern in this area.

II-3c(3.3). Strength, Angle of Internal Friction, and Friction Angles. Because the cover design calls for a maximum slope angle of 3%, the slopes will be very stable. Therefore, the determination of these properties is unnecessary.

II-3c(3.4). Liquefaction. Liquefaction is a term used to identify the shear failure of cohesionless soils, generally caused by minute increases in neutral stress over a period of time, generated by repeated small loadings. However, conditions can occur quickly under no increased load if loose sands are impacted by shock waves. Because only the native soils are sandy, liquefaction of the cover is not considered to be a concern for this design.

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II-3d. Additional Data Needs

A schedule is provided in Table II-2 that indicates the specific tasks and time elements required to determine cover material data needs. This includes identification of cover materials in the field and laboratory testing of engineering properties. The subsurface soils at the 2101-M Pond can be tested in the laboratory at the same time that the other cover materials engineering properties are determined.

II-3e. Cover Permeability

In accordance with WAC 173-303-665(6)(a)(v), the cover system must provide hydraulic conductivity less than or equal to that of the natural subsoils.

The intent of WAC-173-303 regulation is to control the rate of infiltration through the cover such that it does not exceed the water-removal capacity of an engineered cover. The purpose of the low-permeability layer of

the preliminary cover design is to allow for the development of a zone that will hold a significant amount of water for long periods of time. This zone, or layer, will hold the water and make it available for use by surface vegetation and evaporation. In this way, water is kept away from any potentially contaminated zones so that leaching to the groundwater does not occur.

The subsurface soils of the 2101-M Pond site were identified during monitoring of the well drilling operations as part of the Hanford formation. To depths of 210 to 230 ft, the soil consists of 90% or greater sand. Below this depth to approximately 310 ft, is a sandy gravel, and below this depth are the water table and unconsolidated, silty-sandy gravels. These soils have permeability ranges from 1.1×10^{-2} to 3.5×10^{-5} cm/s (Chamness et. al. 1990).

The permeability of the cover system is controlled by the topsoil, and low-permeability components of the cover. Both layers consist of a silt-to-silt-loam soil. These design layers retain water for evapotranspiration to the environment. Beneath these, lies the native soil described above. Water retention in the low-permeability layer is a function of the soil texture and structure, or arrangement of the particles. The pressure head at the soil layer interface must exceed the matrix potential of the soil before any movement of water from the smaller, tighter soil can move into the looser, less dense soil beneath it. Therefore, the interface between soil layers acts as the barrier to downward migration of water because the water, which has infiltrated the fine-textured topsoil, cannot penetrate into the coarser, textured sand layer until sufficient pressure builds at the interface. Therefore, before outflow of free water from a soil can occur, the pressure in the soil must exceed atmospheric pressure (Richards 1950).

The cover provides a hydraulic conductivity much lower than the subsurface soils at the 2101-M Pond. Estimates of water percolation through the cover are provided in Appendix B-5. The HELP model data indicates that the estimated average annual drainage through the bottom of the cover is 37 ft^3 or 0.22% of the average annual precipitation. Therefore, the 2101-M Pond cover design provides a cover system hydraulic conductivity that meets the intent of the WAC-173-303 regulations.

II-4. POSTCLOSURE REQUIREMENTS

The sections have been subdivided into the following six postclosure requirements as follows:

- Postclosure Plan
- Personnel Training
- Procedures to prevent hazards
- Postclosure contact

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- Amendment of the postclosure plan

- Certification of the postclosure care.

For purposes of postclosure planning, it is assumed that the 2101-M Pond will be closed as a landfill with a final cover.

II-4a. Postclosure Plan

Postclosure care of the 2101-M Pond will continue until Ecology stipulates otherwise; however, for planning purposes, a minimum of 30 yr is envisioned. The 30-yr time frame is used throughout this plan to acknowledge the long-term commitment of the postclosure requirements. This section provides details of the postclosure plan and is subdivided into the following three parts:

- Inspection plan, Section II.2.B

- Groundwater monitoring plan, Section II.2.C

- Maintenance plan, Section II.2.C in accordance with 40 CFR 265.117 through 265.120 and 265.310(b).

II-4a(1). Inspection Plan. In accordance with 40 CFR 265.310(b), the inspection plan provides details concerning the necessary security equipment; the inspection of erosion and other factors that might affect the cover integrity; and the inspection of well condition, and benchmark integrity. A logbook will be kept by the personnel conducting the inspections and maintained for examination by the regulatory agency for the entire 30-yr period of postclosure monitoring. The inspector will record (at a minimum) the date, name of person(s) performing the inspection, basic overall condition of the cover (e.g., condition of vegetation, condition of soil surface), condition of monitoring wells, condition of security control measures, any damage to the cover and/or other maintenance needs, as well as the weather conditions and time of day at the time of inspection. The logbook will then be signed, dated, and witnessed.

Maintenance actions, as noted by the inspector in the logbook, will be started and completed within 90 d so that the next logbook entry can document the correction of the problem. Table II-4 depicts the inspection items and frequencies schedule for the postclosure care period.

II-4a(1.1). Security Control Devices. The 2101-M Pond is located within the 200 East Area of the Hanford Site, which is completely fenced. Roadways are restricted to authorized personnel and, for national security reasons, the general public is excluded.

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Table II-4. Minimum Inspection Schedule for the 2101-M Pond.

	Inspection frequency		
	Monthly	Quarterly	Annually
Security control devices		X	
Erosion damage		X	
Cover settlement and displacement		X	
Condition of vegetative cover	X (2 yr)	X	
Well condition and purge water collection system		X	
Benchmark integrity			X

II-4a(1.2). Erosion Damage. The overall erosion control for the 2101-M Pond site will be dictated by the health of the vegetative cover and the slope of the cover. Inspection of the cover will consist of walking over the site to visually check for erosion damage. The inspection is scheduled to observe the site and vegetative cover during different seasonal conditions. Erosion damage for area will be addressed in two areas: precipitation and wind as follows.

- Precipitation--The Hanford Site climate is mild and dry, best described as semiarid. The Hanford Site receives an average of 6.3 in. of annual precipitation. Because of the semiarid climate, much of the annual precipitation is lost to evapotranspiration. The 2101-M Pond area is relatively flat (less than 10 ft vertical to 1,000 ft horizontal). The combination of low annual precipitation, high evapotranspiration rates, relatively flat topography, low cover slopes angle (3%), and a stable vegetative cover reduces the possible damage from precipitation. However, the integrity of the final cover will be inspected to assess any possible damage. The condition of the cover will be noted in the logbook. Any damage observed will be written into the inspection logbook, along with the name of the inspector, time and date, the type of damage noted, the extent of the damage, and any other important information. An inspection also will be scheduled as shortly as possible after any storm event that exceeds a 10-yr, 24-h return cycle for the HMS. This inspection will constitute one of the regularly scheduled inspections if all other quarterly inspection items have been met, and the inspection falls within 30 d before the next regularly scheduled inspection.

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- Wind--The monthly average wind speeds for the Hanford Site range from about 6 mph in the winter to 8 mph in the summer. The prevailing regional winds are from the northwest (Figure II-7). In the spring, early summer, and late fall, the local plant community helps control wind erosion. When the plant communities begin to dry out in late summer, the probability of wind erosion remains low because winds usually tend to decrease during this period. However, the integrity of the final cover will be inspected to assess any possible damage. Any damage observed will be written into the inspection logbook, along with the name of the inspector, time and date, the type of damage noted, the extent of the damage, and any other important information. Also, an inspection will be scheduled as shortly as possible after any unusual wind event (i.e., 24-h time periods where the average wind speed equals or exceeds 15 mph). This inspection will constitute one of the regularly scheduled inspections if all other quarterly inspection items have been met, and the inspection falls within 30 d before the next regularly scheduled inspection.

Erosion damage that results in the accumulated loss of 2 tons/acre/yr (or more) of soil over the surface of the cover will be reported to Ecology within 30 d of observation. After evaluation, maintenance action may include replacement of the fine topsoil layer in the affected area(s), reseeding, and other tasks performed during closure, such as the application of fertilizers to ensure a vigorous vegetative growth. Any maintenance and/or repair activities will be concluded within 90 d of noting the problem in a field logbook.

II-4a(1.3). Cover Settlement and Displacement. The 2101-M Pond cover will be inspected for settlement and displacement by walking over the site. Settlement and displacement are synonymous terms for any surface breach or depressions in the final cover's exterior. Any such breaches or depressions will require an investigation to determine the cause, evaluate the long-term environmental impacts, and provide a corrective solution. The quarterly survey is scheduled to observe the site during different seasonal conditions. The inspection will follow the same logbook procedures as outlined for erosion damage.

Settlement greater than 6-in. in any area will be reported to the regulatory agency within 30 d of observation. Before maintenance activities begin, an investigation into the cause of the problem will take place so that the appropriate maintenance action can be selected. After reestablishment of cover integrity, the vegetative cover will be reestablished as needed.

II-4a(1.4). Vegetative Cover Condition. The 2101-M vegetative cover will be inspected monthly during the growing season until the vegetative cover is established (approximately 2 to 3 yr), noting plant germination success, germination density, winter damage, and plant density during the plant growing cycle. After the vegetative cover is established, a quarterly inspection

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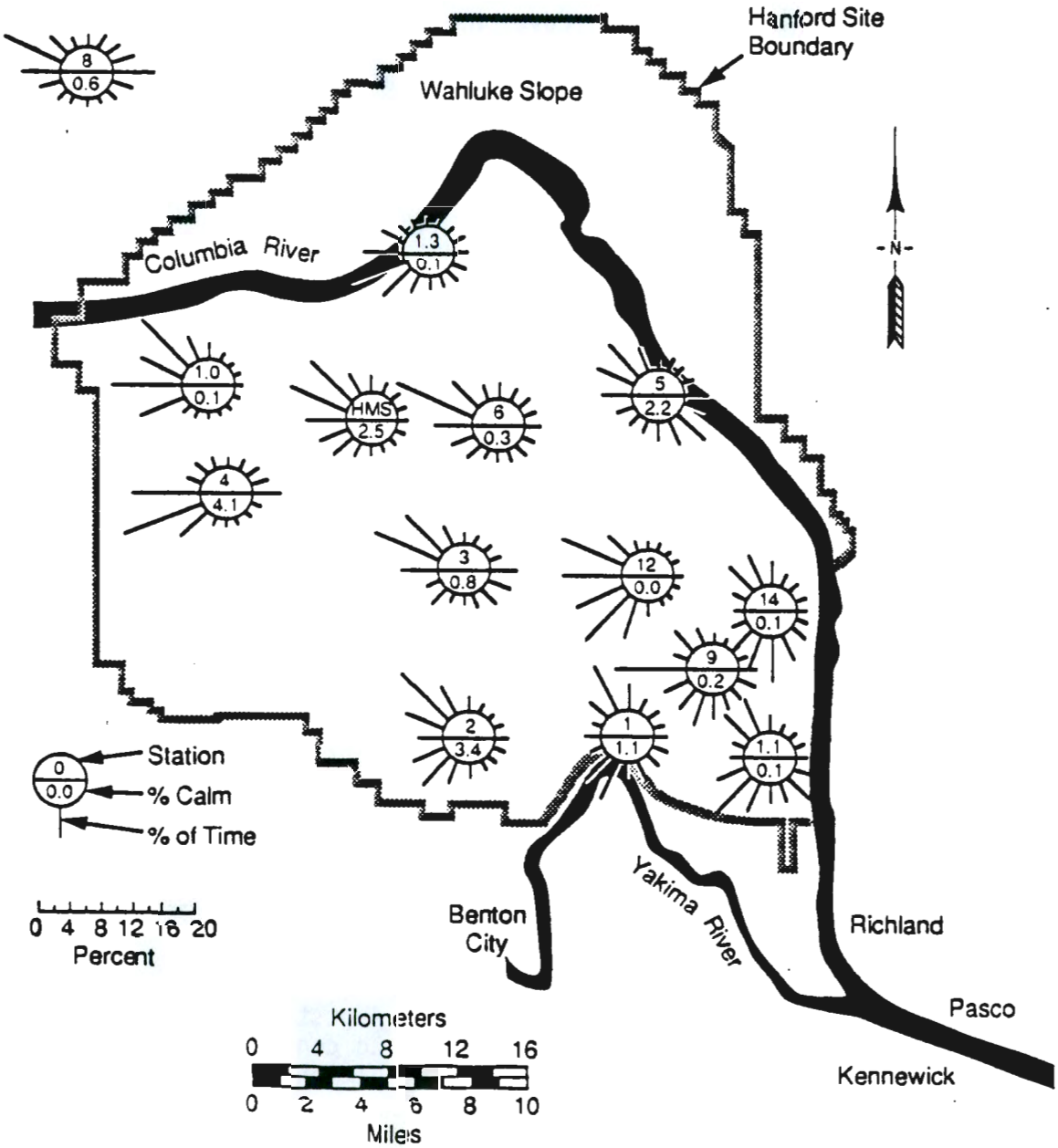

Figure II-7. Wind Rose Telemetry Network.

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during the calendar year will be performed. The condition of the plant cover will be noted in the logbook with additional estimates of percent cover, distribution cover, stand height, stand vigor, as applicable during the calendar year. The vegetative cover is an important factor to the long-term stability of the site.

If after two years vegetative cover has observable soil loss, blowouts, and/or empty spots (>1.8 yd^2) devoid of plant material or plant litter, spot treatment with a gravel veneer or surface sealant should be applied until the next planting season when a hardy perennial grass species will be planted (i.e., Indian Ricegrass (Oryzhopsis hymenoides). These blowouts will be treated at planting time in a similar fashion as a field requiring initial seeding. All broadleaf herbicide applications will be applied in a manner consistent with the herbicide labeling requirements. Additional vegetation technologies that come into mainstream practice within the Soil Conservation Service or the mining industry should be encouraged along with additional field trials to determine new perennial grass species.

II-4a(1.5). Benchmark Integrity. Inspection (surveying) of benchmarks will be performed on a yearly basis. When surveyors do any work on the Hanford Site, the standard practice is to use two or more benchmarks to cross-check the integrity of measurements. Benchmarks observed to be damaged or out of alignment will initiate maintenance action. Maintenance action will include replacement of damaged benchmarks and/or resurveying of benchmarks found to be out of alignment.

II-4b. Postclosure Groundwater Monitoring Plan for 2101-M Pond

Three levels of groundwater monitoring are defined in WAC 173-303-645(9)(a) regulations and are summarized in Figure II-8: (1) detection monitoring is used before any signs of contamination are detected; (2) compliance monitoring is used after contamination has been detected, but before quality standards have been violated; and (3) corrective action monitoring is used when groundwater contamination exceeds acceptable limits and while a corrective action program is underway to treat the contamination. Only a final-status detection level monitoring program will be described in this plan.

The 2101-M Pond has been in an interim-status detection level groundwater monitoring program (40 CFR 265 Subpart F) since August 1988. The purpose of the following groundwater monitoring program is to continue the basic elements of the interim status (40 CFR 265 Subpart F) detection level groundwater monitoring program (Chamness et al. 1989) and to incorporate the additional requirements of "Final Status Groundwater Protection Standards" (WAC 173-303-645) in the event the strategy of clean closure cannot be achieved. The objective of the program is to detect the presence of statistically significant levels of dangerous constituents in the groundwater beneath the 2101-M Pond that can be attributed to discharges to 2101-M Pond.

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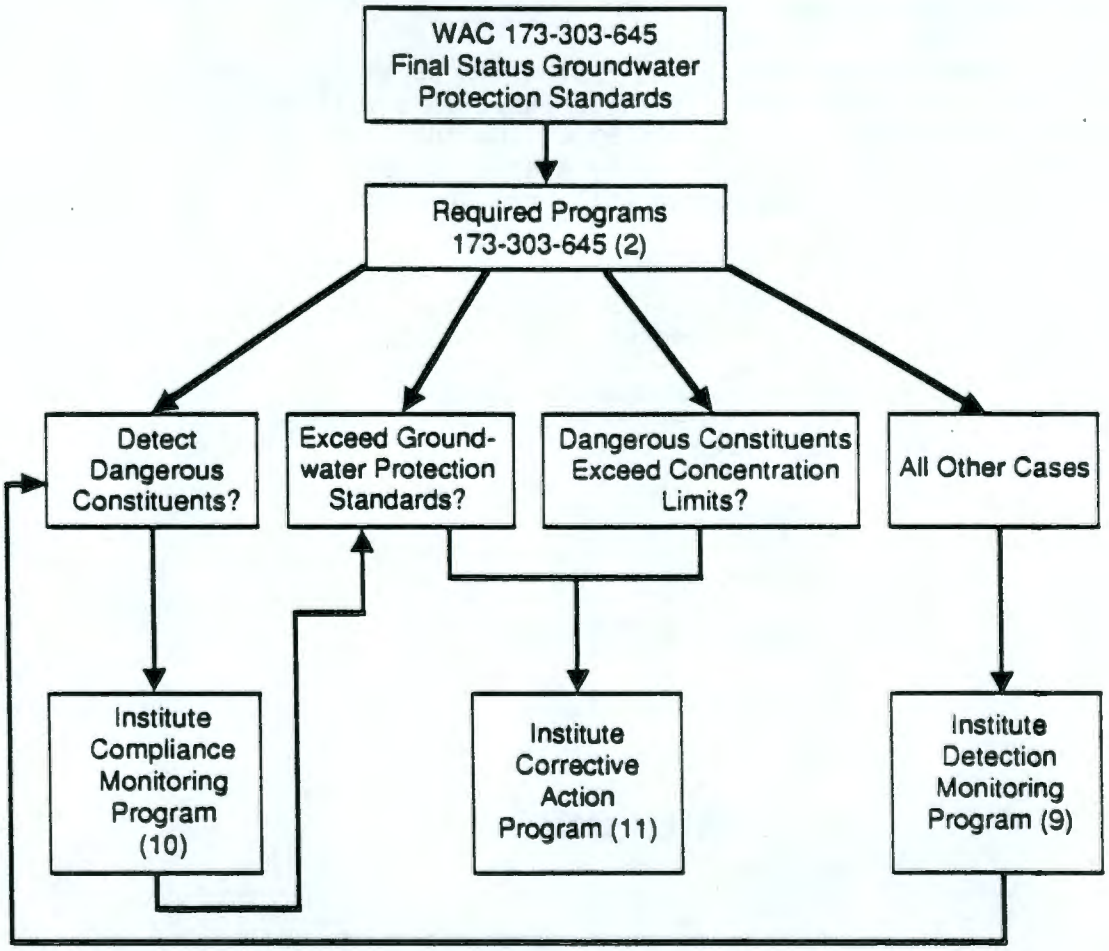

Facility Permit Specifies 173-303-645 (2) (b):

- Specific elements of the monitoring and response program
- Will identify which program will be necessary
  - detection
  - compliance
  - corrective action
- Specific circumstances to implement the above programs

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Figure II-8. Final Status Groundwater Protection Standards.

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II-4b(1). Monitoring System. The existing monitoring well network will include the postclosure monitoring network (WAC 173-303-645(9)(b)). The well configuration allows collection of samples that represent the quality of groundwater passing the point of compliance. Wells were constructed to comply with WAC 173-303-160 and to allow collection of representative groundwater samples. This construction will prevent contamination of the samples, the sampled strata, and communication between aquifers and water-bearing strata. The Site Characterization Report (Chamness 1990) summarizes the well construction information.

II-4b(2). Groundwater Monitoring Protection Parameters and Constituents. Constituents and parameters listed in Table II-5 will be monitored on a semiannual basis (WAC 173-303-645(9)(c) and (d)). Exceeding a maximum concentration or background value by a statistically significant difference for any constituent or parameter will trigger a compliance monitoring program.

Table II-5. Constituent and Parameter Monitoring List.

Groundwater quality parameters
Chloride
Iron
Manganese
Sodium
Sulfate
<u>Indicator parameters</u>
pH
Specific conductance
TOX
TOC
<u>Site specific constituents</u>
Barium
Copper

II-4b(3). Flow Rates. The groundwater flow rate and direction will be determined annually from routine water level measurements taken each time the groundwater is sampled (WAC 173-303-645(9)(e)).

II-4b(4). Procedures. The sampling and analytical methods have been established in the <u>40 CFR 265 Interim Status Groundwater Monitoring Plan</u> (Chamness et. al 1989) (GWMP) and will be the same for the purposes of this final-status groundwater monitoring plan. All sampling activities are currently performed under contract by PNL. An analytical laboratory using EPA-approved test methods will perform sample analysis for most constituents.

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The following procedures will be used for final-status groundwater monitoring and can be found in Surface Environmental Monitoring Procedures Manual, (PNL 1990) (WAC 173-303-645(9)(f)):

- Decontamination
- Water level measurements
- Sample collection
- Sample preservation
- Sample shipment
- Analytical procedures
- Quality assurance
- Chain-of-custody control.

II-4b(5). Statistical Analysis. The purpose of this section is to determine if there has been a statistically significant increase (or in the case of pH, difference) in the mean or median values over the background populations for each constituents and parameters listed in Table II-5. Analytical data from the upgradient well (299-E18-1) will be evaluated against the downgradient compliance point data (299-E18-2, 299-E18-3, and 299-E18-4) using applicable statistical methods. Alternative methods are provided to handle data that are below the analytical detection limit(s). A flowchart depicting the process of selecting a method of analysis is presented in Figure II-9. Statistical analysis methods include analysis of variance (ANOVA), test of proportions, and other methods deemed appropriate (EPA 1989b). The methods selected are based upon knowledge of present conditions, and may be changed as new information is obtained and/or groundwater flow patterns change.

II-4b(5.1). Analysis of Variance (ANOVA). For each constituent, the data from downgradient compliance point wells and background wells will be sampled semi-annually. One-way ANOVA procedures will be used to test with a 95% level of confidence whether the compliance data are drawn from the same population as the background data. A one-point-in-time comparison between background and compliance wells will be used. The one-point-in-time comparison will help reduce the components of seasonal variation by providing for simultaneous comparisons between background well and compliance well monitoring data.

A parametric ANOVA procedure assumes that the data consist of random samples drawn from normal population(s) with a common variance. If the data are shown to be normally or log-normally distributed with a common variance, and if less than 15% of the samples from each population are below the detection limit, the nondetects will be assigned a value equal to one-half of the detection limit and parametric ANOVA will be used.

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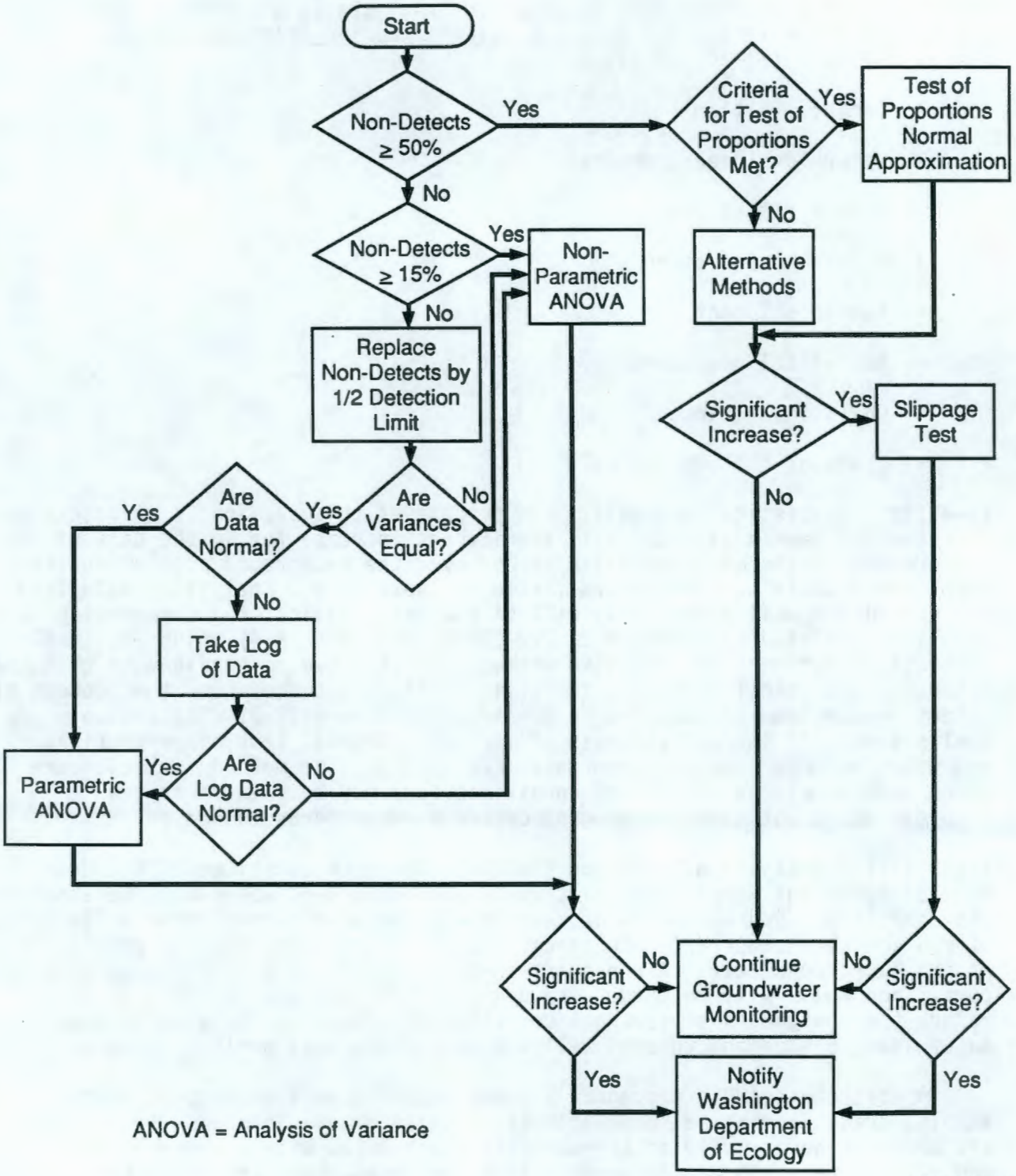

Figure II-9. Flowchart Illustrating Method of Choice of Appropriate Statistical Techniques.

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A nonparametric procedure such as Kruskal-Wallis one-way ANOVA may be used if the data do not meet the parametric ANOVA requirements or if the proportions of nondetects from each population are less than 50% but more than 15%.

If parametric or nonparametric ANOVA is significant at 5% level, multiple comparison procedures will be used to evaluate which compliance well may be contaminated (EPA 1989b).

II-4b(5.2). Test of Proportions. This procedure uses the normal distribution approximation to the binomial distribution. This assumes that the sample size is reasonably large. If more than 50% of the data are below detection limit and the conditions for applying the normal approximation to the binomial are satisfied (EPA 1989b), a test of proportions may be used to compare the background well data with the compliance well data.

If very few quantified values are found, an exact test procedure for the equality of two binomial proportions as described by Nelson (1982) may be used. Alternative methods such as tolerance limits or a quantile test (Johnson et al. 1987) or a slippage test (Rosenbaum 1954) also may be considered. These alternatives would be appropriate when the number of detected compounds is quite small relative to the number of compounds analyzed for as might occur in the detection monitoring.

The test of proportions compares the proportions of detects rather than the magnitude of the actual concentrations of the constituents of concern, and could, therefore, indicate a significant difference when the compliance well concentrations were in fact lower than the background concentrations or vice versa. To protect against such possibilities, a significant difference in proportions will not be considered as an indicator of contamination unless the maximum background concentration is exceeded by that allowed by the slippage test (Rosenbaum 1954). For purpose of the statistical analysis, the practical quantitation limit is considered to be the maximum background concentration in the case when all the background samples are nondetects.

If a statistically significant increase is detected during the analysis of the data, the following steps will be taken.

1. Ecology will be notified within 7 d of those parameters or constituents that showed a statistical increase (WAC 173-303-645(9)(h and i)).

2. The monitoring network will be sampled for WAC 173-303-9905 constituents and any permit constituents, and will continue to be sampled quarterly (WAC 173-303-645(9)(h)(ii)).

3. Background values for each Appendix IX and permit constituent will be established (WAC 173-303-645(9)(h)(iii)).

4. Statistical analysis (described above) will be performed on the data (WAC 173-303-645(9)(h)(iii)(B)).

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5. Ecology will be notified within 45 d that compliance monitoring begins and that a permit modification will be submitted. The application will include: identification at each well of each Appendix IX constituent; any proposed changes to the monitoring network; any proposed changes to the monitoring frequency; analysis procedures or methods, or statistical procedures; and a proposed concentration limit of each constituent (WAC 173-303-45(9)(h)(iv)(A - D)).

6. A plan for corrective action will be submitted within 90 d.

II-4b(6). Alternate Source. If a statistically significant increase occurs and if the contaminants can be demonstrated to be coming from another source, a permit modification application will be submitted (WAC 173-303-645(9)(i)). If it can be successfully shown that a source other than the regulated unit caused the increase, the following will occur.

- The department will be notified within 7 d that a statistically significant increase has been detected.
- A report presenting findings and a permit modification will be submitted within 45 days.
- Detection monitoring will be implemented.

II-4c. Maintenance Plan

In accordance with 40 CFR 265.310(b), this section provides a plan for maintenance of the closed facility area throughout the postclosure period. Elements of this maintenance plan include repair of security devices and erosion damage; correction of settlement and displacement; vegetative cover maintenance; and well replacement. The maintenance plan is based on observations made during the inspection and monitoring phases of the postclosure period.

II-4c(1). Repair of Security Control Devices. The 2101-M Pond is located in the 200 East Area of the Hanford Site and, thus, is inside a fenced area. Any unauthorized access will result in the immediate notification of the Hanford Site security forces. Any necessary repairs will be made upon identification of the problem and notification of the responsible maintenance organization.

Each of the 2101-M Pond groundwater monitoring wells has a locking cap to prevent well tampering. In addition, the wells are surrounded by three steel guardposts to prevent damage from vehicles. The responsible maintenance organization will be notified of any problems to the locks or guardposts and/or other problems noted during inspections and/or well monitoring activities. All necessary repairs will be made before the following inspection period and so noted in the logbook during the inspection.

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II-4c(2). Erosion Damage Repair. Erosion damage to the 2101-M Pond cover may occur as a result of precipitation or wind. There is a greater potential for erosion from wind, particularly during the period of vegetation establishment. At the time of seeding, a straw mulch of 2 tons/acre (or its equivalent) will be used to protect the cover surface. A stable vegetative cover will reduce possible damage from wind and water erosion.

Soil permeabilities and rainfall intensities at the Hanford Site are such that water-induced erosion will be very minor on the relatively flat area surrounding the 2101-M Pond. However, slopes created by the installation of the cover during closure may lead to localized increases in erosion.

Because of the low probability of serious damage caused by erosion, preventative measures beyond those already described are considered unnecessary. However, any erosion damage will be properly noted and reported to the responsible maintenance organization. Minor damage will be repaired with hand tools. Major erosion damage repairs will be initiated immediately, using (as appropriate) grading equipment and fill soils. Maintenance action for major and minor erosion damage will be initiated within 90 d of the time of discovery. Repairs will return all areas to predamaged conditions.

II-4c(3). Correction of Settlement and Displacement. Settlement and displacement are caused primarily by the deformation or compression of fill soils and voids. Careful placement and compaction of the cover during construction will greatly reduce the occurrence of settlement. Differential settlement is not expected; however, a very small and insignificant amount of uniform compression and/or consolidation will occur with time.

It is concluded (EPA 1985b) that even under worst-case conditions (i.e., deep fill, deteriorated drum waste containers, and low-stiffness waste layers), the maximum predicted postclosure landfill cover settlement because of compressibility is under 12% of the total height of the fill and cover at the center of the landfill. Conditions leading to such settlement are not expected at the 2101-M Pond. Any settlement and displacement effects revealed by the quarterly inspection will be repaired, as outlined in Section II-4a(1.2).

II-4c(4). Vegetative Cover Maintenance. Immediately after closure, the area of the 2101-M Pond will be fertilized, as necessary, and seeded to initiate growth of a vegetative cover. The area will be covered with a straw mulch (or similar, accepted method) during establishment of the grass cover to prevent erosion damage. The suggested mix for revegetation is a 2:1 perennial wheatgrass mixture consisting of Siberian wheatgrass (Agropyron sibericum) and Thickspike wheatgrass (Agropyron dasytachyum). This mix should be planted in the fall. If the area is to be revegetated in the spring, an annual such as cereal rye (Secale cereale) may be planted. The rye, acting as a standing mulch during the growth season, will protect the landfill cover from erosion damage. A spring planting of cereal rye should be followed by fall seeding with the perennial wheatgrasses and mulching with straw. Newer cultivated varieties proven to be better suited to the local climate may be substituted for the species listed above. Seeding and mulching of the area will be

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conducted according to standard field practices and procedures. Reseeding of some areas may be necessary during the 2 to 3 yr vegetative establishment period.

Each spring (generally between March 15 and April 15) for 2 to 3 yr following closure, selective herbicides may need to be applied as a pre-emergence herbicide to the closure area to minimize the establishment of broadleaf annual plants that compete with the grasses for moisture and nutrients. Herbicide application will be performed in accordance with regulations promulgated by the Toxic Substances Control Act of 1976 and the Federal Environmental Pesticide Control Act of 1972. Selective herbicide applications will be discontinued following successful establishment of the perennial grass cover. Deep-rooting plants such as sagebrush and Russian thistle, having root systems that can extend into the waste zones are common to the region. Manual removal of such vegetation may be required periodically during the postclosure period.

II-5. PERSONNEL TRAINING

This section describes the training of personnel required to maintain the 2101-M Pond in a safe and secure manner during postclosure care as required in 40 CFR 265.16 and WAC 173-303-330.

II-5a. Outline of the Training Program

This section outlines the introductory and continuing training programs necessary to conduct the postclosure activities at the 2101-M Pond in a safe manner. This section also includes a brief description on how training will be designed to meet actual job tasks as required in 40 CFR 265.16(a).

Surveillance Personnel--The following outline provides information on classroom and on-the-job training that surveillance personnel will complete before conducting independent site surveillance at the 2101-M Pond.

On-The-Job Training

- Cover inspections (water erosion, wind erosion, settlement and displacement, vegetative cover)
- Security inspections
- Location, integrity, and inspection of benchmarks
- Location, integrity, and inspection of groundwater wells.

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II-5a(1). Job Description. This section provides the job description(s) of personnel that will be conducting postclosure activities at the 2101-M Pond as required in 40 CFR 265.16(d)(1) and WAC 173-303-330(2)(a).

Site Surveillance--If the 2101-M Pond is closed as a landfill, personnel with training in the following areas will conduct the inspections:

- Control devices
- Damage
- Settlement and displacement
- Vegetative cover condition
- Benchmark integrity.

II-5a(2). Training Content, Frequency, and Techniques. The training of personnel requires the following job-specific training areas.

- Emergency Preparedness Training--Will include a review of emergency procedures that consists of listening to standard emergency signals, emergency exit routing, and job-specific emergency actions and reporting procedures.
- The RCRA Groundwater Monitoring Scope, Organization, and Quality Assurance Plan--Will include the documentation requirements included in the chain of custody to the laboratory, how to correct mistakes made on field data sheets, and any applicable manifests or shipping orders required for shipping samples to the laboratory.
- Groundwater Field Sampling Procedures--Will include pump description and operation of the three types of pumps (used by the field personnel), operational procedures for the generators and the pumps used to gather groundwater samples, and special requirements for collecting and packaging samples containing volatile organic materials that require acid preservatives or require special filtering. Training also will be given in the areas of field data record preparation and chain of custody to the laboratory.
- Site Cover Inspections--This on-the-job training program is established to ensure that the surveillance personnel know what to inspect after closure of the 2101-M Pond. It will include how to inspect for obvious signs of erosion, proper drainage, settlement, and sedimentation. In addition, personnel will be informed about what constitutes proper vegetation coverage.
- Site Security Inspections--Personnel will be instructed on how to inspect for obvious signs of a security breach. Signs may include cut fencing, unlocked gates, or cut chains.

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- Location, Integrity, and Inspection of Benchmarks--Personnel will be shown the location of benchmarks and instructed on how to report any obvious signs of destruction or deterioration.

- Location, Integrity, and Inspection of Groundwater wells--Personnel will be shown the locations of the groundwater wells and instructed on how to inspect the cap and casing of each well to ensure that it is locked.

II-5a(3). Training Director. The training director for the site surveillance personnel holds the title at Westinghouse Hanford as Manager of Safety Training. This position requires a Bachelor of Science degree in science or engineering with 10 yr of experience in the nuclear industry or related areas, and 5 yr of management experience.

The objectives of this position include providing certification, recertification, and continuing training for all Westinghouse Hanford health physics technicians (HPT) and providing general safety training for all Westinghouse Hanford personnel and other selected Hanford Site contractors, DOE-RL, and visiting personnel working on Westinghouse Hanford facilities.

II-5a(4). Training for Emergency Response. This section will demonstrate that facility personnel who will be conducting postclosure activities at the 2101-M Pond have been fully trained to respond effectively to emergencies and are familiar with emergency procedures and equipment. In addition, 40 h of hazardous waste site operation training will be provided, in accordance with 29 CFR 1910.120. Information on emergency-preparedness training also are described in Section II-5a(1) and II-5a(2).

<u>Procedures Regarding Emergency and Monitoring Equipment</u>--The procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment are covered as part of personnel training. The site surveillance personnel will undergo training in these areas. Additional information can be found in Section II-5a(1) and II-5a(2).

As part of the personnel training described in Section II-5a(2), personnel will become familiar with the audible alarms established to warn personnel of immediate emergency situations.

<u>Response to Fires</u>--The 2101-M Pond will have no existing structures and will be covered with a soil cap if it is closed as a landfill. As such, the need for fire equipment at the 2101-M Pond is virtually unnecessary. However, if personnel are at the facility when a brushfire breaks out, they will notify the Hanford Site Fire Department and the 200 East Area emergency control director by radio.

<u>Response to Groundwater Contamination</u>--A groundwater monitoring and assessment program has been in effect at the 2101-M Pond since the summer of 1988. Currently, there is a 4 well monitoring network in place at the site. At this time, groundwater contamination beneath the 2101-M Pond does not

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constitute an emergency situation, nor will it become so as a result of closure. Therefore, emergency response training in this regard is not warranted at this time.

II-5b. Implementation of Training Program

Surveillance personnel will undergo the required training programs outlined in Section II-5a as they pertain to monitoring requirements. Surveillance personnel will not be allowed to perform inspections at the 2101-M Pond until the required training programs have been completed.

II-6. PROCEDURES TO PREVENT HAZARDS

As required under 40 CFR 265.14 and WAC 173-303-310, the plan will describe procedures to prevent hazards from occurring at the closed facility. This section describes procedures to be used for ensuring proper security at the site, including surveillance measures, intrusion barrier requirements, warning signs, and waiver declarations.

II-6a. Security

Postclosure security will be maintained by routine surveillance, physical barriers, and warning signs that will remain in effect during the postclosure care period.

II-6a(1). Security Procedures and Equipment. If the 2101-M Pond is closed as a landfill, it will be covered with an engineered earthen cap. This cap will be surrounded by a fence with warning signs, in accordance with 40 CFR 265.14(b)(2)(i).

II-6a(1.1). 24-hour Surveillance System. The 2101-M Pond will not have a 24-h surveillance system. Because the closed facility will have an earthen barrier, a fence, and warning signs, it will not require 24-h surveillance.

II-6a(1.2). Barrier, Means to Control Entry, and Warning Signs. The 2101-M Pond is located within the Hanford Site 200 East Controlled Access Area where roadways are restricted to authorized personnel and cannot be accessed by the general public. In addition to site-wide controlled access, the fence will have warning signs wired to it so as to be seen from any approach. The legend will be written in English and will be legible from a distance of at least 25 ft. The legend on the signs will be:

"UNAUTHORIZED PERSONNEL KEEP OUT."

The signs also will indicate the office and telephone number to contact for site information.

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II-7. POSTCLOSURE CONTACT

The following office (or its successor) will be the official contact for the 2101-M Pond during the postclosure care period:

Office of Environmental Assurance,
Permits, and Policy
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352
(509) 376-5441

II-8. AMENDMENT OF POSTCLOSURE PLAN

This postclosure plan will be amended whenever changes in operating plans or facility design affect the postclosure plan. This plan may be amended any time during the active life of the facility or during the postclosure care period. The approved postclosure plan will be amended by submitting a written request to the appropriate regulatory agency to authorize a change in the approved plan. The written request will include a copy of the amended postclosure plan for approval. The modified plan will be submitted at least 60 d before the proposed change in facility design or operation.

II-9. NOTICE IN DEED

Within 60 d of the certification of closure, the DOE-RL will, in accordance with state regulations, sign, notarize, and file for recording, the following notice. The notice will be sent to the Auditor of Benton County, P.O. Box 470, Prosser, Washington, with instructions to record this notice in the General Index. This document normally is reviewed in property title searches.

TO WHOM IT MAY CONCERN

The United States Department of Energy-Richland, Operations Office, an operations office of the United States Department of Energy, which is a department of the United States government, the undersigned, whose local address is the Federal Building, 825 Jadwin Avenue, Richland, Washington, hereby gives the following notice as required by 40 CFR 264.119(b) and WAC 173-303-610(10) (whichever is applicable):

(a) The United States of America is, and since April 1943, has been in possession in fee simple of the following described lands: (legal description of the 2101-M Pond).

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(b) The United States Department of Energy-Richland Operations Office, by operation of the 2101-M Pond, has disposed of hazardous and/or dangerous waste under the terms of regulations promulgated by the United States Environmental Protection Agency and the Washington State Department of Ecology (whichever is applicable) at the above described land.

(c) The future use of the above described land is restricted under terms of 40 CFR 264.117(c) and WAC 173-303-610(7)(d) (whichever is applicable).

(d) Any and all future purchasers of this land should inform themselves of the requirements of the regulations and ascertain the amount and nature of waste disposed of on the above described property.

(e) The United States Department of Energy-Richland Operations Office has filed a survey plat with the Benton County Planning Department and with the United States Environmental Protection Department and with the United States Environmental Protection Agency, Region 10 and the Washington State Department of Ecology (whichever are applicable) showing the location and dimensions of site, and a record of the type, location, and quantity of waste disposed of within the unit.

II-10 CERTIFICATION OF POSTCLOSURE CARE COMPLETION

No later than 60 d after completion of the established postclosure care period, the DOE-RL will submit to the Benton County Auditor and Ecology a certification of postclosure care and a duly certified survey plat. The certification will be signed by both the DOE-RL and an independent professional engineer, stating that postclosure care for the facility was performed in accordance with the approved postclosure plan. The certification will be submitted by registered mail or an equivalent delivery service. Documentation supporting the postclosure certification will be retained and furnished to Ecology upon request. The DOE-RL and the independent professional engineer will certify with a document similar to Figure II-10.

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POSTCLOSURE CERTIFICATION
FOR

_____

Hanford Site
U.S. Department of Energy, Richland Operations Office

We, the undersigned, hereby certify that all _____ _____ closure activities were performed in accordance with the specifications in the approved closure plan.

_____ _____
Owner/Operator Signature DOE-RL Representative Date
(Typed Name)

_____ **P.E.#**_____ **State**___ _____
Signature Independent Registered Professional Engineer Date
(Typed Name, Professional Engineer license number, state of issuance, and date of signature)

Figure II-10. Postclosure Certification for the 2101-M Pond.

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APPENDIX A-1.

PART A PERMIT APPLICATION

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Please print or type in the unshaded areas only
(Elite—12 areas are spaced for elite type, i.e., 12 characters/inch).

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

I. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (mo., day, & yr.)	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION (*place an "X" below and provide the appropriate date*)

☐ 1. EXISTING FACILITY (*See instructions for definition of "existing" facility. Complete item below.*)

MO.	DAY	YR.
0 3		5 3

FOR EXISTING FACILITIES, PROVIDE THE DATE (*mo., day, & yr.*) OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED (*see the boxes to the left*)

☐ 2. NEW FACILITY (*Complete date below.*)

MO.	DAY	YR.

FOR NEW FACILITIES, PROVIDE THE DATE (*mo., day, & yr.*) OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION (*place an "X" below and complete Section I above*)

☒ 1. FACILITY HAS AN INTERIM STATUS PERMIT

☐ 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES — CODES AND DESIGN CAPACITIES

A. PROCESS CODE — Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process (*including its design capacity*) in the space provided on the (*Section III-C*).

B. PROCESS DESIGN CAPACITY — For each code entered in column A enter the capacity of the process.
1. AMOUNT — Enter the amount.
2. UNIT OF MEASURE — For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc.)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET (*the volume that would cover one acre to a depth of one foot*) OR HECTARE-METER
LAND APPLICATION	D82	*ACRES OR HECTARES*
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U

UNIT OF MEASURE	UNIT OF MEASURE CODE
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H

UNIT OF MEASURE	UNIT OF MEASURE CODE
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III (*shown in line numbers X-1 and X-2 below*): *A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400* gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5				
X-2	T 0 3	20	E		6				
1	D 8 4	18,750	G		7				
2					8				
3					9				
4					10				

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Continued from the front.

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

D84
The 2101-M Pond receives nonregulated process and cooling wastes from the 2101-M Laboratory, and, historically received chemical wastes which may have been designated dangerous wastes. Disposal of the wastes occurred by percolation of the wastes through the soil column, using the precipitation, filtration, and ion exchange which occurred in the soil to reduce the toxicity and corrosivity of the wastes. The 2101-M Pond receives approximately 18,750 gallons per day of waste waters, of which the historic discharge of dangerous wastes constituted approximately 6% of the total. This pond has not received dangerous wastes since July 1985 and will be closed under interim status. The process design capacity reflects the maximum volume of water discharged to the facility on a daily basis rather than the physical capacity of the unit.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER — Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non—listed waste(s) that will be handled possess that characteristic or contaminant.

C. UNIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non—listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non—listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER — Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non—listed wastes. Two wastes are corrosive only and there will be an estimate 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)			2. PROCESS DESCRIPTION (If a code is not entered in D(1))
X-1	K 0 5 4	900	P	T 0 3	D 8 0		
X-2	D 0 0 2	400	P	T 0 3	D 8 0		
X-3	D 0 0 1	100	P	T 0 3	D 8 0		
X-4	D 0 0 2			T 0 3	D 8 0		included with above

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Continued from page 2.
NOTE: Photocopy this page before completing if you have more than 26 wastes to list.

I.D. NUMBER (enter from page 1): W A 7 8 9 0 0 0 8 9 6 7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)				2. PROCESS DESCRIPTION (If a code is not entered in D(1))
1	D005	5,500	P	D84				Percolation
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								

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Continued from the front.

IV. DESCRIPTION OF DANGEROUS WASTES *(continued)*

E USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

The 2101-M Pond received, for a two-year period, a discharge of a solution containing barium chloride. This waste exhibited the dangerous waste characteristic of EP toxicity due to the barium. A total of approximately 1,200 gallons of this waste was discharged to the 2101-M Pond.

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail)*.

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground—level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; a sites of future storage, treatment or disposal areas *(see instructions for more detail)*.

VII. FACILITY GEOGRAPHIC LOCATION *This information appears on the attached drawing and photograph

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
Michael J. Lawrence Manager, Richland Operations United States Department of Energy	Michael J. Lawrence	November 16, 1987

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attac documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

NAME *(print or type)*	SIGNATURE	DATE SIGNED
SEE ATTACHMENT		

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X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Michael J. Lawrence — 11-16-87
Michael J. Lawrence
Manager, Richland Operations
United States Department of Energy
Date

W. M. Jacobi — 11/16/87
William M. Jacobi
President
Westinghouse Hanford Company
Date

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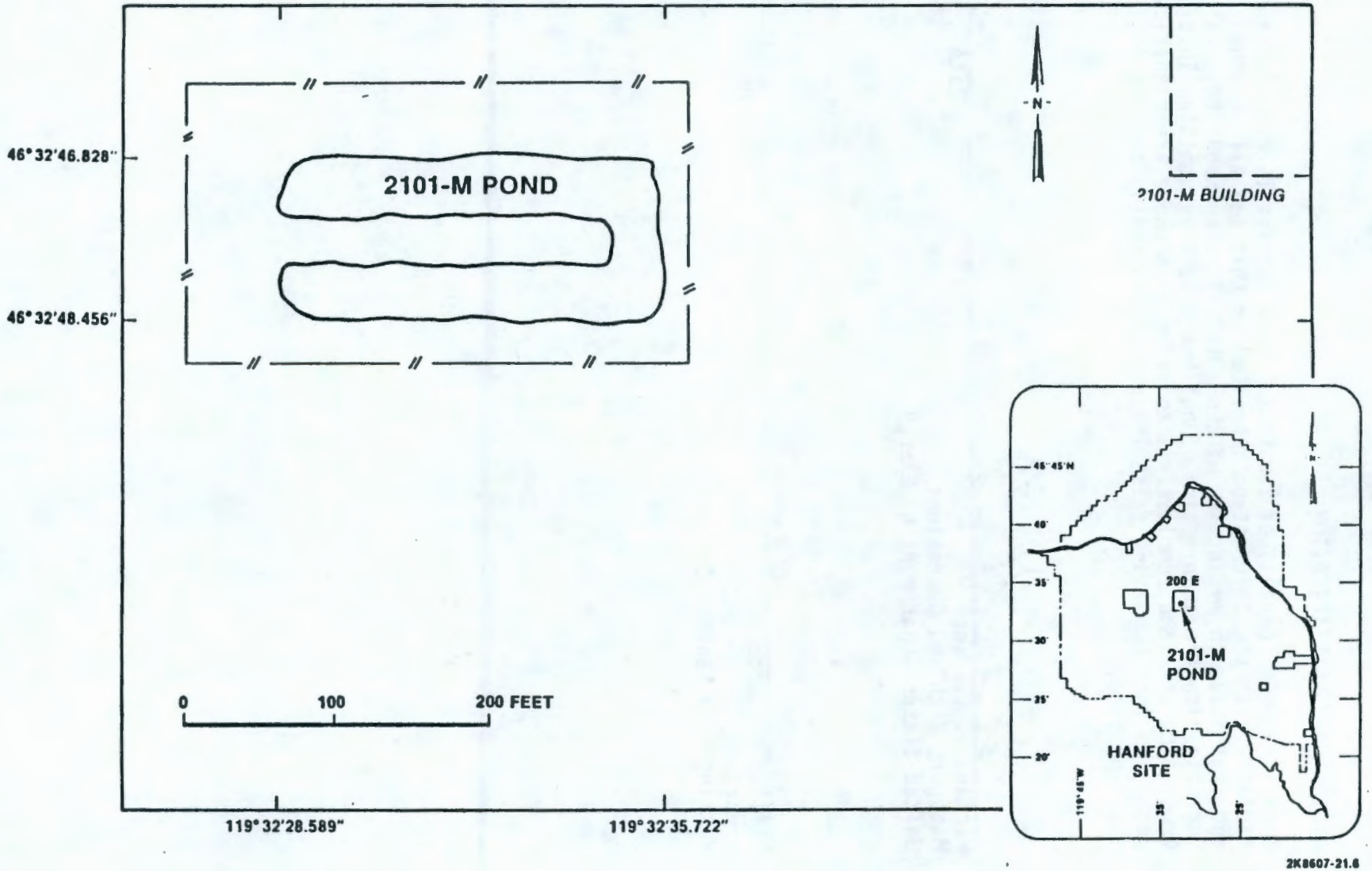
2101-M POND


46°32'46.828"
46°32'48.456"
2101-M POND
N
2101-M BUILDING
0
100
200 FEET
119°32'28.589"
119°32'35.722"
200 E
2101-M
POND
HANFORD
SITE
2K8607-21.6

2101-M POND

46°32'46.828"
46°32'48.456"
119°32'28.589"
119°32'35.722"

8505779-5CN

(PHOTO TAKEN 1985)

2K8607-21.14

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APPENDIX B-1.

LABORATORY INVENTORY

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APPENDIX B-1

LABORATORY INVENTORY

This appendix presents the inventory of chemicals that the BWIP Laboratory might have had on hand during its active life. The BWIP Laboratory inventory was compared to the list of dangerous constituents presented in Appendix IX of 40 CFR 261. An "X" has been placed next to the chemical name if it appears on the Appendix IX list.

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	Chemical/Reagent/Chemical Product	Appendix IX
4	Acetic acid	
5	Acetone	X
6	Acetone, em grade	X
7	Acetonitride	
8	Acetonitrile (UV grade)	X
9	Acid, ammonium salt	
10	Acidic surface cleaner	
11	Acrylic spray coating	
12	Actyl alcohol	
13	Alkaline surface cleaner	
14	Deagglomerated alpha alumina	
15	Gamma alumince	
16	Aluminum orthophosphate	
17	Aluminum hydroxide gel	
18	Aluminum powder	
19	Aluminum sulfate	
20	Ammonia-based cleaner	
21	Ammonium acetate	
22	Ammonium chloride	
23	Ammonium hydroxide	
24	Ammonium molybdate	
25	Ammonium nitrate	
26	Ammonium sulfate	
27	Ammonium thiocyanate	X
28	Amyl acetate	
29	Anion exchange resin	
30	Antipyrine	
31	Arsenic (III) oxide	X
32	Arsenic (V) oxide	X
33	Arsenic (V) conc. 1,000 ppm	X
34	Arsenic (V) conc. 20 ppm	X
35	Ascorbic acid	
36	L-Ascorbic acid	
37	Barium chloride, dihydrate	X
38	Barium diphenylamine sulfonate	X
39	Bentonite	
40	Benzene	X
41	Benzoic acid	
42	Aminobenzoic acid	
43	P-Aminobenzoic acid	
44	3-(Trifluoromethyl) benzoic acid	
45	Beryllium nitrate	
46	Boric acid	
47	Boron (reagent)	
48	Bromcresol green, 0.1%	
49	Bromcresol purple	
50	Brucine sulfate	
51	Cadmium acetate, dihydrate	X

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Chemical/Reagent/Chemical Product	Appendix IX
Cadium nitrate	X
Cadmium sulfate, crystal	X
Calcium (reagent)	
Calcium carbonate	
Calcium chloride, dihydrate	
Calcium hydroxide	
Calcium sulfate, anhydrous	
Carbon tetrachloride	
Cation exchange resin	
Cement	
Acrylic cement (chlorinated solvents)	
Cesium chloride	
Cesium iodide	
Chloride (reagent)	
Chloroform HPLC grade	X
Chromic acid	X
Chromium nitrate	X
Cobalt metal (powder)	
Cobalt oxide	
Cobalt (III) oxide	
Cobalt nitrate	
Cobaltous chloride	
Copper II chloride	
Copper II nitrate	
Copper metal (powder)	
Cupferron	
Cupric chloride, dehydrate	
Deuterium oxide	
Diallyl methalate (mounting compound)	
trans-1,2-diaminocyclohexane tetraacetic acid	
2',7' - Dichlorofluorescein	
2.6 Dichloro-indophenol sodium salt	
Dimethylaniline	
N,N-Dimethylformamide	
N,N-Dimethyl-P-phenylenediamine	
1,4-Dioxane	X
Diphenylamine	
S-diphenyl-carbazide	
2,2-Dipyridyl sodium salt	
Disodium ethylenediamine tetraacetate	
dl-mandelic acid 98%	
Epoxy accelerator B BDMA (N-Benzyl dimethylamine)	
Epoxy plasticizer DBP (dibutyl phthalate)	
Epoxy hardner DDSA (dodecenylsuccinic anhydride)	

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Chemical/Reagent/Chemical Product	Appendix IX
Epoxy resins (contains amines)	
Ethanol (ethyl alcohol)	
Ethylene alcohol	
Ethylene glycol	
Ferric ammonium sulfate, 12-hydrate	
Ferric chloride	
Ferric nitrate, 9-hydrate	
Ferrous ammonium sulfate, 6-hydrate	
Ferrozine (iron reagent)	
Floride (reagent)	
Fluorescein, water soluble	
Formaldehyde	X
Formazin (4,000 NTU Turbidity std)	
Glycerin	
Colloidal graphite	
H_4EDTA	
Hexanol	
1-Hexanol	
Hydraulic-jack oil	
Hydrochloric acid	
Hydrogen peroxide, 30%	
Hydrofluoric acid	X
Hydrophobic silica	
Hydrazine sulfate	X
Hydriodic acid (HI)	
Hydroxylamine hydrochloride crystal reagent	
Indigo carmine	
Iodine	
Iodine oxide	
Iron (reagent)	
Iron metal (powder)	
Iron oxide (Fe_2O_3)	
Iron sulfate	
Isopropyl alcohol	
Isopropyl ether	
Kryon	
Lanthanum nitrate, hexahydrate	
Lead acetate	X
Lead acetate, trihydrate	X
Lead nitrate	X
Linseed oil	
Lithium (reagent)	
Lithium bromide purified	
Lithium carbonate	
Lithium nitrate	
Lithium hydroxide, monohydrate	
Lithium metaborate, anhydrous	
Lithium tetraborate	

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Chemical/Reagent/Chemical Product	Appendix IX
Magnesium (reagent)	
Magnesium chloride	
Magnesium nitrate, 6-hydrate	
Manganese oxide	
Manganous sulfate	
MEK (methyl ethyl ketone) (nitrite rubber)	X
Mercuric chloride	X
Mercuric iodide	X
Mercuric oxide	X
Methanol	
Methyl alcohol	
Methyl alcohol, anhydrous	
Methyl-2-cyanoacrylate (adhesive/catalyst)	
Methyl orange solution 0.1%	
Methyl red hydrochloride crystal	
Methylene blue	
Mineral oil	
Naphthol sulfonic acid	
Nickelous nitrate, hexahydrate	X
Nickel metal (powder)	X
Nickel oxide	X
Niobium chloride	
Nitric acid	
Palladium chloride	
Para-amino	
Pentafluorobenzoic acid	
Petroleum distillates (cleaning polish, glass cleaner, lubricant, oil)	
Phenanthroline	
Phenol	X
Phenolphthalein indicator	X
Phenolic resin powder (mounting compound)	X
Epoxy - phenolic adhesive	X
Phenylazoformic acid 2-phenylhydrazide	
Phosphoric acid	
Phosphorous acid	
Pipe tape (Teflon* spray)	
Polishing agents	
Polyurethane (xylene)	
Potassium carbonate	
Potassium chloride (crystal)	
Potassium dichromate	X
Potassium dihydrogen orthophosphate	
Potassium ferricyanide	X
Potassium ferrocyanide, trihydrate	X
Potassium fluoride	

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Chemical/Reagent/Chemical Product	Appendix IX
Potassium hydrogen phthalate	
Potassium hydroxide	
Potassium iodate	
Potassium iodide	
Potassium nitrate	
Potassium nitrite	
Potassium permanganate	
Potassium persulfate	
Potassium phosphate, monobasic	
Potassium pyrosulfate	
Potassium sulfate	
Potassium thiocyanate	X
2-Amino-2-hydroxymethyl-1,3-propanediol	
Pyridine	X
1-Pyrrolidinecarbodithioic acid ammonium salt	
Rhodamine B	
Samarium chloride	
Selenium (IV) oxide	X
Selenous acid	X
Silica colloidal	
Silicic acid, N-hydrate	
Silicon carbide powder	
Silicon lubricant	
Silicon oil	
Silicon oxide	
Silicon rubber	
Silicon rubber sealant	
Silver chloride	X
Silver diethyldithiocarbamate	X
Silver (II) oxide	X
Silver nitrate	X
Sodium acetate, anhydrous	
Sodium acetate, trihydrate	
Sodium arsenate	X
Sodium arsenite	X
Sodium azide	
Sodium bicarbonate	
Sodium bisulfite	
Sodium borate	
Sodium bromide	
Sodium meta-bisulfite	
Sodium carbonate, anhydrous	
Sodium citrate, dihydrate	
Sodium chloride	
Sodium diphenylamine sulfonate	
Sodium fluoride	
Sodium hydroxide	

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Chemical/Reagent/Chemical Product	Appendix IX
Sodium hypochlorite	
Sodium hypophosphite	
Sodium iodide	
Sodium molybdate	
Sodium nitrate	
Sodium nitrite	
Sodium nitroprusside (cyanide compound)	X
Sodium oxalate	
Sodium phosphate, dibasic	
Sodium selenate	X
Sodium selenite	X
Sodium meta-silicate	
Sodium sulfate anhydrous (reagent)	
Sodium sulfide 9-hydrate	
Sodium sulfide anhydrous	
Sodium sulfite	
Sodium tartrate, dihydrate	
Sodium tetrahydroborate	
Sodium thiosulfate	
Sodium thiosulfate, pentahydrate	
Soluble oil	
Stannous chloride, dihydrate	
Starch, soluble	
Strontium (reagent)	
Strontium carbonate	
Strontium chloride	
Strontium nitrate	
Structural adhesive (contains amines and epoxy resins)	
Sucrose (ultrex)	
Sulfanilic acid	
Sulfate (reagent)	
Sulfer capping compound	
Sulfuric acid	
Tetraethylorthosilicate	
Thallium (I) salt	X
Tin, mossy	
Titanium (III) chloride	
Titanium chloride ($TiCl_4$)	
Toluene (acrylic)	
Toluene	X
Trichloroethylene	X
1-1-1 Trichloroethane	X
1,1,2-Trichloro-trifluoroethane	
Zinc (reagent)	
Zinc acetate, dihydrate	
Zinc dust	
Zinc granular, 20 mesh	

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Chemical/Reagent/Chemical Product	Appendix IX
Zinc nitrate	
Zinc sulfate	
Zirconium tetrachloride	
Additive Cooling Fluid	
Best-Test* Paper Cement	
Bestine* Solvent and Thinner	
Buehler* Epoxide Hardner	
Buehler* Epoxide Resin	
Buehler* Polishing Oil	
Buehler* Release Agent	
200 Catalyst*	
Weld-on 3 Solvent Cement*	
Chem-Grip A*	
Chem-Grip B*	
Chemgrip Treating Agent*	
Collodian* Flexible (topical protectant)	
EPO - Kwick Hardner	
EPO - Kwick Resin	
Epomet Molding Compound	
Epoxy Casting Resin A* (Araldite 6005)	
Epoxy Solvent 537*	
Eriochrome Black T Solution*	
Fiberlay Epoxy*	
550 Fluid (contains benzene)*	
Gacoflex Thinner*	
Incal Oil*	
Iso Cut Fluid*	
Leco* Microid Diamond Extender	
Low-Ba Vacuum Oil	
LPS 1* Greaseless Lubricant	
Magomet Polishing Compound	
M-Bond 200	
Metacoat* Protective Lacquer	
Mitadi Fluid Diamond Paste Extender	
Monometer* Fluid	
Multitherm* PG-1 Oil	
Never-Seez*	
Nitri Ver III*	
PAR Oil*	
Petropoxy 154 Curing Agent	
Petropoxy 154 Resin	
PG-1 Oil*	
711 Plastic Pipe Cement*	
Primer P-70* for PVC	
E RTV* Moldmaking Rubber	
RTV E* Catalist	
RTV* 630 A (Silicone Rubber Compound)	
RTV* 630 B (Curing Agent)	
RTV* Silicone Rubber Sealant	

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Chemical/Reagent/Chemical Product	Appendix IX
Silicones RTV* 31 Silicone Rubber Compound	
Silicones RTV* 60 Silicone Rubber Compound	
Silicone Mold Release	
Thermoplastic Cement	
Titan* Casting Resin	
Titan* Hardener	
Transoptic Powder (mounting compound)	
Triton X-100*	
Ultramet* Cleaning Solutions	

*Best-Test is a trademark of Union Rubber, Inc.
Bestine is a trademark of Union Rubber, Inc.
Buehler is a trademark of Buehler, Limited.
200 Catalyst is a trademark of M-Line Accessories.
Weld-on 3 Solvent Cement is a trademark of Industrial Polychemical Services.
Chem-Grip is a trademark of Chemplast, Inc.
Chemgrip Treating Agent is a trademark of Chemplast, Inc.
Collodian is a trademark of J.T. Baker.
Epoxy Casting Resin A is a trademark of R.P. Cargille Labs, Inc.
Epoxy Solvent 537 is a trademark of R.P. Cargille Labs, Inc.
Eriochrome Black T Solution is a trademark of Ciba-Geigy Corporation.
Fiberlay Epoxy is a trademark of Chemical Processing Company.
550 Fluid is a trademark of Dow Corning.
Gacoflex is a trademark of Gaco Western, Inc.
Incal Oil is a trademark of Conoco.
Iso Cut Fluid is a trademark of Buehler, Limited.
Leco is a trademark of Leco Corporation.
LPS 1 is a trademark of Holt Lloyd Company.
Metacoat is a trademark of Buehler, Limited.
Monometer is a trademark of Humbolt Test Equipment.
Multitherm is a trademark of Multitherm Corporation.
Never-Seez is a trademark of Never-Seez Corporation.
Nitri Ver III is a trademark of Hach Company.
PAR Oil is a trademark of Conoco.
PG-1 Oil is a trademark of Multitherm Corporation.
711 Plastic Pipe Cement is a trademark of Industrial Polychemical Services.
Primer P-70 is a trademark of Industrial Polychemical Services.
RTV is a trademark of General Electric Company.
Teflon is a trademark of DuPont.
Titan is a trademark of California Titan Products, Inc.
Triton X-100 is a trademark of Spectrum Chemical Manufacturing Corporation.
Ultramet is a trademark of Ultra-met Manufacturing Company.

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APPENDIX B-2.

SAMPLE BWIP ADMINISTRATIVE PROCEDURE FOR HANDLING HAZARDOUS WASTE

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DI NO. DI-71100-03 REV. 1

Controlled Copy # 001
BWIP Laboratory Department

TITLE HAZARDOUS WASTE HANDLING, STORAGE, AND SHIPPING IN THE BWIP LABORATORY GROUP

J. R. Smith	10-23-87	W. F. Davis	10/23/87
Author	Date	Project Assurance Engineer	Date
P. D. Mix	10/23/87	A. F. Noonan	10/27/87
Manager, Laboratory Support Section	Date	Manager, BWIP Laboratory Group	Date

1.0 PURPOSE

This desk instruction (DI) describes the practices that shall be followed in the generation, identification, storage, and shipment of chemical wastes in the Basalt Waste Isolation Project (BWIP) laboratory in the 2101-M building. It will bring the facility into compliance with the Washington State Department of Ecology Regulations (Washington Administration Code [WAC] 173-303) and Department of Transportation (DOT) Hazardous Material Regulations (49 CFR 171-179).

2.0 APPLICABILITY

The requirements outlined in this DI apply to all activities and personnel working in the BWIP laboratory in the 2101-M building.

3.0 DEFINITIONS

3.1 CHEMICAL WASTE

For the purpose of this DI, chemical waste is any hazardous substance as defined in WAC 173-303, "Dangerous Waste Regulations." A hazardous substance is any liquid, solid, gas, or sludge, including any material, substance, product commodity, or waste, regardless of quantity, that exhibits any of the physical, chemical, or biological properties described in WAC 173-303. This includes dangerous wastes, hazardous wastes, and extremely hazardous wastes.

NOTE: This desk instruction is essentially a complete rewrite, therefore, no revision bars are indicated in the right margin.

EXAMPLE

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3.2 CHEMICAL WASTE CONTAINER INVENTORY SHEET

A Chemical Waste Container Inventory Sheet (figure 1) is used to record the contents of a chemical waste container. An entry is made on the sheet for each waste added to the container. A separate sheet is maintained for each container.

3.3 CHEMICAL WASTE CONTAINER STICKER

A chemical waste container sticker (figure 2) is a sticker obtained from the hazardous chemical waste disposal (HCWD) coordinator. It is placed on all chemical disposal containers. The internal unique hazardous chemical waste container identification number (ID) is written on this sticker.

3.4 ENVIRONMENTAL PROTECTION AGENCY HAZARDOUS WASTE STICKER

An Environmental Protection Agency (EPA) hazardous waste stickers (figure 3) are markings required by law to be on all waste containers. These stickers are store stock items available from the HCWD coordinator. When the stickers are applied to a waste container, the "ACCUMULATION START DATE" line is completed by the HCWD coordinator. The lines on the sticker are completed using information provided by the Hazardous Waste Unit (HWU). The manifest number is written in the upper right corner. The unique shipping container number is written in the upper left corner.

3.5 HAZARDOUS CHEMICAL WASTE CONTAINER IDENTIFICATION NUMBER

A hazardous chemical waste container ID is a number assigned by the HCWD coordinator. This number provides unique identification of the container to which it is affixed. It is part of the traceability of waste containers required in a waste generating facility.

3.6 HAZARDOUS CHEMICAL WASTE DISPOSAL COORDINATOR

The HCWD coordinator is an individual, designated by the Manager, Solution and Solids Characterization Section, to be responsible for coordination of the activities outlined in this instruction.

3.7 WASTE GENERATOR

A waste generator is any individual who generates chemical waste.

EXAMPLE

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INFORMATION ONLY

4.0 RESPONSIBILITIES

4.1 MANAGER, BASALT WASTE ISOLATION PROJECT LABORATORY GROUP

The Manager, BWIP Laboratory Group (BLG), is responsible for ensuring that the provisions of this DI are conveyed to all employes in the BLG who generate hazardous wastes.

4.2 MANAGER, SOLUTION AND SOLIDS CHARACTERIZATION SECTION

The Manager, Solution and Solids Characterization Section, is responsible for:

- reviewing test plans for hazardous waste potential
- appointing an HCWD coordinator for the BLG
- ensuring that training of the HCWD coordinator is current
- maintaining a list of response personnel for hazardous waste problem response
- conducting weekly inspection of hazardous waste storage and staging areas
- reviewing procurement documents to minimize waste generation.

4.3 HAZARDOUS CHEMICAL WASTE DISPOSAL COORDINATOR

The HCWD coordinator is responsible for assessing the wastes that may be generated prior to the start of any test in the BWIP laboratory. All requests for shipments of hazardous wastes are generated by the HCWD coordinator.

4.4 WASTE GENERATOR

The waste generator is responsible for contacting the HCWD coordinator prior to the start of any test that may produce hazardous waste. Similarly, the waste generator must notify the HCWD coordinator of any condition (i.e., spills or accidents) that may involve hazardous chemicals.

EXAMPLE

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5.0 REQUIREMENTS

Materials designated as "Dangerous Waste" or "Extremely Hazardous Waste" by WAC 173-303 shall be retained for proper disposal. The waste generator will maintain the waste in a properly labeled and documented container in the generator's work area. When the waste container is filled or otherwise ready for disposal, the container and accompanying documentation are transferred to the HCWD staging area (2101-M: designated hood in room 216, designated hood in room 220, and the door 111 entry). The HCWD coordinator will arrange for the proper disposal of the waste. The HCWD coordinator and the alternate shall have completed the Hazardous Waste Shipment Certification Course 0055.

6.0 INSTRUCTION

1. Prior to the start of any test in the BWIP Laboratory, an assessment of the chemical wastes that may be generated shall be performed by the waste generator with the assistance of the HCWD coordinator.

2. The waste generator shall obtain a chemical waste container sticker (figure 2), an EPA hazardous waste sticker (figure 3), and a Chemical Waste Container Inventory Sheet (figure 1) from the HCWD coordinator (see Definitions, Appendix A) for each chemical waste to be produced.

3. The waste generator shall obtain a chemical waste disposal container. These are available from Westinghouse Hanford Company Stores or offsite vendors as applicable. All containers shall be DOT approved for the intended use (see Title 49 CFR, parts 170-179).

   Chemical waste disposal containers may be plastic, glass, or metal. Aqueous waste should be stored in plastic bottles. Glass bottles may be suitable for some organic wastes. Special containers may be required for flammable chemical wastes. The HCWD coordinator, upon request, will assist the waste generator in the selection of suitable containers for storage of chemical wastes prior to disposal.

4. The HCWD coordinator will assign a hazardous chemical waste container ID to each container. The ID shall be written on the chemical waste container sticker and on the Chemical Waste Container Inventory Sheet.

5. If enough information is available, the HCWD coordinator shall assign a DOT hazard class and a Washington State Department of Ecology waste code to the wastes to be accumulated. This information shall be written on the chemical waste container sticker (figure 2) and on the Chemical Waste Container Inventory Sheet (figure 1).

EXAMPLE

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6. The stickers (figures 2 and 3) shall be affixed to the chemical waste disposal container to receive the waste.

7. The HCWD coordinator enters the appropriate information on the Chemical Waste Container Identification Log Sheet (figure 4) in the first four columns.

8. The waste generator shall place the chemical waste disposal container in the laboratory where the wastes will be generated.

9. The waste generator shall maintain the Chemical Waste Container Inventory Sheet in close proximity to the chemical waste disposal container at all times.

10. When chemical wastes are generated, all hazardous chemical wastes shall be placed in chemical waste disposal containers.

    The transfer of wastes to containers shall be performed in a hood or in a well-ventilated area in the laboratory.

11. The waste generator shall make an entry on the Chemical Waste Container Inventory Sheet each time wastes are added to a container.

12. When the container is full, the waste generator shall contact the HCWD coordinator.

13. The HCWD coordinator shall move the chemical waste disposal container to the HCWD staging area.

    Staging areas are in designated hoods in rooms 208 and 216, and the BWIP Laboratory storage area.

14. The waste generator shall calculate the weight percent composition of the chemical wastes in the container. This information shall be entered on the Chemical Waste Container Inventory Sheet.

15. The Chemical Waste Container Inventory Sheet is then given to the HCWD coordinator.

16. The HCWD coordinator completes a Chemical Waste Disposal Request (figure 5) according to instructions given in the Hazardous Waste Shipment Certification Course 006S.

17. The Chemical Waste Disposal Request is sent to the HWU.

18. The personnel of the HWU prepare a chemical waste disposal analysis and send it to the HCWD coordinator.

EXAMPLE

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ONLY

19. The chemical waste disposal analysis provides instructions on the proper packaging for shipment, the proper labeling and marking, and gives the manifest number for shipment.

20. The HCWD coordinator prepares the waste for shipment according to the instructions.

21. The HCWD coordinator completes the hazardous waste sticker using information supplied by the HWU.

22. The HCWD coordinator requests an inspection by the HWU personnel.

23. Hazardous Waste Unit personnel conduct a preshipment inspection to verify compliance with packaging instructions. Properly completed Uniform Hazardous Waste Manifest(s) shall be delivered and initialed by the HWU representative upon satisfactory inspection.

24. The HCWD coordinator will arrange for transportation.

25. When the transporter arrives to pick up the wastes, the generator shall sign the manifest, obtain the transporter's signature, and retain the tissue "generator copy" of the manifest.

26. The HCWD coordinator shall verify that proper placards are displayed on the truck.

27. The original and remaining copies of the manifest must accompany the shipment.

28. When the shipment is complete, the HWU personnel will return the original copy of the manifest to the generator.

EXAMPLE

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6.1 INSPECTIONS

The Manager, Solution and Solids Characterization Section, or his delegate, shall conduct a weekly inspection of the chemical waste inventory. Records of these inspections shall be maintained by the responsible section manager or his delegate.

The inspection shall be recorded on the Weekly Inspection Log (figure 6).

6.2 ACCIDENTAL RELEASE OF REGULATED CHEMICALS

If a regulated chemical is accidentally released into a laboratory drain, the HCWD coordinator or the alternate shall be notified immediately.

NOTE: The HCWD coordinator shall maintain records and report monthly all accidental releases of regulated chemicals to the environment using approved forms. If the quantity of material released exceeds regulatory limits, the HCWD coordinator shall complete a Comprehensive Environmental Response, Compensation and Liability Act/Washington Department of Ecology Hazardous Substance Release Report. Instructions for completion of such a report are given in a letter from Mr. J. C. Fulton, Manager, Process Engineering Department, on Chemical Sewer Management (65900-86-171).

7.0 RECORDS

The HCWD coordinator shall maintain the following records:

- Chemical Waste Container Inventory Sheets (figure 1)
- Chemical Waste Container Identification Log Sheets (figure 4)
- Copies of Chemical Waste Disposal Requests (figure 5)
- Weekly Inspection Log (figure 6)
- Copies of the Uniform Hazardous Waste Manifests--These shall be maintained in a auditable file by authorized Washington Department of Ecology, U.S. Department of Energy, and contractor personnel.

EXAMPLE

8.0 APPLICABLE DOCUMENTS

Code of Federal Regulations

40 CFR 260-265, "Environmental Protection Agency Regulations"

49 CFR 171-179, "Department of Transportation Hazardous Material Regulations"

WAC 173-303 Washington State Department of Ecology Regulations.

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9.0 ATTACHMENTS

- Figure 1. Chemical Waste Container Inventory Sheet.
- Figure 2. Chemical Waste Container Sticker.
- Figure 3. Environmental Protection Agency Hazardous Waste Sticker.
- Figure 4. Chemical Waste Container Identification Log Sheet.
- Figure 5. Chemical Waste Disposal Request.
- Figure 6. Weekly Inspection Log Generating Facility Temporary Hazardous Waste Storage Area.

EXAMPLE

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CHEMICAL WASTE CONTAINER INVENTORY SHEET

BOTTLE NO. _____ CATEGORY _____

DATE	BATCH NAME	BATCH VOL.	CHEMICAL COMPOSITION	WT. %	COMMENT

EXAMPLE

Figure 1. Chemical Waste Container Inventory Sheet.

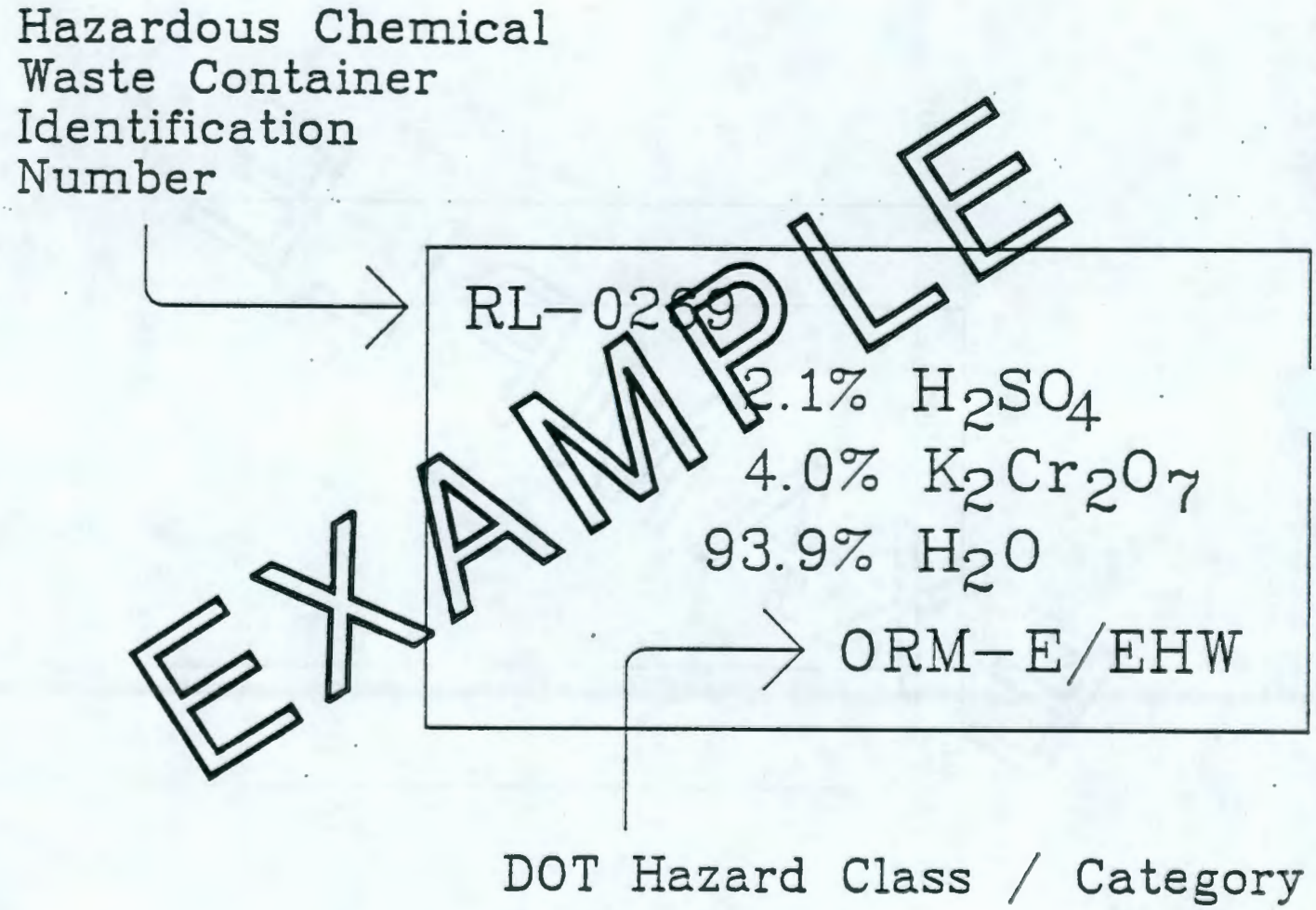

Figure 2. Chemical Waste Container Sticker.

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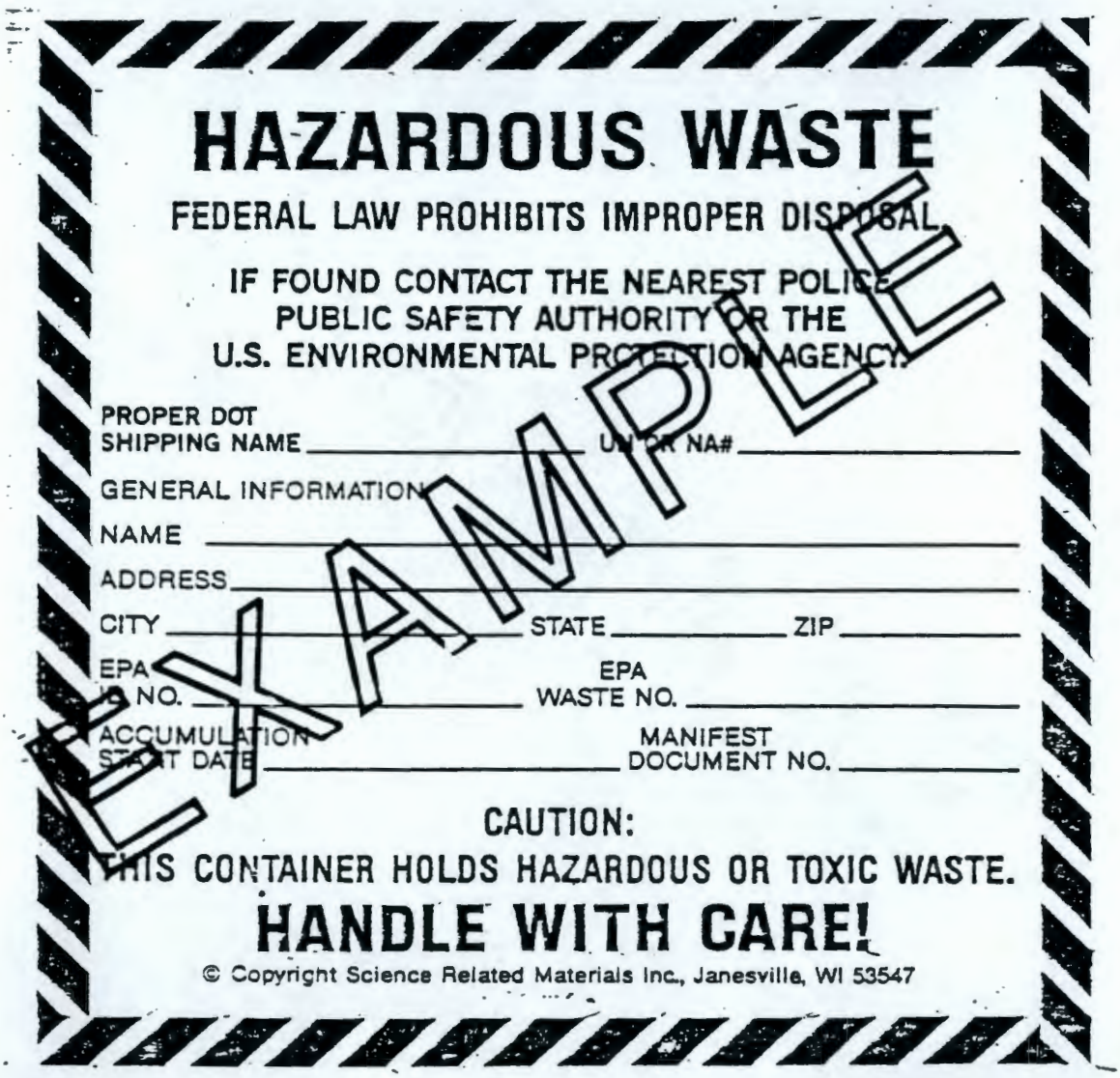

Figure 3. Environmental Protection Agency Hazardous Waste Sticker.

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CHEMICAL WASTE CONTAINER IDENTIFICATION LOG SHEET

BOTTLE NUMBER	NAME OF WASTE GENERATOR	DATE OF ISSUE	CATEGORY DESIGNATION	DRUM NO.	SHIPPED DATE

EXAMPLE

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Figure 4. Chemical Waste Container Identification Log Sheet.

Complete unshaded parts and forward to: SWP&DU
2750E/A105/200E
Hockwell

CHEMICAL WASTE DISPOSAL REQUEST

Logbook No.

Manifest(s) cross reference

Requested by | Telephone Number | Address | Company

Signature _____ Date _____ Waste Location: _____

WASTE DESCRIPTION (For additional items, continue on the back of this form)

A Item No	B No of Containers	C Container Size	D Total Waste Quantity (kg)	E Container Description	F Waste Description	G Chemical Components	H Weight %	I Physical State	J Hazards	K Waste Status	L Container Status	M Accumulation Date
Example 1	1	55 gal	305	Steel Drum	TURCO Decon 4521 Solution, 10% In Water	TURCO 4521, MSDS Attached Water	10.0 90.0	L	C	O	F	7-3-86
Example 2	1	5 gal	34	Metal Can	Waste from Hg Cleanup	Mercury Rags Soil	1.3 4.0 94.7	S	EP	S	PF	7-7-86
Example 3	23	55 gal	0	Steel Drum	Empty Conoco 32 Oil Drums - Contained Used Oil	Oil - MSDS Attached PCB - Label Data Attached	100.0 < 1 ppm	L	None	U	MT	7-10-86

EXAMPLE

INSTRUCTIONS

COLUMN A - ITEM NUMBER — Item number for each unique waste.

COLUMN B - NUMBER OF CONTAINERS — Number of containers of a unique waste to be disposed.

COLUMN C - CONTAINER SIZE — Size of containers specified in Column B. If multiple container sizes, specify number and size of each.

COLUMN D - TOTAL WASTE QUANTITY — Total waste quantity (in kilograms only) of each unique waste to be disposed.

COLUMN E - CONTAINER DESCRIPTION — Specify container type e.g. steel drum, glass bottle.

COLUMN F - WASTE DESCRIPTION — Specify trade name or general description of each unique waste.

COLUMN G - CHEMICAL COMPONENTS — List all organic and inorganic components of the unique waste using specific chemical names. Attach Material Safety Data Sheets, analytical data or other documents to the waste to describe the composition of the waste.

COLUMN H - WEIGHT (%) — For each waste component indicate percent or range of percents in which the component is present in the waste. Trace amounts of pesticides, herbicides, heavy metals and PCB's should be specified. Components must add up to 100% including water, earth, or other components. If a unit other than percent is used, indicate the unit. When possible provide lab results or other documentation to verify percentages.

COLUMN I - PHYSICAL STATE — Indicate whether Solid (S), Liquid (L), or Gas (G) or any combination of these phases.

COLUMN J - HAZARDS — Indicate whether waste is Corrosive (C), Ignitable (I), Reactive (R), Toxic (T), Explosive (E), Persistent (P), LP Toxic (EP) or Carcinogenic (X).

COLUMN K - WASTE STATUS — Indicate whether waste is: Reacted (Re), Treated (T) New (unused) (N), Used (U), Old (or expired) (O), Spill Material (S).

COLUMN L - CONTAINER STATUS — Indicate whether container is: Full (F), Partially Full (PF), Empty (< ½ in in 55 Gal Drums) (MT), Triple Rinsed (TR).

COLUMN M - ACCUMULATION DATE — Indicate the accumulation date marked on each container.

Figure 5. Chemical Waste Disposal Request

WEEKLY INSPECTION LOG
GENERATING FACILITY TEMPORARY
HAZARDOUS WASTE STORAGE AREA

DATE _____

FACILITY _____

LOCATION _____

	STATUS		
	NO PROBLEMS NOTED	REQUIRED REMEDIAL ACTIONS/DATE	SEE COMMENTS
1. CONTAINER CONDITION AND COMPLIANCE			
A. CLOSED	☐	☐ _____	☐
B. STRUCTURAL DEFECTS	☐	☐ _____	☐
C. CORROSION	☐	☐ _____	☐
D. LABELS REQUIRED	☐	☐ _____	☐
E. EVIDENCE OF SPILLS OR LEAKING	☐	☐ _____	☐
F. INCOMPATIBLE CONTAINERS SEPARATED	☐	☐ _____	☐
G. CONTAINER ACCUMULATION DATE COMPLIANT	☐	☐ _____	☐
2. SAFETY/EMERGENCY EQUIPMENT			
A. ABSORBENTS	☐	☐ _____	☐
B. OVERPACK DRUMS	☐	☐ _____	☐
C. EYEWASH	☐	☐ _____	☐
D. FIRE EXTINGUISHER	☐	☐ _____	☐
E. COMMUNICATION EQUIPMENT	☐	☐ _____	☐
F. PROTECTIVE CLOTHING	☐	☐ _____	☐
G. RESPIRATORS/CARTRIDGES	☐	☐ _____	☐

3. COMMENTS

4. STATUS OF OUSTANDING ACTIONS PREVIOUS INSPECTION

5. INSPECTOR SIGNATURE

_____
PRINT NAME

_____
SIGN NAME

2K8606-1.1

EXAMPLE

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Figure 6. Weekly Inspection Log Generating Facility Temporary Hazardous Waste Storage Area.

APPENDIX A

SAFETY

HAZARDS

The handling, storage, and shipment of hazardous wastes is associated with numerous health and safety hazards. Specific hazards are associated with the chemicals being disposed, the materials used in the packaging of the waste, as well as physical hazards associated with the mass of the containers of waste.

The major laboratory wastes include mineral acids (hydrochloric, hydrofluoric, nitric, phosphoric, sulfuric), alkalis (ammonia water, sodium hydroxide), poisonous metal salts (primarily barium chloride), solvents (acetone, benzene, ethanol, and methanol), and cyanides.

HAZARD MITIGATION

Fundamental to hazard mitigation is that waste handling is limited to trained personnel.

Transfer of chemicals to waste disposal bottles shall be performed in a laboratory hood or well ventilated area.

Weekly inspections shall include the hoods and drum or laboratory pack storage areas.

Specific hazard mitigation measures (including clothing and respiratory protection) are listed in the appropriate Material Safety Data Sheets.

RULES/REGULATIONS

Specific statutory rules covering disposal of hazardous waste appear in the text of this procedure.

Specific Accident Prevention Standards (APS) involved with handling hazardous waste include: 11.A (Foot Protection), 11.B (Eye & Face Protection), 11.C (Protective Headware), 17 (Materials Handling & Storage), 19 (Flammable and Combustible Liquids), 29 (Respiratory Protective Equipment), and 42 (Hazardous Materials).

EXAMPLE

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Specific Accident Prevention Bulletins involved with handling hazardous waste include: A-2 (Office Safety), B-5 (Equipment Cleaning-Compressed Air, Solvents, Steam, and Ultrasonic), and D-3 (Handling Containers of Corrosive Liquids).

PERSONNEL PROTECTION

Specific personnel protection required depends largely on the nature and mass of the wastes.

In general, ordinary laboratory safety equipment (safety glasses, rubber gloves, and laboratory coat) provide adequate protection when transferring most wastes.

Specific protective equipment information can be obtained from the appropriate Material Safety Data Sheets (located in Laboratory 208, 2101-M building).

EMERGENCY RESPONSE

The emergency situations envisioned include: (1) cuts, (2) exposure of worker to hazardous gases or mists, (3) skin or eye contact with hazardous liquids, (4) leakage or rupture of containers, and (5) generation of gases in enclosed containers.

For cuts, the worker is to wash the affected area with water for at least 15 minutes, notify management, and go to First Aid.

For skin and eye contact with hazardous liquids, the worker is to leave the contaminated area immediately, rinse affected areas at least 15 minutes, notify management, and go to first aid.

For exposure to hazardous gases or mists, the worker is to leave the contaminated area immediately, rinse affected areas at least 15 minutes, notify management, and go to first aid.

For leakage or rupture of containers, the specific response depends on the nature of the leak. In general, the casual "passer by" is to warn others in the work site of the leak, notify management, and call 811. The HCWD coordinator is permitted to mitigate the hazard using best judgement (see APS 2). Major spills are reported (section 6.2).

For pressurization of containers of waste, the specific response depends on the contents of the container. In general, the casual "passer by" is to warn others in the work site of the hazard, notify management, and call 811. The HCWD coordinator is permitted to mitigate the hazard using best judgement (see APS 2).

EXAMPLE

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APPENDIX B-3.

ON-SITE SHIPPING DOCUMENTS

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APPENDIX B-3

ON-SITE SHIPPING DOCUMENTS

This appendix presents the on-site shipping documents and disposal analysis records for a one-year period from September 1985 through September 1986.

Uniform Hazardous Waste Manifests are not required per WAC 173-303 for wastes being transported onsite. The were used, as a matter of convienience to document intra-facility shipment of dangerous wastes from the BWIP Laboratory to the onsite Hanford storage facility. These on-site shipping documents provide the quantity and types of chemical wastes generated at the BWIP Laboratory and collected for ultimate disposal at an offsite dangerous waste management unit.

Disposal analysis records have been prepared for each on-site shipping document to provide an estimate of the chemical makeup of each waste listed on the on-site shipping documents. The disposal analysis records were generated from various BWIP Laboratory records. The percentage of each chemical in a waste container is generally reported on the disposal analysis record as it was documented in the BWIP Laboratory records. As a result, percentages are reported to varying significant figures, and the total of all chemicals in a waste container does not necessarily add up to 100 percent.

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ON-SITE SHIPPING DOCUMENTS

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Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2060-0404. Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No: WA 789 000 8967
Manifest Document No: RHO-19-13
2. Page 1 of 1
Information in the shaded areas is not required by Federal law

3. Generator's Name and Mailing Address
A.D. Marcy/RHO
2102-M/200 East Area
4. Generator's Phone (509) 373-3841

A. State Manifest Document Number
B. State Generator's ID

5. Transporter 1 Company Name: Rockwell Hanford Operations
6. US EPA ID Number: WA 789 000 8967
C. State Transporter's ID
D. Transporter's Phone: 376-1420

7. Transporter 2 Company Name
8. US EPA ID Number
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
2727-S/200 West Area
Storage Facility
10. US EPA ID Number: ~~WA~~ WA 789 000 8967
G. State Facility's ID
H. Facility's Phone: 373-4032

	11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.	Waste Corrosive Liquid, NOS (ICP/AES solutions pH below 2) Corrosive material UN1760	1	DM	~~3~~ 21	K	D002, D006 D007, D008
b.	Waste Benzene Flammable Liquid UN1114	1	DM	0.22	K	U019
c.	Waste Corrosive Liquid, NOS (pH above 10) Corrosive material UN1760	1	DM	4	K	D002, D003
d.						

J. Additional Descriptions for Materials Listed Above
Item a. is one 30-gallon 17H or 17C metal drum.
Item b. is one 1-gallon metal paint can (DOT).
Item c. is one 30-gallon 17H or ~~17H~~ 17C metal drum.

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment. Certified by Reserve Land 2-28-86

GENERATOR

Printed/Typed Name: A. DALE MARCY
Signature: A.D. Marcy
Month 02 Day 28 Year 86

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: J.A. Aldridge
Signature: J A Aldridge
Month 03 Day 05 Year 86

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name
Signature
Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name: A. W. Lilly
Signature: A W Lilly
Month 3 Day 5 Year 86

Style F15R-6 Labelmaster, Div. of American Labelmark Co. Inc. 60646
EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete.

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Disposal Analysis
No. RHO-19-13

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
1. (RL-0050A)	Waste corrosive liquid, NOS (ICP/AES solutions, pH below 2)	ICP standards*	0.06	21.0
		Nitric acid	2.00	
		Water	97.94	
(RL-0070)	Waste corrosive liquid, NOS (ICP/AES solutions, pH below 2)	ICP standards*	.22	
		Nitric acid	2.00	
		Water	97.78	
2. (RL-0017)	Waste benzene	Benzene	98.0	0.22
		Paraffin	2.0	
3. (RL-0002)	Waste corrosive liquid, NOS (pH above 10)	$K^4Fe(CN)^6 \cdot 3H_2O$	0.46	1.0
		$K_3Fe(CN)_6$	0.33	
		$KF \cdot 2H_2O$	0.34	
		H_2SO_4	0.003	
		Ba	0.004	
		NaOH	0.5	
		Water	93.0	
(RL-0036)		Na_2S	≤1.0	1.0
		NaOH	10.0	
		Water	89.0	
(RL-0040)		Na_2S	0.1	2.0
(RL-0041)		NaOH	1.0	
		Water	98.9	

*See waste analysis sheets on following pages.
AES = atomic emission spectroscopy
DOT = U.S. Department of Transportation
ICP = inductively coupled plasma
NOS = not otherwise specified.

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Waste Analysis Sheet

Analysis of RL-0070		Analysis of RL-0050	
Element	Concentration in mg/L (unless otherwise specified)	Element	Concentration in mg/L (unless otherwise specifies)
Na	1561.7	Na	47.784
K	198.77	K	46.159
Ca	5.4277	Ca	45.087
Mg	3.9144	Mg	45.633
Cu	3.6863	Cu	44.918
Fe	4.3658	Fe	44.576
Mn	3.7885	Mn	44.724
Ce	1.0059	Ce	47.051
Ba	5.9151	Ba	22.322
Sr	4.0855	Sr	22.076
Li	9.9130	Li	22.851
V	0.7076	V	22.565
Rb	<0.4150	Rb	23.623
La	No quantitative value	La	No quantitative value
Al	58.250	Al	11.630
Pb	66.102	Pb	10.178
Zn	42.038	Zn	5.0634
Cr	43.562	Cr	10.709
Co	42.590	Co	5.0526
Cd	42.133	Cd	5.0189
Ni	42.163	Ni	4.9656
Be	23.488	Be	9.9550
Bi	24.248	Bi	5.4462
Ag	3.6136	Ag	3.8697
Total in mg/L	2191.8824	Total in mg/L	546.2574
Total in percent*	0.22	Total in percent*	0.05

*10,000mg/L = 1%.

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1 **ON-SITE SHIPPING DOCUMENTS**
2
3 RHO-19-13A

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DOE/RL 88-41
Revision 2

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No 2000-0404 Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. WA 789 000 8967

Manifest Document No RHO-19-13A

2. Page 1 of 1

Information in the shaded areas is not required by Federal law

3. Generator's Name and Mailing Address
A. D. Marcy/RHO
2101-M/200 East Area

4. Generator's Phone (509) 373-4100

A. State Manifest Document Number

B. State Generator's ID

5. Transporter 1 Company Name
Rockwell Hanford Operations

6. US EPA ID Number
WA 789 000 8967

C. State Transporter's ID

D. Transporter's Phone 376-1420

7. Transporter 2 Company Name
N/A

8. US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone

9. Designated Facility Name and Site Address
2727-S/200 West Area
Storage Facility

10. US EPA ID Number
WA 789 000 8967

G. State Facility's ID

H. Facility's Phone 373-4032

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)

		12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. Hazardous Waste Liquid, NOS (selenium solution 80 ppm) ORM-E NA9189		1	DM	2	K	D010
b.						
c.						
d.						

J. Additional Descriptions for Materials Listed Above
Item a. is one 5-gallon 17C steel drum labpacked with two plastic bottles and absorbent.

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage or disposal currently available to me which minimizes the present and future threat to human health and the environment. Certified by RLK 5-12-86

Printed/Typed Name: A.D. MARCY | Signature: A.D. Marcy | Month 5 Day 14 Year 86

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name: K.L. STEENSMA | Signature: K. L. Steensma | Month 5 Day 14 Year 86

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | Month Day Year

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name: TR Romero | Signature: TR Romero | Month 5 Day 14 Year 86

GENERATOR / TRANSPORTER / FACILITY

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Style F15R-6 Labelmaster, Div. of American Labelmark Co. Inc. 60646

EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete.

Disposal Analysis
No. RHO-19-13A

Item number	DOT Shipping name	Constituents	Percent of volume	Total quantity (kg)
1. (RL-0020)	Hazardous waste	Se	0.008	2.0
(RL-0021)	liquid, NOS (selenium solution 80 ppm)	Water	99.9	

DOT = U.S. Department of Transportation
NOS = not otherwise specified.

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ON-SITE SHIPPING DOCUMENTS

RHO-22-37

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Please print or type. (Form designed for use on elite (12-pitch) typewriter) Form Approved. OMB No. 2000-0404 Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No: WA 789 000 8967
Manifest Document No: RHO-22-37
2. Page 1 of 2
Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
A. D. Marcy/RHO
2101-M/200 East Area
4. Generator's Phone (509) 373-4100

A. State Manifest Document Number
B. State Generator's ID

5. Transporter 1 Company Name: Rockwell Hanford Operations
6. US EPA ID Number: WA 789 000 8967
C. State Transporter's ID
D. Transporter's Phone: 376-1420

7. Transporter 2 Company Name: N/A
8. US EPA ID Number:
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
2727-S/200 West Area
Storage Facility
10. US EPA ID Number: WA 789 000 8967
G. State Facility's ID
H. Facility's Phone: 373-4032

	11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)			12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.	Waste Acid Liquid, NOS (ICP/AES waste solution, pH <1)	Corrosive Material	NA1760	1	DM	20	K	WT01,D002 D008,D010
b.	Waste Acid Liquid, NOS (ICP/AES waste solution pH <1)	Corrosive Material	NA1760	1	DM	20	K	WT01,D002 D005,D010
c.	Waste Acid Liquid, NOS (Spectrometric waste solution)	Corrosive Material	NA1760	1	DM	20	K	F003,D002
d.	Waste Acid Liquid, NOS (lab waste w/sulfuric acid & potassium dichromate in H_2O)	Corrosive Material	NA1760	2	DM	5	K	D002,D007

J. Additional Descriptions for Materials Listed Above
Items a., b. and c. are labpacks in 30-gallon 17H steel drums.
Item d. is two 5-gallon 17C steel drums of labpacks;
all inner containers are plastic bottles with filler used.

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment. Certified by ALK 5-12-86

GENERATOR

Printed/Typed Name: A. D. Marcy
Signature: Allen Dale Marcy
Month 5 Day 14 Year 86

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: K. L. STEENSMA
Signature: K. L. Steensma
Month 5 Day 14 Year 86

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name:
Signature:
Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name: M R Reynolds
Signature:
Month 5 Day 14 Year 86

Style F15R-6 Labelmaster, Div. of American Labelmark Co. Inc. 60646
EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete.

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DOE/RL 88-41
Revision 2

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Form Approved. OMB No. 2000-0404 Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST (Continuation Sheet)	21. Generator's US EPA ID No. WA 789 000 8967	Manifest Document No. RHO-22-37	22. Page 2	Information in the shaded areas is not required by Federal law.

23. Generator's Name
A. D. Marcy/RHO
2101-M/200 East Area

L. State Manifest Document Number

M. State Generator's ID

24. Transporter 1 Company Name: Rockwell Hanford Operations
25. US EPA ID Number: WA 789 000 8967

N. State Transporter's ID

O. Transporter's Phone: 376-1420

26. Transporter ___ Company Name: N/A
27. US EPA ID Number:

P. State Transporter's ID

Q. Transporter's Phone

	28. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)			29. Containers No.	Type	30. Total Quantity	31. Unit Wt/Vol	R. Waste No.
a.	Hazardous Waste Liquid, NOS (lab waste potassium ferrocyanide)	ORM-E	NA9189	1	DM	1	K	D003
b.	Hazardous Waste Liquid, NOS (Cr^{3+} and Cr^{6+} solutions)	ORM-E	NA9189	1	DM	2	K	D007
c.	Waste Alkaline Liquid, NOS (Colorimetric wastes)	Corrosive Material	NA1719	1	DM	3	K	D002
d.	Waste Alkaline Liquid, NOS (Na_2S standard solutions)	Corrosive Material	NA1719	1	DM	3	K	D002,D003
e.	Waste Sulfuric Acid, Spent	Corrosive Material	UN1832	1	DM	1.3	K	D002
f.								
g.								
h.								
i.								

S. Additional Descriptions for Materials Listed Above
Items a., b., c. and d. and e. are all labpacks of plastic bottles in 5-gallon 17C steel drums with absorbent.

T. Handling Codes for Wastes Listed Above

32. Special Handling Instructions and Additional Information

GENERATOR

TRANSPORTER

33. Transporter ___ Acknowledgement of Receipt of Materials
Printed/Typed Name: A.D. MARCY
Signature: A.D. Marcy
Date: Month 5 Day 14 Year 86

34. Transporter ___ Acknowledgement of Receipt of Materials
Printed/Typed Name: R.L. STEENSMA
Signature: R. L. Steensma
Date: Month 5 Day 14

FACILITY

35. Discrepancy Indication Space

APP B3-16

9312972.0739

Style F16-6 Labelmaster, Chicago, IL 60646 (312) 478-0900

EPA Form 8700-22A (3-84)

ORIGINAL - RETURN TO GENERATOR

Disposal Analysis
No. RHO-22-37
(sheet 1 of 2)

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
1. (RL-0086)	Waste acid liquid, NOS (ICP/AES waste solution, pH below 1)	ICP standards*	0.03	20.0
		Nitric acid	2.00	
		Water	97.97	
2. (RL-0076)	Waste acid liquid, NOS (ICP/AES waste solution, pH below 1)	ICP standards*	0.02	20.0
		Nitric acid	2.00	
		Water	97.98	
3. (RL-0043)	Waste acid liquid, NOS (spectrometric waste solution)	p-amino-dimethyl aniline	0.005	
		Methylene blue	5.0×10^{-5}	
		HCl	0.3	
		H_2SO_4	1.6	
		Cr^6	1.3×10^{-4}	
		Diphenyl	0.018	
		carbazide	0.07	
		Acetone	98.0	
		Water		
		<u>Spectrophotometric Wastes</u>		
4. (RL-0082)	Waste acid liquid, NOS (lab waste with H_2SO_4, and KCr_2O_7 as main components with sulfuric acid and potassium dichromate)	$K_2Cr_2O_7(Cr^{6+})$	0.05	1.0
		H_2SO_4	9.8	
		Diphenylamine carbazide	<0.05	
		Water	90.0	
		<u>Calorimetric Wastes</u>		
(RL-0088)		$K_4Cr_2O_7$	0.03	3.0
(RL-0089)		H_2SO_4	1.1	
(RL-0090)		Water	98.9	
(RL-0083)		Cr^{6+} stock solution	0.28	1.0
		$K_2Cr_2O_7$	9.6	
		H_2SO_4	90.1	
		Water		

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Disposal Analysis
No. RHO-22-37
(sheet 2 of 2)

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
5. (RL-0026)	Hazardous waste liquid, NOS (lab waste potassium ferrocyanide)	$K_4Fe(CN)_6 \cdot 3H_2O$	0.46	1.0
		$K_3Fe(CN)_6$	0.33	
		$KF \cdot 2H_2O$	0.34	
		Water	98.8	
6. (RL-0091)	Hazardous waste liquid, NOS (Cr^3 and Cr^6 solutions)	$K_2Cr_2O_7$	0.5	1.0
		Water (deionized)	99.5	
(RL-0092)		Cr^{3+}	0.5	1.0
		Water	99.5	
7. (RL-0095) (RL-0096)	Waste alkaline liquid, NOS (calorimetric wastes)	EDTA	7.0	3.0
		Ascorbic acid	4.0	
		NaOH	8.0	
		Water	81.0	
8. (RL-0093) (RL-0094) (RL-0097)	Waste alkaline liquid, NOS (Na_2S standard solutions)	Na_2S	0.3	3.0
		NaOH	1.0	
		Water	98.7	
(RL-0098)		Na_2S	0.2	
		NaOH	1.0	
		Water	98.8	
9. (RL-0102)	Waste sulfuric acid, spent	n,n-dimethyl-p-phenylenediamine sulfate	1.2	1.3
		H_2SO_4	50.0	
		Water	48.8	

*See waste analysis sheets on following pages.
AES = atomic emission spectroscopy
DOT = U.S. Department of Transportation
ICP = inductively coupled plasma
NOS = not otherwise specified.

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Waste Analysis Sheet

Analysis of RL-0086		Analysis of RL-0076	
Element	Concentration in mg/L (unless otherwise specified)	Element	Concentration in mg/L (unless otherwise specified)
Na	10.722	Na	15.773
K	199.39	K	46.978
Ca	3.0887	Ca	3.6956
Mg	2.7103	Mg	5.2572
Cu	34.835	Cu	7.4664
Fe	2.3384	Fe	22.264
Mn	2.3174	Mn	4.2498
Ce	2.0027	Ce	1.0090
Ba	1.0715	Ba	1.4857
Sr	1.1723	Sr	3.0695
Li	1.0538	Li	2.2308
V	1.0354	V	0.5315
Rb	1.1715	Rb	<0.6500
La	0.9845	La	0.3940
Al	34.055	Al	8.7113
Pb	1.3846	Pb	0.4319
Zn	1.1482	Zn	16.963
Cr	0.8063	Cr	2.3655
Co	0.8410	Co	0.2882
Cd	0.8503	Cd	0.3415
Ni	0.8100	Ni	0.2887
Be	0.8258	Be	0.2863
Bi	0.9498	Bi	0.2950
Ag	0.1346	Ag	0.0491
Se	1.4731	Se	3.4483
As	No quantitative value	As	<5.0000
Total in mg/L	307.2222	Total in mg/L	153.5322
Total in percent*	0.03	Total in percent*	0.02

*10,000 mg/L = 1%.

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1 **ON-SITE SHIPPING DOCUMENTS**
2
3 RHO-22-165

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DOE/RL 88-41
Revision 2

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. WA 789 000 8967
Manifest Document No. RHO-22-165
2. Page 1 of 2
Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
A.D. Marcy/RHO
2101M/200 East
4. Generator's Phone (509) 373-4100

A. State Manifest Document Number
B. State Generator's ID

5. Transporter 1 Company Name: Rockwell Hanford Operations
6. US EPA ID Number: WA 789 000 8967
C. State Transporter's ID
D. Transporter's Phone 376-1420

7. Transporter 2 Company Name
8. US EPA ID Number
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
2727-S/200 West Area
Storage Facility
10. US EPA ID Number: WA 789 000 8967
G. State Facility's ID
H. Facility's Phone 373-4032

	11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.	Waste Acid Liquid,NOS (RL-0104) Corrosive material NA1760	1	DM	20	K	D008,D010 D004,D002
b.	Waste Acid Liquid,NOS (RL-0105) Corrosive material NA1760	1	DM	20	K	D002,D004
c.	Waste Acid, Liquid,NOS (RL-0108) Corrosive material NA1760	1	CF ~~DM~~	20	K	D002,D010 D008
d.	Waste Acid Liquid,NOS (RL-0130) Corrosive material NA1760	1	CF	20	K	D006,D007 D008,D010 D002

J. Additional Descriptions for Materials Listed Above
Items a and b are labpacked in 30-gallon 17H steel drums.
Items c and d are labpacked in 5-gallon 12P fiberboxes with 2U inner polyethylene containers.

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment. NLP 7-21-86

GENERATOR

Printed/Typed Name	Signature	Month	Day	Year
A. D. MARCY	A D Marcy	7	21	86

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year
K.L. STEENSMA	K L Steensma	7	23	86

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year

TRANSPORTER

19. Discrepancy Indication Space

FACILITY

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name	Signature	Month	Day	Year
H C Boynton	H C Boynton	7	23	86

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UNIFORM HAZARDOUS WASTE MANIFEST
(Continuation Sheet)

21. Generator's US EPA ID No.: WA 789 000 8967

Manifest Document No.:

22. Page: 2

...the shaded ... required by Federal law.

23. Generator's Name: A.D. Marcy/RHO 2101M/200 East

RHO-22-165

L. State Manifest Document Number:

M. State Generator's ID:

24. Transporter 1 Company Name: Rockwell Hanford Operations

25. US EPA ID Number: WA 789 000 8967

N. State Transporter's ID:

O. Transporter's Phone: 376-1420

26. Transporter ___ Company Name:

27. US EPA ID Number:

P. State Transporter's ID:

Q. Transporter's Phone:

28. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)			29. Containers No.	Type	30. Total Quantity	31. Unit Wt/Vol	R. Waste No.
a. Waste Acid Liquid,NOS (RL-0107,RL-0109--RL-0113,RL-0120)	Corrosive material	NA1760	3	DM	26	K	D002
b. Hazardous Waste Liquid,NOS (RL-0081)	ORM-E	NA9189	1	DM	0.9	K	D003
c. Waste Alkaline liquid,NOS (RL-0114-RL-0116,RL-0118 RL-0119,RL-0132)	Corrosive material	NA1719	2	DM	5.45	K	D002,D003
d. Waste Alkaline Liquid,NOS (RL0117)	Corrosive material	NA1719	1	DM	1.0	K	D008,D002
e. Waste Acid Liquid,NOS (RL-0121-RL-0125,RL-0135)	Corrosive material	NA1760	2	DM	6	K	WT01,D002 D007
f. Waste Toluene (RL-0131)	Flammable Liquid	UN1294	1	DM	1.0	K	U220,F0(
g. Waste Hydrofluoric Acid Solution(48%)(RL-0134)	Corrosive material	UN1790	1	CF	6.0	K	U134
h. Hazardous Waste Liquid,NOS (RL-0137)	ORM-E	NA9189	1	DM	24.6	K	D005
i. Waste Acid Liquid,NOS (RL-0106)	Corrosive material	NA1760	1	DM	20	K	D002,D010

S. Additional Descriptions for Materials Listed Above

Item a is two 5-gallon 17C drums and one 30-gallon 17H drum labpack. Items b, c, d, e, and f are 5-gallon 17C drum labpacks.Item g. is a 12P CF with a 2U inner poly container. Items h and i are 30-gallon 17H steel drum labpacks.

T. Handling Codes for Wastes Listed Above

32. Special Handling Instructions and Additional Information

GENERATOR

TRANSPORTER

33. Transporter ___ Acknowledgement of Receipt of Materials

Printed/Typed Name: R.L. STEENSMA

Signature: R.L. Steensma

Date: Month Day Year 7 23 86

34. Transporter ___ Acknowledgement of Receipt of Materials

Printed/Typed Name:

Signature:

Date: Month Day Year

FACILITY

35. Discrepancy Indication Space

APP B3-24

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Disposal Analysis
No. RHO-22-165
(sheet 1 of 3)

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
1. (RL-0104)	Waste acid liquid, NOS (ICP/AES waste solution containing lead, selenium, and arsenic)	ICP Standards* Nitric acid Water	0.10 2.00 97.90	20
2. (RL-0105)	Waste acid liquid, NOS (ICP/AES waste solution containing arsenic)	ICP Standards* Nitric acid Water	1.45 2.00 96.55	20
3. (RL-0108)	Waste acid liquid, NOS (ICP/AES waste solution containing lead and selenium)	ICP Standards* Nitric acid Water	0.06 2.00 97.94	20
4. (RL-0130)	Waste acid liquid, NOS (ICP/AES waste solution containing lead, chromium, cadmium, and selenium)	ICP Standards* Nitric acid Water	0.05 2.00 97.95	20
5. (RL-0107)	Waste acid liquid, NOS (sulfuric acid, spectrometric waste solutions)	H_2SO_4 $FeCl_3$ Para-amino dimethyl aniline (PADMA) Water	2.8 0.75 0.009 96.4	20
(RL-0109 RL-0110 RL-0111 RL-0112)		$CdSO_4$ H_2SO_4 $FeCl_3$ PADMA Methylene blue Water	0.2 3.0 0.1 0.05 0.0001 96.6	5.0
(RL-0120)		PADMA H_2SO_4 Water	0.3 50.0 49.7	1.0

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Disposal Analysis
No. RHO-22-165
(sheet 2 of 3)

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
6. (RL-0081)	Hazardous waste liquid, NOS (potassium ferro-cyanide complexes)	$K_4Fe(CN)_6 \cdot 3H_2O$	0.46	0.9
		$K_3Fe(CN)_6$	0.33	
		$KF \cdot 2H_2O$	0.34	
		Water	98.87	
7. (RL-0114)	Waste alkaline liquid, NOS (Na_2 standards solutions)	Na_2S	0.005	
		Water	99.995	
(RL-0115)				
		Na_2S	1.0	3.0
		Water	99.0	
(RL-0116)				
		Na_2S	0.005	
		Water	99.995	
(RL-0118)				
		Na_2S	0.75	
		NaOH	0.5	2.0
		Water	98.75	
(RL-0119)				
		Na_2S	1.8	
		Water	98.2	0.45
8. (RL-0117)	Waste alkaline liquid, NOS (sodium hydroxide with lead)	NaOH	8.0	1.0
		EDTA	7.0	
		Ascorbic acid	4.0	
		Solid PbS	1.0	
		$Pb(NO_3)_2$	0.05	
		H_2O	79.95	
9. (RL-0121 RL-0124)	Waste acid liquid, NOS (chromic acid solutions)	Cr_2O_3	4.1	
		Water	95.9	
				3.0
(RL-0135)	Cleanup from leaking chromic acid vials	Cr_2O_3	3.0	
		Water	97.0	
(RL-0122 RL-0123)	Cleanup from leaking chromic acid vials	Cr_2O_3	8.2	
		Water	91.8	
				3.0
(RL-0125)	Cleanup from leaking	Cr_2O_3	1.0	

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Disposal Analysis
No. RHO-22-165
(sheet 3 of 3)

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
10. (RL-0131)	Waste toluene	Toluene	100.0	1.0
11. (RL-0134) (RL-0136) (RL-0129)	Waste hydrofluoric acid solution (trace amount of Zr)	HF Water	48.0 52.0	6.0
12. (RL-0137)	Hazardous waste liquid, NOS (barium waste solution)	See waste analysis sheets on following pages Water	0.70 99.30	24.6
13. (RL-0106)	Waste acid liquid, NOS (ICP/AES waste solution containing selenium)	ICP standards* Nitric acid Water	0.01 2.00 97.99	20.0

*See waste analysis sheets on following pages.
AES = atomic emission spectroscopy
DOT = U.S. Department of Transportation
ICP = inductively coupled plasma
NOS = not otherwise specified.

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Waste Analysis Sheet

Analysis of RL-0104		Analysis of RL-0105	
Element	Concentration in mg/L (unless otherwise specified)	Element	Concentration in mg/L (unless otherwise specified)
Na	531.17	Na	30.465
K	6.3830	K	9.2606
Ca	2.7781	Ca	7.8282
Mg	1.8726	Mg	2.7290
Cu	3.3071	Cu	54.542
Fe	3.3961	Fe	8.2753
Mn	1.7989	Mn	0.5956
Ce	1.4739	Ce	0.5223
Ba	2.9840	Ba	69.148
Sr	0.8316	Sr	0.3968
Li	14.478	Li	165.25
V	0.7924	V	0.2084
Rb	0.3525	Rb	0.3534
La	0.5949	La	0.2242
Al	1.0757	Al	65.147
Pb	45.137	Pb	0.2135
Zn	0.4512	Zn	0.3645
Cr	2.7182	Cr	0.0952
Co	0.0824	Co	0.0731
Cd	0.3812	Cd	0.1555
Ni	0.0742	Ni	0.1425
Be	0.0907	Be	0.0467
Bi	<0.0340	Bi	0.3134
Ag	0.0524	Ag	0.0095
Se	151.77	Se	0.9917
As	224.60	As	66.000
Si	7.3276	Si	38.112
B	26.986	Mo	0.1519
Mo	0.0901		
Total in mg/L	1033.0838	Total in mg/L	521.6153
Total in percent*	0.10	B in percent	1.4
		Total in percent*	1.45

*10,000 mg/L = 1%.

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Waste Analysis Sheet

Analysis of RL-0108		Analysis of RL-0130	
Element	Concentration in mg/L (unless otherwise specified)	Element	Concentration in mg/L (unless otherwise specified)
Na	23.903	Na	103.709
K	241.66	K	17.255
Ca	2.1098	Ca	15.529
Mg	2.8750	Mg	13.511
Cu	1.4455	Cu	12.833
Fe	1.0532	Fe	13.613
Mn	1.1520	Mn	13.183
Ce	0.9522	Ce	12.707
Ba	0.9362	Ba	6.9672
Sr	0.5315	Sr	6.3842
Li	0.9667	Li	6.4643
V	0.5146	V	6.4511
Rb	0.3810	Rb	6.3361
La	0.4953	La	6.3666
Al	0.8587	Al	19.532
Pb	149.59	Pb	82.047
Zn	113.46	Zn	17.745
Cr	2.3358	Cr	9.0063
Co	0.3762	Co	9.0192
Cd	0.5915	Cd	8.9671
Ni	24.490	Ni	9.2826
Be	0.3558	Be	9.0041
Bi	0.2863	Bi	9.0506
Ag	0.0641	Ag	0.0903
Se	1.0579	Se	111.89
As	0.4717	As	0.5566
Si	4.7246	Si	2.9655
B	20.025	B	0.2412
Mo	5.7198	Mo	0.5110
Total in mg/L	603.3834	Total in mg/L	531.2090
Total in percent*	0.06	Total in percent*	0.05

*10,000 mg/L = 1%.

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Waste Analysis Sheet

Analysis of RL-0137		Analysis of RL-0106	
Element	Concentration in mg/L (unless otherwise specified)	Element	Concentration in mg/L (unless otherwise specified)
Na	7000.0	Na	45.451
K	3.3764	K	1.8931
Ca	4.8843	Ca	1.0667
Mg	2.3434	Mg	0.7224
Sr	0.0114	Cu	0.8223
Ba	2.9413	Fe	0.7684
Li	0.0162	Mn	0.8205
V	<0.0200	Ce	0.5402
Si	7.7766	Ba	1.2799
B	<0.1000	Sr	0.3369
Mo	<0.6000	Li	2.7759
Cu	<0.0300	V	0.3185
Fe	<0.0300	Rb	<0.0830
Mn	<0.0100	La	0.2985
Zn	<0.0400	Al	0.3898
Al	<0.2000	Pb	0.2112
Ti	<0.2000	Zn	0.1686
Zr	<0.2000	Cr	0.1168
		Co	0.1144
Total in mg/L	7022.7796	Cd	0.1159
		Ni	0.1068
Total in percent*	0.70	Be	0.1226
		Bi	0.0689
		Ag	0.0531
		Se	2.0767
		As	1.3245
		Si	3.8420
		B	3.1921
		Mo	0.0211
		Total in mg/L	69.0988
		Total in percent*	0.01

*10,000 mg/L = 1%.

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ON-SITE SHIPPING DOCUMENTS

RHO-22-246

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No: WA 789 000 8967
Manifest Document No: RHO-22-246
2. Page 1 of 1
Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
A.D. Marcy/RHO
2101M/200 East
4. Generator's Phone: (509) 373-4100

A. State Manifest Document Number
B. State Generator's ID

5. Transporter 1 Company Name: Rockwell Hanford Operations
6. US EPA ID Number: WA 789 000 8967
C. State Transporter's ID
D. Transporter's Phone: 376-1420

7. Transporter 2 Company Name
8. US EPA ID Number
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
2727-S/200 West Area
Storage Facility
10. US EPA ID Number: WA 789 000 8967
G. State Facility's ID
H. Facility's Phone: 373-4032

GENERATOR

	11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.	Flammable Waste Liquid,NOS (Acetone bottle, Toluene bottle) Flammable Liquid UN1993	1	DM	1.2	K	U002,F003 U220,F005
b.	Waste Acid liquid,NOS (ICP/AES nitric acid with Se) Corrosive material NA1760	1	CF	20	K	D002,D010
c.	Hazardous Waste Liquid,NOS (05% sodium sulfite solution) ORM-E NA9189	1	DM	8	K	WT02
d.						

J. Additional Descriptions for Materials Listed Above
Item a is a labpacked 5-gallon 17C steel drum with kitty litter
Item b is a 5-gallon 12P fiberboard box with a 2U inner polyethylene container. Item c is a labpacked 17H 30-gallon steel drum with kitty litter filler.

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment. 7-30-86

Printed/Typed Name: A.D. Marcy
Signature: A.D. Marcy
Month 8 Day 5 Year 86

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: D.E. McNaa
Signature: D.E. Mc
Month 8 Day 6 Year 86

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name
Signature
Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name: H.C. Boynton
Signature: H.C. Boynton
Month 8 Day 8 Year 86

Style F15R-6 Labelmaster, Div. of American Labelmark Co. Inc. 60646
EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete.

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Disposal Analysis
No. RHO-22-246

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
1. (RL-0011)	Flammable liquid, NOS (acetone bottle, toluene bottle)	Acetone	99.0	1.0
		Basalt	1.0	
(RL-0087)		Toluene	95.0	0.2
		Epoxy	5.0	
2. (RL-0138)	Waste acid liquid, NOS (ICP/AES metric acid with selenium)	ICP standards*	0.03	20.0
		Nitric acid	2.0	
		Water	97.97	
3. (RL-0073)	Hazardous waste liquid, NOS (5% sodium sulfite solution)	Na_2SO_3	5.0	7.0
(RL-0067)		Water	95.0	1.0

*See waste analysis sheets on following page.
AES = atomic emission spectroscopy
DOT = U.S. Department of Transportation
ICP = inductively coupled plasma
NOS = not otherwise specified.

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Waste Analysis Sheet

Analysis of RL-0138

Element	Concentration in mg/L (unless otherwise specified)
Na	31.901
K	14.430
Ca	14.065
Mg	13.255
Cu	12.818
Fe	13.750
Mn	12.944
Ce	1.5580
Ba	11.761
Sr	11.455
Li	45.387
V	1.0544
Rb	0.9083
La	0.8512
Al	4.2272
Pb	0.8073
Zn	0.4606
Cr	0.3844
Co	0.4040
Cd	0.3786
Ni	0.3955
Be	0.3865
Bi	0.4740
Ag	0.0610
Se	1.1867
As	0.3888
Si	42.960
B	71.424
Mo	15.631
Total in mg/L	325.7075
Total in percent*	0.03

*10,000 mg/L = 1%.

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1 ON-SITE SHIPPING DOCUMENTS
2
3 RHO-22-282

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UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. WA 789 000 8967 | Document No. RHO-22-282 | 2. Page 1 of 2 | Information in the shaded areas is required by Federal law.

3. Generator's Name and Mailing Address
~~Xxx Xxx Xxxxx Xxxx~~ J. R. Smith
2101-M/200 East Area
4. Generator's Phone (509) 373-4100

A. State Manifest Document Number
B. State Generator's ID

5. Transporter 1 Company Name: Rockwell Hanford OPerations
6. US EPA ID Number: WA 789 000 8967
C. State Transporter's ID
D. Transporter's Phone: 376-1420

7. Transporter 2 Company Name: N/A
8. US EPA ID Number:
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
2727-S/200 West Area
Storage Facility
10. US EPA ID Number: WA 789 000 8967
G. State Facility's ID
H. Facility's Phone: 373-4032

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)		12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. Waste Alkaline, Liquid, NOS (item #1) Corrosive Material NA1719		4	DF	456	K	D002 D005
b. Waste Acid, Liquid, NOS (item #2) Corrosive Material NA1760		2	DM	7	K	D002
c. Waste Acid, Liquid, NOS (item #3) Corrosive Material NA1760		1	DM	15	K	D002 F003
d. Waste Acid, Liquid, NOS (item #4) Corrosive Material NA1760		1	CF	20	K	WT02 D002

J. Additional Descriptions for Materials Listed Above: Item a. are 4 DOT 34, 30-gallon plastic drums. Item b. is 2 4-liter plastic bottles labpacked in 25-gallon 17C drum with kitty litter filler. Item c. is a 5-gallon plastic jug labpacked in a 30-gallon 17H steel drum with kitty litter. Item d. is a 5-gallon DOT 12P fiberboard box with a 2U inner poly container.

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.
Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment. 8-27-86

Printed/Typed Name: J. R. Smith | Signature | Month 9 Day 3 Year 86

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: D. E. Mollas | Signature | Month 9 Day 3 Year 86

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name | Signature | Month Day Year

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name: Gary M. DeWinkle | Signature | Month 9 Day 3 Year 86

Style F15R-6 Labelmaster, Div. of American Labelmark Co. Inc. 60646 EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete.

.. type. (Form designed for use on elite (12-pitch) typewriter.) DOE/RL 88-41 Revision 2 Form Approved. OMB No. 2050-0404 Expires 7-31-88

UNIFORM HAZARDOUS WASTE MANIFEST (Continuation Sheet)	21. Generator's US EPA ID No. WA 789 000 8967	Document No. RHO-22-282	22. Page 2	Information in the shaded areas is not required by Federal law.

23. Generator's Name
XXXXXXXXXXXXXXXXXX J. R. Smith
2101-M/200 East Area

L. State Manifest Document Number

M. State Generator's ID

24. Transporter 1 Company Name — 25. US EPA ID Number: WA 789 000 8967

N. State Transporter's ID

O. Transporter's Phone

26. Transporter ___ Company Name — 27. US EPA ID Number

P. State Transporter's ID

Q. Transporter's Phone

	28. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	29. Containers No.	Type	30. Total Quantity	31. Unit Wt/Vol	R. Waste No.
a.	Waste Acid, Liquid, NOS (item #5) Corrosive Material NA1760	1	CF	17	K	D002 WT02
b.						
c.						
d.						
e.						
f.						
g.						
h.						
i.						

S. Additional Descriptions for Materials Listed Above
Item a. is a 5-gallon DOT 12P fiberboard box with an inner DOT 2U poly container.

T. Handling Codes for Wastes Listed Above

32. Special Handling Instructions and Additional Information

GENERATOR

TRANSPORTER

33. Transporter ___ Acknowledgement of Receipt of Materials

Printed/Typed Name: D.R. McLuan — Signature: [signature] — Date: Month 9 Day 13 Year 86

34. Transporter ___ Acknowledgement of Receipt of Materials

Printed/Typed Name — Signature — Date: Month Year

FACILITY

35. Discrepancy Indication Space

APP B3-40

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RETURN TO

Disposal Analysis
No. RHO-22-282

Item number	DOT shipping name	Constituents	Percent of volume	Total quantity (kg)
1. (RL-0140 RL-0148 RL-0154 RL-0155)	Waste alkaline liquid, NOS	$BaCl_2$	0.4	456.0
		$NaOH$	0.2	
		Water	99.4	
2. (RL-0146 RL-0153)	Waste acid liquid, NOS	H_2SO_4	2.8	7.0
		$FeCl_3$	0.75	
		Para-amino dimethyl aniline	0.009	
		Water	96.4	
3. (RL-0151)	Waste acid liquid, NOS	H_2SO_4	0.03	15.0
		Diphenyl carbazide	0.0005	
		Acetone	0.08	
		$K_2Cr_2O_7$	0.0003	
		Water	99.8	
4. (RL-0152)	Waste acid liquid, NOS	NHO_3	2.0	20.0
		Heavy metals	0.01	
		Water	98.0	
5. (RL-0157)	Waste acid liquid, NOS	$LiBO_2$	0.6	17.0
		HNO_3	4.0	
		Clay components	0.06	
		Water	95.3	

DOT = U.S. Department of Transportation
NOS = not otherwise specified.

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APPENDIX B-4.

WELL CONSTRUCTION DIAGRAMS

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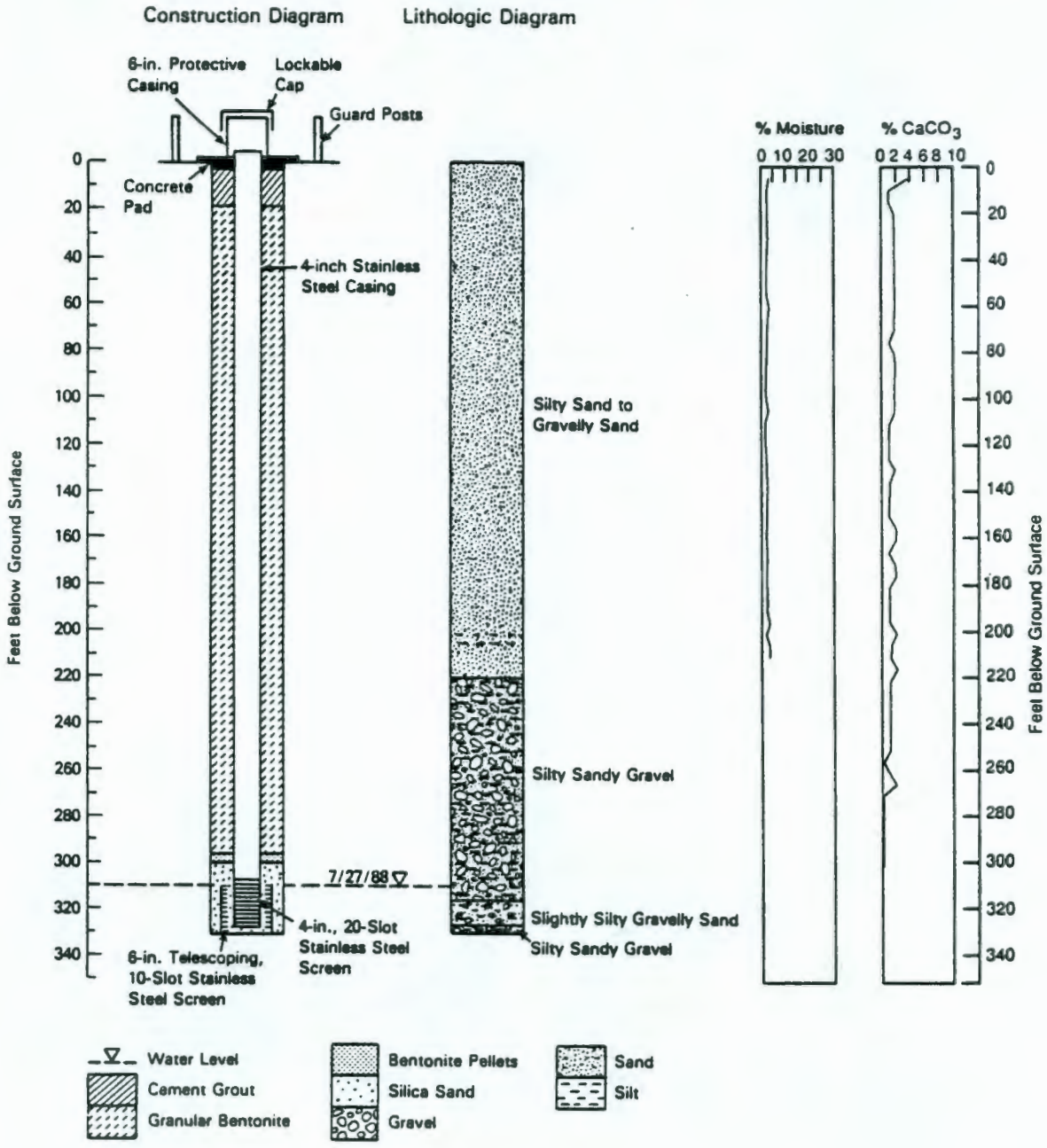

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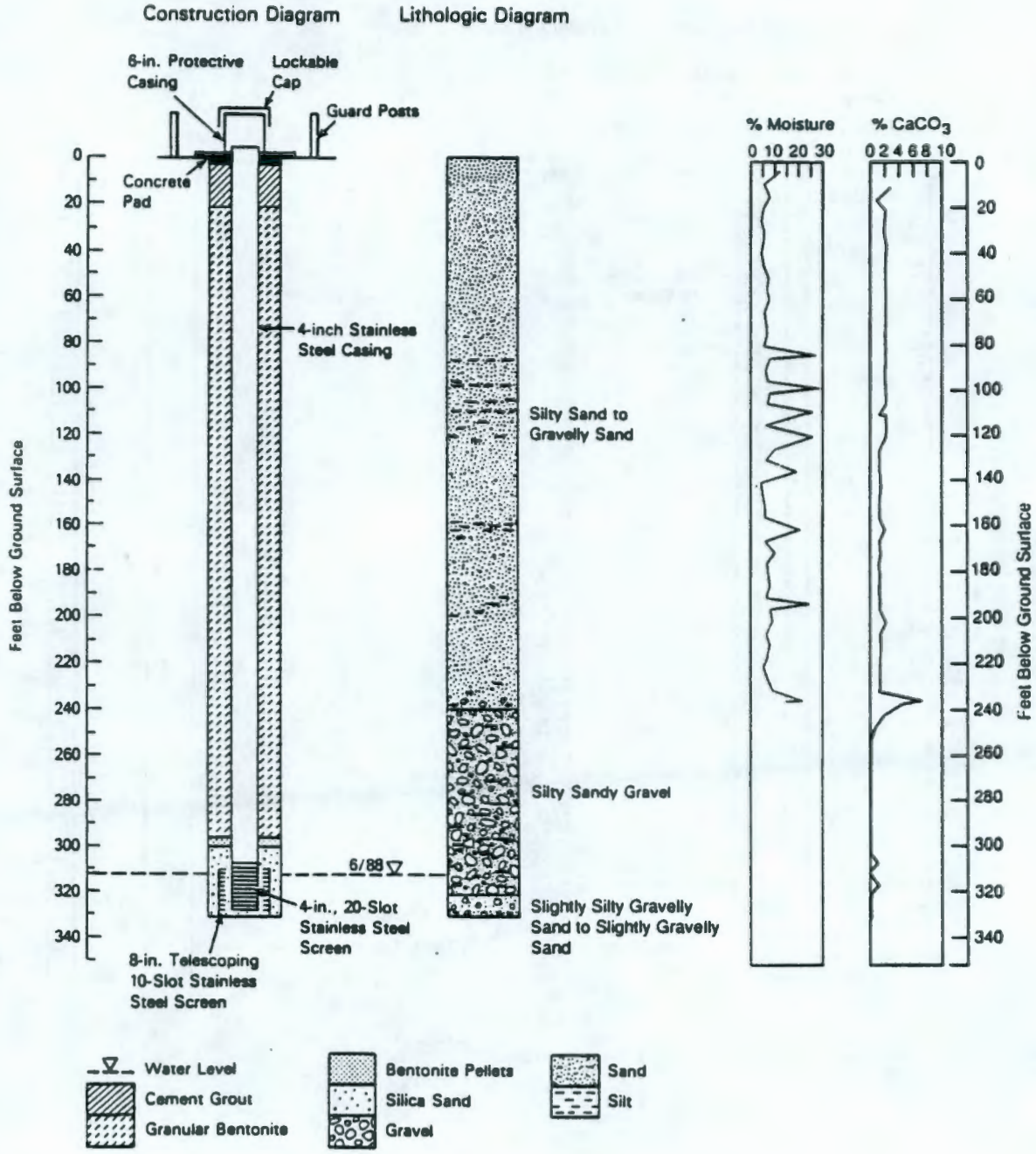

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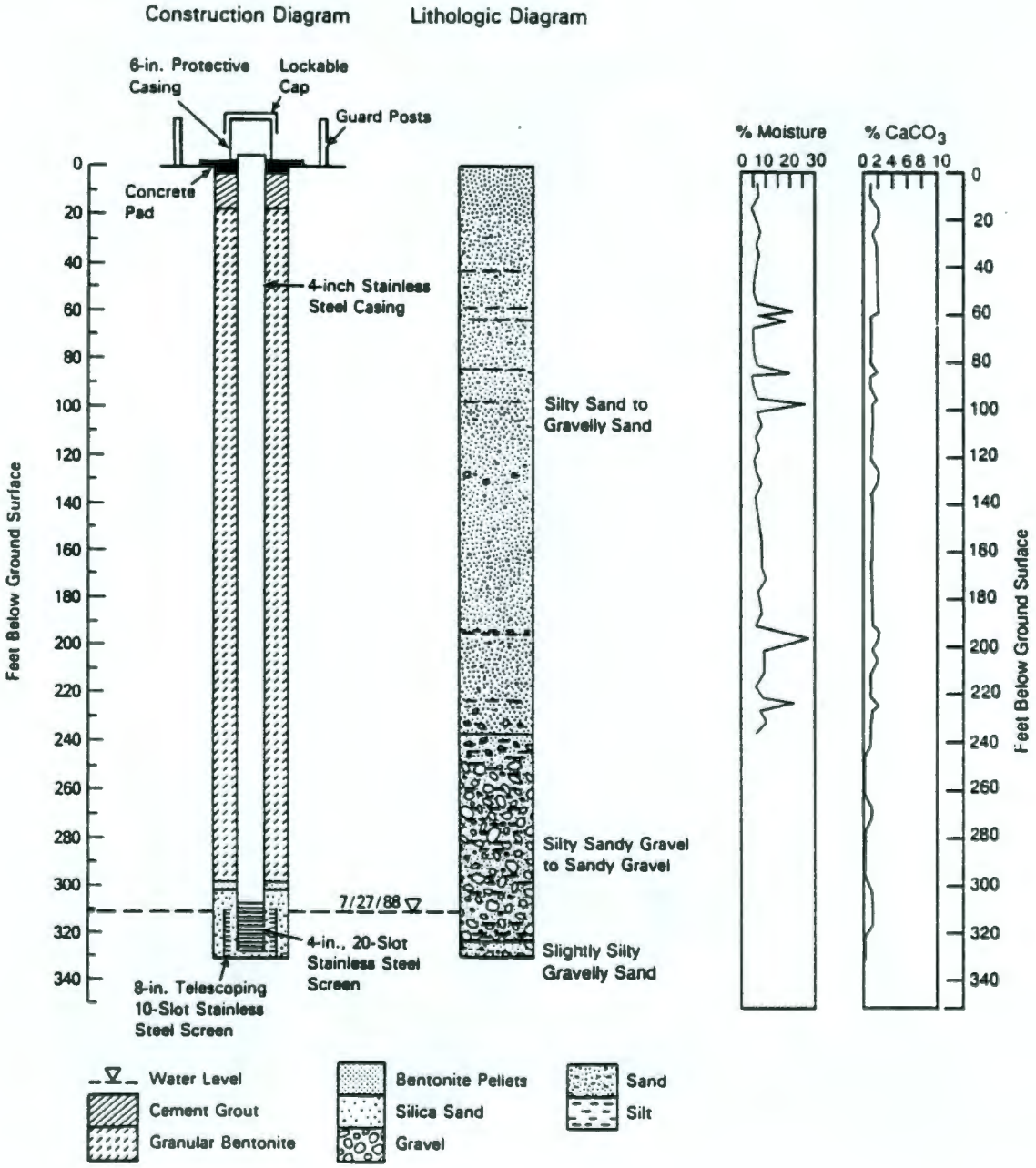

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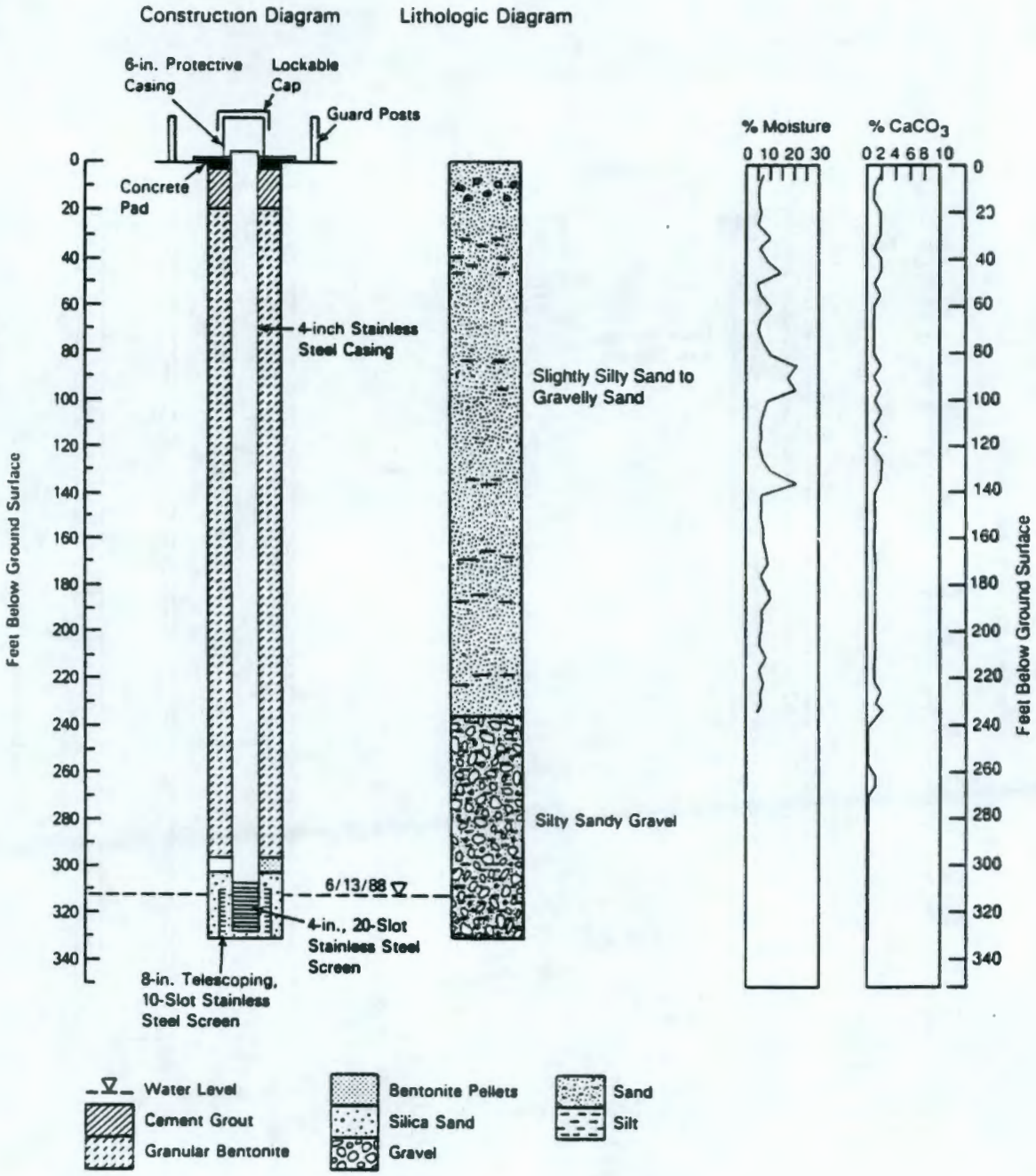

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APPENDIX B-5.

EVALUATION OF COVER DESIGN PERFORMANCE

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2.0 SURFACE WATER EROSION . . . . . APP B5-1

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1.0 INTRODUCTION

The following sections evaluate the performance of the preliminary cover design as required by WAC-173-303. The areas in which the cover is evaluated are (1) surface water erosion, (2) wind erosion, (3) and landfill performance (HELP model evaluation). These evaluations support the effectiveness of the preliminary cover design.

2.0 SURFACE WATER EROSION

Water Erosion Potential--The erosion potential of the cover surface soil because of precipitation events is evaluated using the U.S. Department of Agriculture (USDA) Universal Soil Loss Equation (USLE). The Universal Soil Loss Equation consists of six quantifiable factors, as follows (EPA 1979):

$$A = RKLSCP$$

where:

A = average soil loss (tons/acre/yr)
R = rainfall and run-off erosivity index
K = soil erodibility factor
L = slope length factor
S = slope steepness factor
C = cover/management factor
P = practice factor.

For this preliminary design, McGee Ranch will be the assumed borrow site for the topsoil layer. The following topsoil properties and cover design details are used to evaluate A:

- Topsoil type: silt to silt loam
- Average percent organic matter: 0.23% (Routson 1973)
- Estimated percent clay: 6% (Routson 1973)
- Estimated percent silt: 85% (Last et al. 1987)
- Estimated percent sand: 9% (Last et al. 1987)
- Uniform percent cover slope: 3%
- Cover length (Maximum drainage length): 50 ft
- Cover vegetation: Thickspike and Siberian wheatgrasses.

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Therefore:

R = 20, from Figure B5-1 (EPA 1979)
K = 0.64, from Figure B5-2 (EPA 1979)
LS = 0.24, from Table B5-1 (EPA 1979)
C = 0.20 (Nyhan 1986)
P = 1.0 (Nyhan 1986)
A = (20)(0.64)(0.24)(0.20)(1.0) = 0.62 tons/acre per yr.

This is an acceptable erosion rate as the overall site erosion is recommended to be limited to 2 tons/acre, which is a rate that does not significantly increase cover maintenance (EPA 1982).

Sheet Erosion Potential of Cover--The cover design is evaluated also to determine if the 3% topsoil slope can withstand overland or sheet flow with a minimum of erosion. The 50-yr, 20-minute storm rainfall intensity of 1.6 in./hour (Table B5-2) is assumed for the design storm (Stone et al. 1983). The 50-yr storm was selected because it exceeds the minimum design life of the cover. The 20-minute rainfall intensity of 1.6 in./hour was assumed because that intensity did occur once in a 20-minute thunderstorm over the 37 yr that data was recorded at the Hanford Meteorology Station (Stone et al. 1983). The Rational Method is used for determining design discharge for tributary areas of 1 m^2 or less (about 1.196 yd^2) (Nelson and Abt 1986). Unit width analysis is used where area is expressed as slope length by unit width and where unit width = 1 foot.

$$Q = CiA$$

where:

Q = Maximum design discharge (ft^3/s)
C = Run-off coefficient (assuming C = 1.00 indicates no infiltration or worst-case scenario)
i = Intensity of rainfall (in./h)
A = Area of tributary (acres).

A portion of the design is all that need to be evaluated. The portion will be assumed to be a homogeneous watershed area. It will have a 3% slope with a length and a width of roughly 55 ft. Because the entire cover section cannot contribute to a single tributary, it is assumed that any tributary area is square. This yields an area of 0.07 acres.

Therefore:

$$Q = (1\ ft)(1.6\ in/hr)(0.07\ acres) = 0.11\ ft^3/s$$

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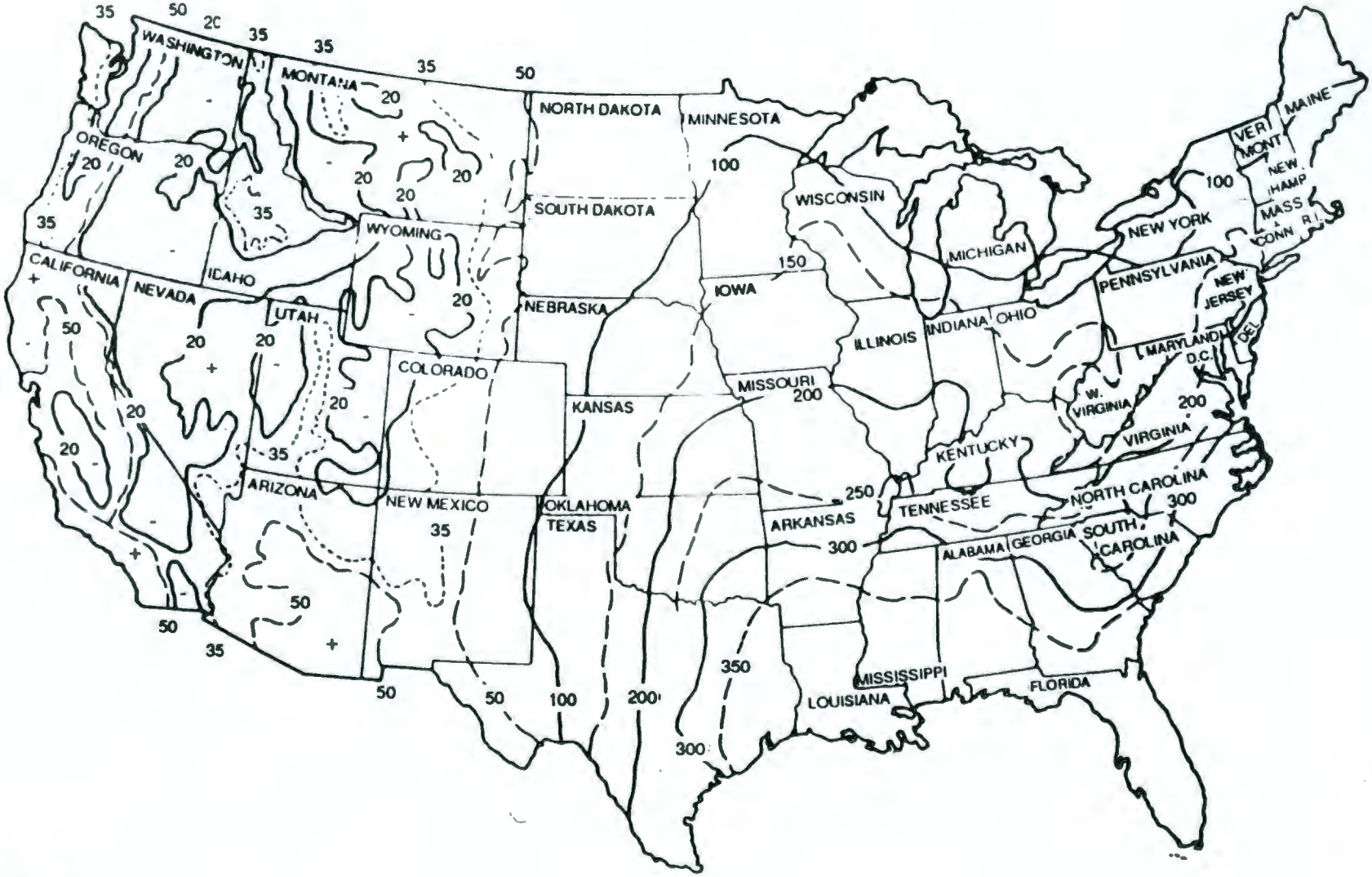
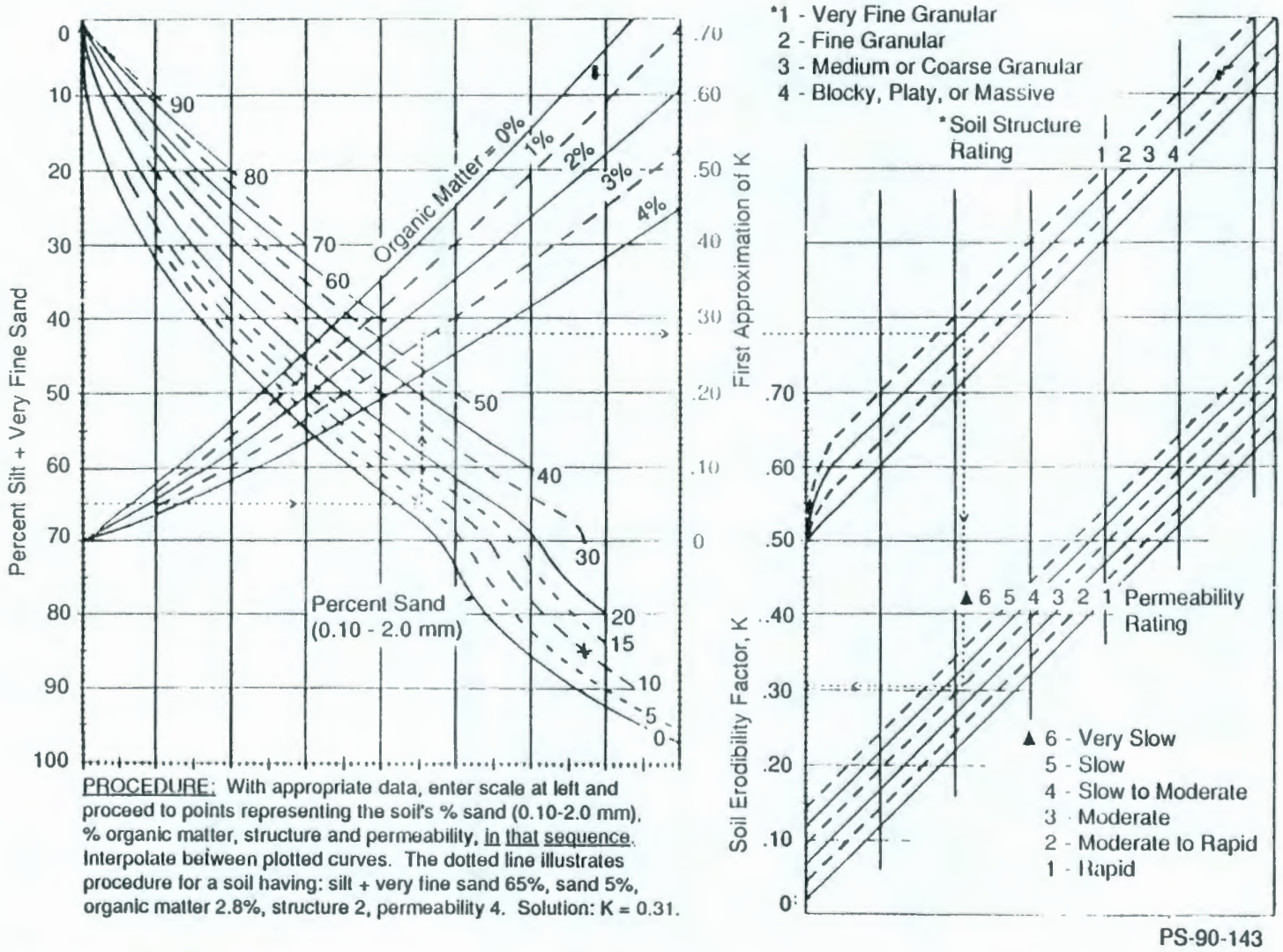


EPA, 1979

PS-90-138

Figure B5-1. Average Annual Values of Rainfall-Erosivity Factor R. (EPA 1979).

EPA, 1979



PROCEDURE: With appropriate data, enter scale at left and proceed to points representing the soil's % sand (0.10-2.0 mm), % organic matter, structure and permeability, in that sequence. Interpolate between plotted curves. The dotted line illustrates procedure for a soil having: silt + very fine sand 65%, sand 5%, organic matter 2.8%, structure 2, permeability 4. Solution: K = 0.31.

1 **Figure B5-2. Nomograph for Determining Soil-Erodibility Factor K for U.S. Mainland. (EPA 1979).**

Table B5-1. Values of the Factor LS for Specific Combinations of Slope Length and Steepness.

% Slope	Slope length (feet)											
	25	50	75	100	150	200	300	400	500	600	800	1,000
0.5	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
1	0.09	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.21	0.22	0.24	0.26
2	0.13	0.16	0.19	0.20	0.23	0.25	0.28	0.31	0.33	0.34	0.38	0.40
3	0.19	0.23	0.26	0.29	0.33	0.35	0.40	0.44	0.47	0.49	0.54	0.57
4	0.23	0.30	0.36	0.40	0.47	0.53	0.62	0.70	0.76	0.82	0.92	1.0
5	0.27	0.38	0.46	0.54	0.66	0.76	0.93	1.1	1.2	1.3	1.5	1.7
6	0.34	0.48	0.58	0.67	0.82	0.95	1.2	1.4	1.5	1.7	1.9	2.1
8	0.50	0.70	0.86	0.99	1.2	1.4	1.7	2.0	2.2	2.4	2.8	3.1
10	0.69	0.97	1.2	1.4	1.7	1.9	2.4	2.7	3.1	3.4	3.9	4.3
12	0.90	1.3	1.6	1.8	2.2	2.6	3.1	3.6	4.0	4.4	5.1	5.7
14	1.2	1.6	2.0	2.3	2.8	3.3	4.0	4.6	5.1	5.6	6.5	7.3
16	1.4	2.0	2.5	2.8	3.5	4.0	4.9	5.7	6.4	7.0	8.0	9.0
18	1.7	2.4	3.0	3.4	4.2	4.9	6.0	6.9	7.7	8.4	9.7	11.0
20	2.0	2.9	3.5	4.1	5.0	5.8	7.1	8.2	9.1	10.0	12.0	13.0
25	3.0	4.2	5.1	5.9	7.2	8.3	10.0	12.0	13.0	14.0	17.0	19.0
30	4.0	5.6	6.9	8.0	9.7	11.0	14.0	16.0	18.0	20.0	23.0	25.0
40	6.3	9.0	11.0	13.0	16.0	18.0	22.0	25.0	28.0	31.0	--	--
50	8.9	13.0	15.0	18.0	22.0	25.0	--	--	--	--	--	--
60	12.0	16.0	20.0	23.0	28.0	--	--	--	--	--	--	--

NOTE: Values given for slopes longer than 300 ft or steeper than 18% are extrapolations beyond the range of the research data and, therefore, are less certain than the others (EPA 1979).

Table B5-2. Average Return Period and Existing Record for Various Precipitation Amounts and Intensity During Specified Time Periods at the Hanford Site (based on extreme value analysis of 1947 through 1969 records).

Average return period years	Time period (amount in inches)							Time period (intensity in inches per hour)						
	Minutes		Hours					Minutes		Hours				
	20	60	2	3	6	12	24	20	60	2	3	6	12	24
2	0.16	0.26	0.30	0.36	0.48	0.62	0.72	0.49	0.26	0.15	0.12	0.08	0.052	0.030
5	0.24	0.40	0.48	0.55	0.77	0.95	1.06	0.72	0.40	0.24	0.18	0.13	0.079	0.044
10	0.37	0.50	0.59	0.67	0.96	1.17	1.28	1.1	0.50	0.30	0.22	0.16	0.098	0.053
25	0.47	0.62	0.74	0.83	1.21	1.45	1.56	1.4	0.62	0.37	0.28	0.20	0.121	0.065
50	0.53	0.72	0.85	0.96	1.40	1.66	1.77	1.6	0.72	0.42	0.32	0.23	0.138	0.074
100	0.60	0.81	0.96	1.07	1.59	1.87	1.99	1.8	0.81	0.48	0.36	0.27	0.156	0.083
250	0.68	0.93	1.11	1.22	1.82	2.13	2.26	2.0	0.93	0.55	0.41	0.30	0.177	0.094
500	0.73	1.02	1.22	1.33	2.00	2.34	2.47	2.2	1.02	0.61	0.44	0.33	0.195	0.103
1,000	0.80	1.11	1.33	1.45	2.20	2.55	2.68	2.4	1.11	0.67	0.48	0.37	0.212	0.122
Existing record	[a]	0.59	0.88	1.08	1.68	1.88	1.91	[a]	0.59	0.44	0.36	0.28	0.157	0.080
Month/day		6/12	10/1	10.5	10.5	10.5	10.5		6/12	10/1	10/1	10.5	10.5	10.5
Year	--	1969	1957	1957	1957	1957	1957	--	1969	1959	1959	1959	1959	1959

NOTE: Records for 1947 through 1969 are from Stone et al. (1983).

[a]No records have been kept for time periods of less than 60 min. However, the rain gage chart for 6-12/69 shows the 0.55 in occurred during a 20-min period from 6:35 p.m., Pacific Standard Time. An additional 0.04 in occurred between 6:55 p.m. and 7:10 p.m., Pacific Standard Time, to account for the record 60-minute amount of 0.59 inch.

In order to do unit analysis, the depth of flow for this discharge must be determined. Flow depth is calculated as follows:

$$y = [Qn/(1.486)(S^{0.5})]^{0.6}$$

where:

y = depth of flow (ft)
Q = maximum design discharge (ft^3/second) (from previous equation)
n = manning roughness coefficient (where n = 0.02 for silt loam (Nelson and Abt 1986))
S = cover slope (percent).

Therefore:

$$y = [(0.11\ cfs)(0.020)/(1.486)(0.03)^{0.5}]^{0.6} = 0.06\ ft.$$

The velocity can now be determined for a unit area (one flow depth deep, and one foot in width).

$$V = Q/A$$

where:

V = design flow velocity (ft/s)
Q = maximum design discharge (ft^3/s)
A = y (area of flow).

$$V = (0.11\ cfs)/(1\ ft)(0.06\ ft) = 1.83\ ft/s.$$

Allowable V for silt loam is 3 ft/second (Nelson and Abt 1986). Therefore, sheet erosion potential of the cover materials is not a problem.

3.0 WIND EROSION EVALUATION

To evaluate the wind erosion potential of the cover surface soil, the Wind Erosion Equation (WEQ) was developed by the USDA Agricultural Research Service (ARS). It has been modified for use in the state of Washington by the

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Soil Conservation Service (USDA 1987). The equation is used to evaluate the potential for wind erosion of soil surfaces and is used as follows:

$$E = f(IKCLV)$$

where:

- E = the estimated average annual soil loss in tons/acre/yr due to wind erosion
- f - an indication that the equation includes functional relationships that are not straight-line mathematical functions
- I = soil erodibility factor
- K = ridge roughness factor
- C = climatic factor
- L = unsheltered distance
- V = vegetative factor.

The equation can be considered to be successive modifications to I. The I factor is the potential annual wind erosion in tons/acre/yr for a given soil on an isolated, level, smooth, unsheltered, wide, and bare field with a noncrusted surface where the climatic factor is 100 percent.

The I factor is dependent on the soil texture and the percentage of dry aggregates over 0.84 mm in size. From DOE 1990, this value is roughly 3% for McGee Ranch Silt. To evaluate a soil in a realistic manner entails determining the normal, natural occurring state of the soil after exposure to the elements. McGee Ranch soils normally exhibits a crusted surface condition, for which the I value in Table B5-3 is 36.7. It is expected that the topsoil layer will form a crusted surface relatively soon after construction, in response to rain and snowfall events during the winter of the first year. If necessary, the formation of a crusted surface may be accelerated by direct application of water.

This I value must be adjusted for the portion of the cover that will be sloped and facing the prevailing winds. This is applied where an unsheltered distance of 500 ft or less exists as is the case with the 2101-M Pond cover. With a cover slope of 3%, the adjustment factor from Table B5-4 is 1.3, therefore;

$$I = (36.7)(1.3) = 48 \text{ tons/acre/yr}$$

The ridge roughness factor's (K) primary use is in application to agricultural related activities that take place on a recurring basis (e.g., plowing, planting, discing, harrowing, etc.). Ridges may be created at planting time, but these will exist for only a short period of time. This assumes that the seed is planted using a drill as opposed to planting by broadcast seeding methods. Assuming a ridge height of 1 in. after seeding, a

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Table B5-3. Soil Erodibility Index (I).

Percent of dry soil not passing a 20 mesh screen	0	1	2	3	4	5	6	7	8	9
(Units)	Noncrusted soil surface (tons/acre)									
0	0	310	250	220	195	180	170	160	150	140
10	134	131	128	125	121	117	113	109	106	102
20	98	95	92	90	88	86	83	81	79	76
30	64	72	71	69	67	65	63	62	60	58
40	56	54	52	51	50	48	47	45	43	41
50	38	36	33	31	29	27	25	24	23	22
60	21	20	19	18	17	16	16	15	14	13
70	12	11	10	8	76	6	4	3	3	2
80	2	0	0	0	0	0	0	0	0	0
	Fully crusted soil surface (tons/acre)									
0	0	51.7	41.7	36.7	32.5	30.0	28.7	26.7	25.0	23.3
10	22.3	21.8	21.3	20.8	20.2	19.5	18.8	18.2	17.7	17.0
20	16.3	15.8	15.3	15.0	14.7	14.3	13.8	13.5	13.2	12.7
30	12.3	12.0	11.8	11.5	11.2	10.8	10.5	10.3	10.0	9.7
40	9.3	9.0	8.7	8.5	8.3	8.0	7.8	7.5	7.2	6.8
50	6.3	6.0	5.5	5.2	4.8	4.5	4.2	4.0	3.8	3.7
60	3.5	3.3	3.2	3.0	2.8	2.7	2.7	2.5	2.3	2.2
70	2.0	1.8	1.7	1.3	1.2	1.0	0.7	0.5	0.5	0.3
80	0.3	0	0	0	0	0	0	0	0	0

Israelsen et al. 1980.

Table B5-4. Knoll Erodibility I Correction Factor.

Knoll facing wind rise in percent slope (along prevailing wind erosion direction)	I slope correction
3	1.3
4	1.6
5	1.9
6	2.3
8	3.0
10	3.6

K factor of 0.6 is obtained from Figure B5-3. This ridge height can only be assumed for the first year of the cover's life because the 2101-M Pond cover will not be subjected to annual tillage activities to develop and maintain soil ridges. The K factor will have little or no influence on the cover design after this first year. Therefore, the ridge height is assumed to be zero over long periods of time. From Figure B5-3, the K value is then 1.

The distribution of climatic factor (C) across Washington State is indicated in Figure B5-4. Appropriate ranges for the C factor is 60 to 70 for the 2101-M Pond area.

The vegetative factor (V) is difficult to characterize. During the first year after cover construction, before a mature stand of cover vegetation has been produced, the soil surface will be protected from wind erosion by spreading and crimping 4,000 lbs of straw per acre on or into the soil surface. For following years, the amount of plant production for the site must be estimated. The USDA Soil Conservation Service has performed a number of evaluations of range site conditions for varying soil and precipitation conditions. The average annual rainfall for this area is in the 6- to 9-in. range. Using the data from similar climate and land use areas, the total annual production of air-dry weight per acre for the 2101-M Pond vegetative cover runs from a low of 200 lbs for unfavorable years, to 500 lbs for favorable years (USDA 1981). The design assumes the median value for V. This yields 350 lbs of air-dry material. Using Crested Wheatgrass from Table B5-5 to represent the cover vegetation, the flat small grain equivalent is roughly 1,100 lbs/acre. The unsheltered field length (L) for the worst case condition on the cover is 50 ft.

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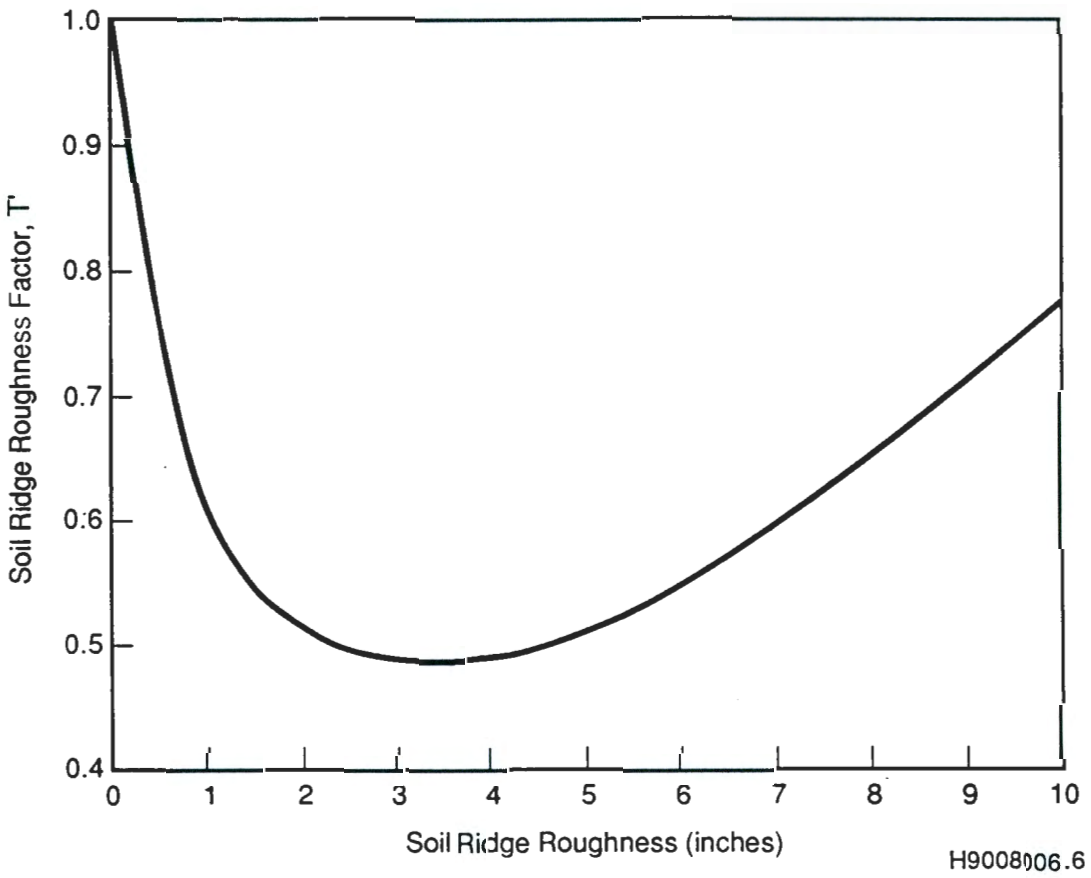

Figure B5-3. Soil Ridge Roughness Factor K From Actual Soil Ridge Roughness (EPA 1979).

Washington

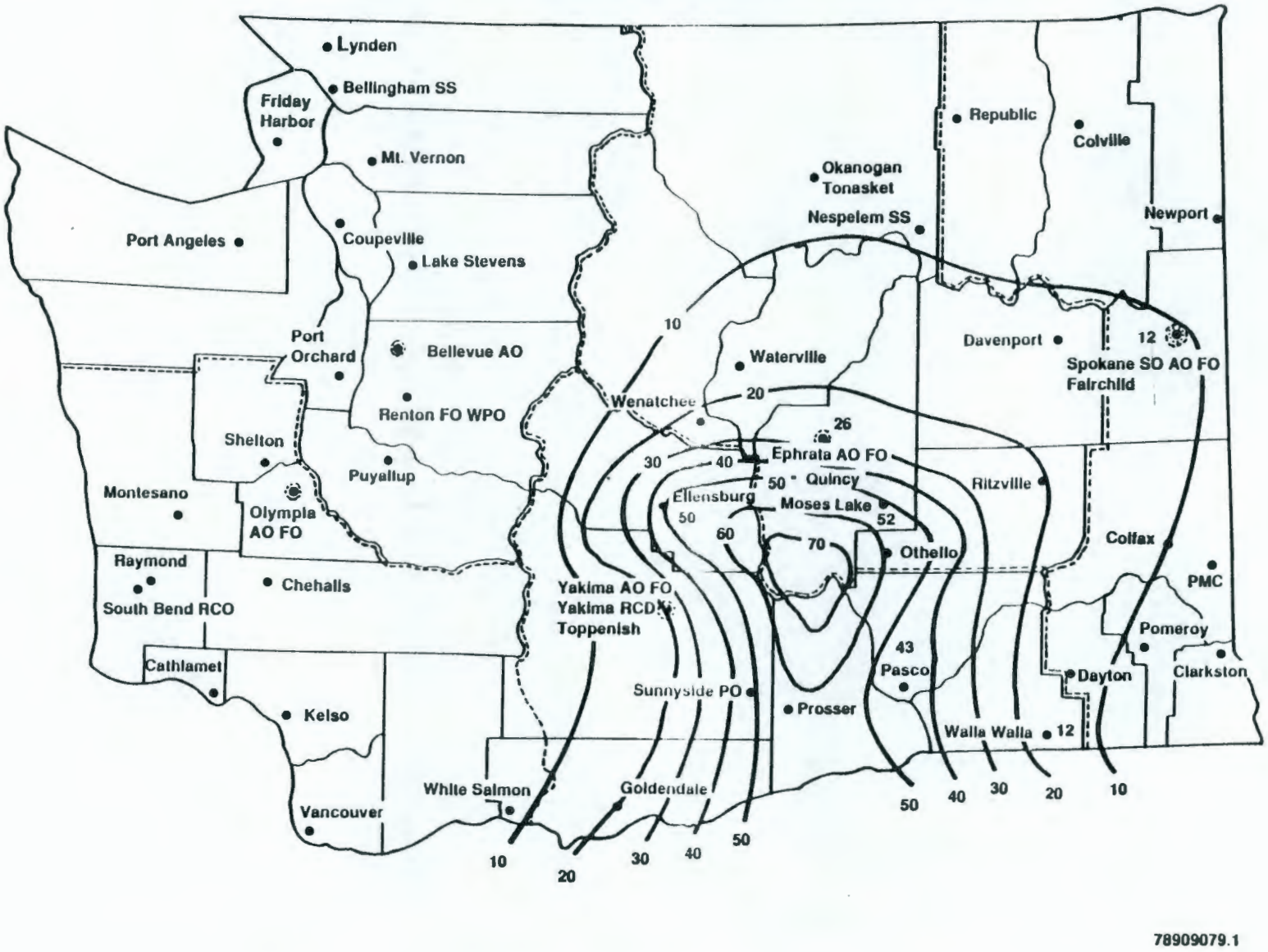

Figure B5-4. Annual Wind Erosion Climatic 'C' Factor Map.

Table B5-5. Guide for Converting Range Vegetation to Equivalent Quantity of Flat Small Grain Residue. (sheet 1 of 2)

Grass plants	Pounds per acre of range vegetation										
	50	100	200	300	400	500	600	700	800	900	1,000
Buffalograss[a], burrograss, and Inland saltgrass	320	720	1,630	2,630							
Big bluestem[a]	45	110	280	480	705	950	1,215	1,495	1,785	2,090	2,410
Western wheatgrass[a], creeping wildrye, and side oats grama	155	245	775	1,240	1,740	2,260	2,795	3,345			
Little Bluestem[a]	45	110	285	495	735	995	1,280	1,580	1,900	2,230	2,575
Blue grama[a], threadleaf sedge, and perennial three-awn	110	235	490	760	1,040	1,325	1,610	1,905			
Galleta and tobosa	150	300	800	1,200	1,700	2,600					
Bottlebrush squirreltail, needle and thread[a], and thruber needlegrass	70	150	300	600	800	1,200					
Alkali sacaton	60	150	400	800	1,400	2,200	2,800	3,600			
Bluebunch wheatgrass	50	120	300	550	850	1,150	1,500	1,900	2,300	2,600	3,000
Idaho fescue	100	200	400	900	1,500	2,300					

Table B5-5. Guide for Converting Range Vegetation to Equivalent Quantity of Flat Small Grain Residue. (sheet 2 of 2)

Grass plants	Pounds per acre of range vegetation										
	50	100	200	300	400	500	600	700	800	900	1,000
Indian ricegrass	100	175	300	600	900	1,400					
Crested wheatgrass	130	300	600	900	1,300	1,800	2,400	3,100	4,000		
Cheatgrass	100	200	300	600	800	1,000	1,200	2,000	2,500	3,000	

NOTE: Other grass species equivalents were estimated by comparing the growth characteristics with the tested species.

[a]Lyles and Allison (1980).

With the given information: I= 48, K=0.6 for the first year and then 1.0 for the life of the cover; C= 60 to 70, L=50, and V=4,000 for the first year and then 1,100 for following years; the value of E can be determined from interpolation of SCS wind erosion charts for these values.

Wind erosion for the first year is estimated to be essentially zero. This is primarily attributed to the projected effectiveness of the straw mulch treatment. In following years, wind erosion will be determined by the condition of the grass stand. In the years following the initial seeding, when an average stand is present, wind erosion is predicted to be less than 0.5 tons/acre/yr. It is assumed also that the straw mulch will continue to assist in reducing wind erosion for two to three years after placement. This will be dependent upon the climatic conditions during that time span.

In those years when a less-than-average stand of grass develops (200 lbs air-dry weight/acre), the estimated V will drop to roughly 600 lbs/acre. This will yield a predicted erosion rate of 0.7 ton/acre/yr (C=60) to 1.0 ton/acre/yr (C=70). As is demonstrated by these results, the projected soil losses are highly dependent on the vegetative factor. In those years when the vegetation yield is above the predicted average, the erosion rate will be insignificant. Until the vegetative cover becomes fully established, the erosion rates may exceed the estimated average range. After establishment of the vegetative cover, the erosion rates should more closely coincide with the predicted rates. An increase in the vegetative growth to around optimal production (500 lbs air-dry weight per acre) would decrease soil losses to zero.

4.0 HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE

The Hydrologic Evaluation of Landfill Performance (HELP) computer modelling results are included in this appendix. The HELP model was developed by the U.S. Environmental Protection Agency (EPA) to aid hazardous waste landfill designers in estimating water budget and quantity of leachate from a landfill. Therefore, the model is used as a tool to estimate water drainage and percolation through covers and/or liner and leachate collection systems for landfills. The model uses a deterministic, sequential daily analysis to calculate run-off, evapotranspiration, percolation, and lateral drainage. The following discussion is based on the documentation of the HELP Model, Version 2.0 (EPA 1984). The newest existing released version of the HELP model will be used during definitive design.

The HELP model requires the use of specific cover-soil physical properties and local climatological data. The HELP model is provided with climatological data for many locations across the United States. Local climatological data available from the Hanford Meteorological Station were input to the HELP model where available (Skelly 1990).

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The model is set up to run four different kinds of layers, only one of which is used for this design. The four types of layers are: (1) vertical percolation, (2) lateral drainage, (3) barrier or low-permeability components, and (4) waste layer. For the model, only the vertical drainage layer was used as a cover component as opposed to the low-permeability component to build some conservatism into the evaluation. The vertical layers work on the principle that there is no significant resistance to vertical flow. Water can move up or down to account for evapotranspiration as well as percolation. No lateral drainage is assumed for vertical drainage components.

The model calculates water movement off of the cover surface and through the cover on a daily basis. The model handles precipitation as subdivided into components including runoff, evapotranspiration, percolation, and subsurface lateral drainage.

Surface run-off is that component of precipitation that does not infiltrate the soil. Once the infiltration requirements are fulfilled, water begins to be stored in natural surface depressions and flows through small channels in the cover surface. A Soil Conservation Service curve number is assigned to the soil and is coupled with a Darcian flow equation modified for unsaturated flow conditions.

Infiltration has been calculated based on the differences between daily precipitation and the sum of the change in surface storage of precipitation, the daily run-off, and surface evaporation. If the mean daily temperature is below 32 °F, the precipitation would be stored as snow.

Evapotranspiration has been modelled as a function of available energy, vegetation, soil, water transmissivity, and water content. For the evapotranspiration function, available surface water is first addressed and then subsurface water is used to separately calculate plant transpiration and evaporation on a daily basis.

The model assumes that each layer is homogeneous with respect to hydraulic conductivity, porosity, and field capacity.

The products of the model runs are summaries of annual totals, average annual total for 5 yr, and peak daily totals for precipitation, run-off, evapotranspiration, and percolation from base of cover. The following summary data is provided.

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2101-M Pond
Steady State Output
7/16/90

Layer 1

Vertical Percolation Layer

Thickness	=	30.00 In.
Porosity	=	0.5140 Vol/Vol
Field Capacity	=	0.2585 Vol/Vol
Wilting Point	=	0.0681 Vol/Vol
Initial Soil Water Content	=	0.0899 Vol/Vol
Saturated Hydraulic Conductivity	=	0.001000000047 Cm/Sec

Layer 2

Vertical Percolation Layer

Thickness	=	12.00 In.
Porosity	=	0.3470 Vol/Vol
Field Capacity	=	0.2585 Vol/Vol
Wilting Point	=	0.0681 Vol/Vol
Initial Soil Water Content	=	0.0925 Vol/Vol
Saturated Hydraulic Conductivity	=	0.000000300000 Cm/Sec

Layer 3

Vertical Percolation Layer

Thickness	=	12.00 In.
Porosity	=	0.4370 Vol/Vol
Field Capacity	=	0.1050 Vol/Vol
Wilting Point	=	0.0470 Vol/Vol
Initial Soil Water Content	=	0.1114 Vol/Vol
Saturated Hydraulic Conductivity	=	0.002700000070 Cm/Sec

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General Simulation Data

SCS Runoff Curve Number	=	80.00
Total Area of Cover	=	27600. Sq. Ft
Evaporative Zone Depth	=	36.00 In.
Upper Limit Veg. Storage	=	17.5020 In.
Initial Veg. Storage	=	3.2520 In.
Initial Snow Water Content	=	0.0000 In.
Initial Total Water Storage in Soil and Waste Layers	=	5.1438 In.

Soil Water Content Initialized by User.

Climatological Data

User Specified Rainfall with Synthetic Daily Temperatures and Solar Radiation for Hanford Wash

Maximum Leaf Area Index	=	1.60
Start of Growing Season (Julian Date)	=	113
End of Growing Season (Julian Date)	=	288

Normal Mean Monthly Temperatures, Degrees Fahrenheit

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
29.30	36.30	45.10	53.10	61.50	69.30
76.40	74.30	65.20	53.00	39.80	32.70

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Monthly Totals for Year 1979						
	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	0.54 0.09	0.17 0.38	0.54 0.20	0.52 0.67	0.10 1.43	0.00 0.99
Run-off (in.)	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
Evapotranspiration (in.)	0.778 0.090	0.324 0.280	0.206 0.300	0.447 0.137	0.606 0.349	0.309 0.531
Percolation From Layer 3 (in.)	0.0030 0.0026	0.0026 0.0025	0.0028 0.0024	0.0027 0.0024	0.0027 0.0023	0.0026 0.0023

Annual Totals for Year 1979			
	(Inches)	(Cubic Feet)	Percent
Precipitation	5.63	12949.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	4.357	10021.	77.39
Percolation from Layer 3	0.0309	71.	0.55
Change in Water Storage	1.242	2856.	22.06
Soil Water at Start of Year	5.14	11831.	
Soil Water at End of Year	6.39	14687.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1980

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	1.32	1.30	0.30	0.86	1.43	0.96
	0.00	0.02	0.85	0.33	0.44	1.89
Run-off (in.)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
Evapotranspiration	0.487	1.187	1.937	0.663	1.678	2.076
(in.)	0.215	0.020	0.379	0.362	0.291	0.324
Percolation from	0.0023	0.0021	0.0022	0.0021	0.0021	0.0020
Layer 3 (in.)	0.0020	0.0020	0.0019	0.0019	0.0018	0.0019

Annual Totals for Year 1980

	(Inches)	(Cubic Feet)	Percent
Precipitation	9.70	22310.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	9.619	22124.	99.17
Percolation from Layer 3	0.0244	56.	0.25
Change in Water Storage	0.057	130.	0.58
Soil Water at Start of Year	6.39	14687.	
Soil Water at End of Year	6.44	14817.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1981

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	0.56 0.19	0.60 0.03	0.70 0.60	0.02 0.39	0.99 1.08	0.43 1.45
Run-off (in.)	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
Evapotranspiration (in.)	0.696 0.181	1.502 0.030	1.071 0.098	0.431 0.334	0.367 0.537	1.395 0.558
Percolation from Layer 3 (in.)	0.0018 0.0017	0.0016 0.0017	0.0018 0.0016	0.0017 0.0016	0.0017 0.0015	0.0016 0.0016

Annual Totals for Year 1981

	(Inches)	(Cubic Feet)	Percent
Precipitation	7.04	16192.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	7.202	16565.	102.30
Percolation from Layer 3	0.0199	46.	0.28
Change in Water Storage	-0.182	-419.	-2.59
Soil Water at Start of Year	6.44	14817.	
Soil Water at End of Year	6.26	14399.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1982

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	0.38 0.22	0.57 0.20	0.30 0.55	0.75 1.37	0.28 0.91	0.75 1.79
Run-off (in.)	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
Evapotranspiration (in.)	0.692 0.717	1.161 0.195	1.038 0.291	0.583 0.399	0.709 1.038	0.342 0.569
Percolation from Layer 3 (in.)	0.0015 0.0014	0.0014 0.0014	0.0015 0.0013	0.0014 0.0014	0.0015 0.0013	0.0014 0.0013

Annual Totals for Year 1982

	(Inches)	(Cubic Feet)	Percent
Precipitation	8.07	18561.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	7.735	17791.	95.85
Percolation from Layer 3	0.0168	39.	0.21
Change in Water Storage	0.318	731.	3.94
Soil Water at Start of Year	6.26	14399.	
Soil Water at End of Year	6.58	15130.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1983

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation	1.44	1.36	1.00	0.42	0.52	0.68
(in.)	0.31	0.12	0.46	0.52	2.12	2.12
Run-off (in.)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
Evapotranspiration	0.597	1.000	2.188	0.863	0.706	2.009
(in.)	0.680	0.132	0.452	0.165	0.700	0.459
Percolation from	0.0013	0.0012	0.0013	0.0012	0.0013	0.0012
Layer 3 (in.)	0.0012	0.0012	0.0012	0.0012	0.0011	0.0012

Annual Totals for Year 1983

	(Inches)	(Cubic Feet)	Percent
Precipitation	11.07	25461.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	9.951	22887.	89.89
Percolation from Layer 3	0.0145	33.	0.13
Change in Water Storage	1.105	2541.	9.98
Soil Water at Start of Year	6.58	15130.	
Soil Water at End of Year	7.68	17671.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1984

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation	0.23	0.94	1.01	0.60	0.55	0.99
(in.)	0.06	0.00	0.42	0.07	1.83	0.57
Run-off (in.)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
Evapotranspiration	0.463	1.325	2.024	0.624	0.748	2.403
(in.)	0.235	0.000	0.217	0.268	0.468	0.595
Percolation from	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
Layer 3 (in.)	0.0011	0.0011	0.0010	0.0010	0.0010	0.0010

Annual Totals for Year 1984

	(Inches)	(Cubic Feet)	Percent
Precipitation	7.27	16721.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	9.369	21548.	128.87
Percolation from Layer 3	0.0128	29.	0.18
Change in Water Storage	-2.112	-4857.	-29.05
Soil Water at Start of Year	7.68	17671.	
Soil Water at End of Year	5.57	12814.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1985

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	0.34 0.12	0.82 0.01	0.36 0.63	0.01 0.46	0.12 1.24	0.15 0.86
Run-off (in.)	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
Evapotranspiration (in.)	0.673 0.027	1.205 0.103	0.933 0.339	0.050 0.263	0.130 0.279	0.150 0.632
Percolation from Layer 3 (in.)	0.0010 0.0010	0.0009 0.0010	0.0010 0.0009	0.0010 0.0009	0.0010 0.0009	0.0009 0.0009

Annual Totals for Year 1985

	(Inches)	(Cubic Feet)	Percent
Precipitation	5.12	11776.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	4.785	11006.	93.46
Percolation from Layer 3	0.0114	26.	0.22
Change in Water Storage	0.323	744.	6.32
Soil Water at Start of Year	5.57	12814.	
Soil Water at End of Year	5.89	13558.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1986

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	1.76 0.21	1.21 0.02	0.76 0.96	0.00 0.29	0.30 0.65	0.00 0.77
Run-off (in.)	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
Evapotranspiration (in.)	0.542 0.981	1.381 0.020	1.746 0.320	0.443 0.265	0.367 0.234	0.457 0.272
Percolation from Layer 3 (in.)	0.0009 0.0009	0.0008 0.0009	0.0009 0.0008	0.0009 0.0008	0.0009 0.0008	0.0008 0.0008

Annual Totals for Year 1986

	(Inches)	(Cubic Feet)	Percent
Precipitation	6.93	15939.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	7.028	16164.	101.41
Percolation from Layer 3	0.0102	24.	0.15
Change in Water Storage	-0.108	-249.	-1.56
Soil Water at Start of Year	5.89	13558.	
Soil Water at End of Year	5.79	13309.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals for Year 1987

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	0.80 0.50	0.55 0.07	1.05 0.01	0.14 0.00	0.39 0.40	0.08 1.63
Run-off (in.)	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
Evapotranspiration (in.)	0.274 0.500	1.025 0.070	1.593 0.010	0.643 0.000	0.671 0.234	0.383 0.231
Percolation from Layer 3 (in.)	0.0008 0.0008	0.0007 0.0008	0.0008 0.0007	0.0008 0.0008	0.0008 0.0007	0.0008 0.0008

Annual Totals for Year 1987

	(Inches)	(Cubic Feet)	Percent
Precipitation	5.62	12926.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	5.634	12958.	100.25
Percolation from Layer 3	0.0093	21.	0.17
Change in Water Storage	-0.023	-53.	-0.41
Soil Water at Start of Year	5.79	13309.	
Soil Water at End of Year	5.76	13256.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Monthly Totals For Year 1988

	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation (in.)	0.48 0.13	0.00 0.00	0.60 0.39	1.12 0.01	0.33 0.82	0.11 0.40
Run-off (in.)	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
Evapotranspiration (in.)	0.254 0.130	0.165 0.000	0.279 0.190	1.040 0.210	1.410 0.303	1.057 0.297
Percolation from Layer 3 (in.)	0.0008 0.0007	0.0007 0.0007	0.0007 0.0007	0.0007 0.0007	0.0007 0.0007	0.0007 0.0007

Annual Totals for Year 1988

	(Inches)	(Cubic Feet)	Percent
Precipitation	4.39	10097.	100.00
Run-off	0.000	0.	0.00
Evapotranspiration	5.335	12270.	121.52
Percolation from Layer 3	0.0085	20.	0.19
Change in Water Storage	-0.953	-2193.	-21.72
Soil Water at Start of Year	5.76	13256.	
Soil Water at End of Year	4.81	11064.	
Snow Water at Start of Year	0.00	0.	
Snow Water at End of Year	0.00	0.	
Annual Water Budget Balance	0.00	0.	0.00

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Average Monthly Values In Inches for Years 1979 Through 1988						
	Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
Precipitation						
Totals	0.78	0.75	0.66	0.44	0.50	0.42
	0.18	0.09	0.51	0.41	1.09	1.25
Std. Deviations	0.53	0.46	0.29	0.40	0.41	0.40
	0.14	0.12	0.28	0.40	0.57	0.60
Run-off						
Totals	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
Std. Deviations	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
Evapotranspiration						
Totals	0.546	1.028	1.302	0.579	0.739	1.058
	0.376	0.085	0.260	0.240	0.443	0.447
Std. Deviations	0.178	0.441	0.707	0.268	0.472	0.855
	0.323	0.094	0.133	0.118	0.257	0.151
Percolation from Layer 3						
Totals	0.0015	0.0013	0.0014	0.0013	0.0014	0.0013
	0.0013	0.0013	0.0013	0.0013	0.0012	0.0012
Std. Deviations	0.0007	0.0006	0.0007	0.0006	0.0006	0.0006
	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005

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Average Annual Totals and (Standard Deviations) for Years 1979 Through 1988

	(Inches)		(Cubic Feet)	Percent
Precipitation	7.08	(2.085)	16293.	100.00
Run-off	0.000	(0.000)	0.	0.00
Evapotranspiration	7.101	(2.060)	16333.	100.25
Percolation from Layer	0.0159	(0.0073)	37.	0.22
Change in Water Storage	-0.033	(0.965)	-77.	-0.47

Peak Daily Values for Years 1979 Through 1988

	(Inches)	(Cubic Feet)
Precipitation	0.93	2139.0
Run-off	0.000	0.0
Percolation from Layer 3	0.0001	0.2
Snow Water	0.76	1738.3
Maximum Veg. soil water (vol/vol)	0.1694	
Minimum Veg. soil water (vol/vol)	0.0679	

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Final Water Storage at End of Year 1988		
Layer	(Inches)	(Vol/Vol)
1	2.66	0.0888
2	0.97	0.0807
3	1.18	0.0982
Snow Water	0.00	

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5.0 COVER MATERIAL VOLUME ESTIMATES

The required volume of each of the cover components is estimated in Table B5-6. The exact surface area requirements for the cover have yet to be determined. However, a preliminary amount of materials required for each cover component is estimated based on the following assumptions:

- Cover area is 100 ft x 230 ft
- Cover is 3 ft high (above grade)
- The individual component thicknesses are as depicted in Figures II-5 and II-6.

Table B5-6. Cover Material Volume/Area Estimates.

Cover Component	Cubic Yards
Foundation Soil	1,600
Low-Permeability Soil	850
Topsoil	1,700

NOTE: Ecology must approve the final cover design before construction.

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6.0 REFERENCES

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