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DEPARTMENT OF THE NAVY
NAVAL WEAPONS SUPPORT CENTER
CRANE, INDIANA 47522-5000

IN REPLY REFER TO:

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0924

29 JUN 1990

RCRA Activities
U.S. EPA, Region V
Post Office Box A-3587
Chicago, Illinois 60690-3587

Gentlemen:

Submitted for review is the Draft Report for the Dye Tracer Test conducted at the Ammunition Burning Grounds (ABG) in January 1990. In addition to the Draft Report, Naval Weapons Support Center Crane (NWSCC) Crane, Indiana is submitting for review the plan for conducting a second Dye Tracer test at ABG. Requirements for submittal of these reports were set forth in the Corrective actions portion of the Hazardous Waste Part B Permit issued to NWSCC in January 1990.

NWSCC point of contact is Mr. Jim Hunsicker, Code 0924, telephone 812-854-3233.

Sincerely,

H. J. FREY
Commander, CEC, USN
Public Works Officer
By direction of the
Commanding Officer

Encl:
(1) Draft Technical Report for Dye Tracer Test Conducted in the Beech Creek Aquifer at the ABG
(2) Proposal to Conduct Second Dye Tracer Test at the ABG

Copy to:
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DRAFT TECHNICAL REPORT FOR DYE TRACER TEST
CONDUCTED IN THE BEECH CREEK AQUIFER
AT THE ABG (SWMU 03/10)

06/29/90

was replaced by

DRAFT TECHNICAL REPORT FOR DYE TRACER TEST
CONDUCTED IN THE BEECH CREEK AQUIFER
AT THE ABG (SWMU 03/10)

11/27/90

Proposal to Conduct Second Dye Trace at the Ammunition Burning Ground
Naval Weapons Support Center Crane, Indiana

Purpose

1. This document proposes a second dye trace be performed at and near the Ammunition Burning Ground (ABG), a Solid Waste Management Unit (SWMU) of the Naval Weapons Support Center (NWSC) Crane, Indiana. The dye trace will be conducted by the US Army Waterways Experiment Station, Vicksburg, Mississippi and Northern Division, Naval Facilities Engineering Command, Philadelphia, Pennsylvania in the summer of 1990. The dye trace will include monitoring of springs or other ground water outlets outside the boundaries of NWSC Crane as well as sites on NWSC property. Details of the proposed second dye trace are presented herein.

Background

2. A sequence of remedial investigations and remedial actions have been performed at NWSC Crane since 1981. The Hazardous and Solid Waste Amendments (HSWA) of RCRA established corrective actions programs (CAP) at Treatment, Storage and Disposal (TSD) facilities. The provision required the NWSC Crane to address past releases of hazardous waste or hazardous constituents at Solid Waste Management Units (SWMUs) and regulated units. The ABG was listed as a SWMU and thus required Corrective Action under the 1989 USEPA RCRA Part B Permit and Ground Water Assessment Plan. The Navy submitted three documents to the USEPA Region V in April, 1989: 1) an updated Ground Water Assessment Plan for the ABG; 2) a dye tracer test proposal; and 3) a report on hydrogeologic investigation of the ABG by Hunt (1988). At the request of USEPA Region V, the dye tracer test proposal was rewritten and submitted to the EPA in July 1989.

3. Final approval of the dye tracer test proposal and the Hunt (1988) report were established in the Federal portion of the joint RCRA Part B permit issued to the US Navy by the USEPA and the State of Indiana. A dye tracer test was conducted for the NWSC Crane by USAE WES in January 1990 and a summary of results (a point paper) submitted to EPA in February 1990. The first dye tracer test yielded positive results, proving the effectiveness of dye tracing in the Beech Creek aquifer. In April 1990 the NWSC Crane submitted a Modified RFI Phase III Release Characterization Work Plan for Ground Water at the ABG. The Work Plan scheduled the submittal of the draft dye tracer report and a proposal to conduct a second dye trace.

Study Area Location

4. The NWSC Crane is located in southwest Indiana approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky (Figure 1). The NWSC occupies approximately 100 square miles of the northern portion of Martin County and small portions of neighboring Greene, Daviess, and Lawrence Counties. The ABG is in the eastern part of the NWSC. The ABG and surrounding area were described in the first dye trace proposal submitted to EPA Region V on 24 July 1989.

Scope of Work

5. The area of the proposed second dye trace has been expanded to include

Encl 2

off-post monitoring points. Figure 2 is a topographic map showing the expanded study area. The map is a composite of the Williams and Indian Springs (Indiana) 7-1/2 minute U.S. Geological Survey topographic quadrangle maps and is reproduced at a scale of 1 inch = 2000 ft. Springs A through F and Mountain Springs were monitored during the first dye trace. The second dye trace will include springs off-post, north and west of the heavy dashed line that roughly follows the center-line of the flood plain of Big Sulphur Creek. Several off-post springs were located during a field excursion in May of 1990 (SP1-90 through SP15-90) and are also shown on the map.

6. Only four wells were monitored for dye in the first dye trace. The second dye trace will include monitoring additional wells screened in the Beech Creek aquifer (the solid squares of Figure 2). Selection of the wells to be monitored will be made prior to the start of field work.

Procedures for Second Dye Trace

7. The proposal submitted for the first dye trace (24 July 1989) discussed dye tracing methods and materials, dye injection procedures, dye monitoring (detection) methods, and analytical procedures. Specific procedures to be followed in conducting the second dye trace are discussed in this section.

Dye Injection.

8. Figure 3 is a map of the ABG showing locations of monitoring wells. Well clusters 03C3 and 03C2 are highlighted because they were the dye injection sites for the first tracer test. Well 03C2P2 (the Beech Creek well of the cluster) was chosen in the first test because the screen is set directly in a karst solution zone of the Beech Creek with immediate access to the system of ground-water conduits in the formation. Well 03C3P2 (the Beech Creek well of the 03C3 cluster) was injected because (1) it has produced above-detectable amounts of monitored hazardous constituents in prior sampling and analysis, (2) it is centrally located within the ABG operations area, and (3) it is in a zone of solution-widened discontinuities which permitted good access to the aquifer. Actual takes of water added to the wells to flush the dyes in the first tracer test were 20 gpm for well 03C2P2 and 7 gpm for well 03C3P2.

9. Although well 03C3P2 is less hydraulically transmissive than 03C2P2, C3P2's location and acceptable take rate are considered to make it a more desirable location for dye injection in the second dye trace. One feature to be investigated in the dye trace is the potential for flow back to the south and west through Johnson Hollow through the Beech Creek aquifer. Injection into the centrally located well 03C3P2 is more likely to tap that potential pathway than the more southeasterly located well 03C2P2 (see the Hunt (1988) report and the 24 July, 1989 dye trace proposal for further discussion of the hydrology at the ABG). For these reasons dye will be injected into well 03C3P2 in the proposed second dye trace. Potential flow through the Beech Creek to the north toward Mtn Springs is also better traced through well 03C3P2 than 03C2P2.

10. Field procedures of injecting the dyes into wells and flushing with water from a tanker truck were described in the proposal submitted for the first tracer test (July, 1989). The same procedures will be followed for the proposed second test.

Dye to be injected

11. Results of the first dye trace conducted in January of 1990 showed that sodium fluorescein dye (CI acid yellow 73) produced discernible positive results at selective sampling points in the trace study area. The other two dyes used in the first test, Phorwite-AR optical brightener and Direct Yellow 96 (Diphenyl Brilliant Flavine) produced ambiguous and poorly discernible results. The latter dyes, particularly optical brightener, are apparently present in the background waters in the ABG study area, making them difficult to discern from pre-injection background samples, and produced only weak indications in the dye collectors (cotton). It is proposed to inject only fluorescein dye into the one centrally located well in the second dye trace.

12. A little over one pound of fluorescein was injected for the first test. Because no visible coloration of the ground water exiting the springs or the stream below the ABG was evident with that amount, the quantity of dye to be injected for the second test will be increased to about three pounds (three pounds dye powder dissolved in three gallons of water. The greater quantity of dye will increase the chances of detecting traces of dye in distant monitoring stations and lessen the effects of adsorption of the dyes in the less transmissive aquifer of well 03C3P2.

Dye collectors

13. Two kinds of dye collectors (bugs) were used in the first dye trace, cotton and coconut charcoal. Cotton is used to adsorb optical brightener and Direct Yellow 96; charcoal adsorbs fluorescein. Only the charcoal bugs will be needed for the second dye trace. A spoonful of coconut charcoal will be placed in an aluminum screen packet, closed with staples, for each dye monitoring site. The packet will be anchored into the stream bed or the mouth of the spring and the anchor secured with nylon cord to a tree or other stable object. The packets will be replaced with new charcoal-filled packets at each collection.

Well monitoring methods.

14. The method used to sample the wells for dye in the first tracer test, whereby water bailed from a well was poured over a cotton swab and a charcoal packet retained in a short section of PVC pipe, was considered at the end of the field work to have been unsatisfactory. Field personnel were not confident that sufficient water nor sufficient contact time was available with this procedure to permit dye accumulation in the bugs. No positive indications of dye were recorded for the well samplers.

15. An improved method for monitoring the wells for dye traces in the proposed second trace consists of suspending the bugs in a mesh container from the inside surface of the well casing cap. The mesh container will hang submerged beneath the water surface in the well and be continuously exposed to water flowing through the aquifer and into the well, increasing the probability of accumulating detectable concentrations of dye. The mesh container will be constructed of stainless steel or Teflon to safeguard monitoring well quality.

16. Piezometric elevations on the Beech Creek aquifer will be monitored more closely in the second test than they were in the first. Levels in the wells will be measured prior to dye injection and at least once weekly for the duration of the test. If a major rainfall occurs during the test monitoring, piezometric levels will be measured during or immediately after the precipitation event.

Monitoring sites

17. All of the on-post springs monitored for dye presence in the first test

will be monitored in the second test. The two Little Sulphur Creek monitoring points will be repeated and an additional station nearer the ABG will also be monitored (see triangles of Figure 2). The second dye trace will include all of the off-post springs and seeps SP1-90 through SP15-90 for which permission can be obtained from property owners. Two to three additional monitoring stations will be located in Little Sulphur Creek south of the NWSC boundary fence.

18. Springs SP1-90 through SP12-90 flow from the Big Clifty/ Beech Creek limestone aquifer. Springs SP13-90 through SP15-90 have been identified by the WES geologist as Beaver Bend limestone springs. The Beaver Bend is a formation occurring approximately 70 ft below the Beech Creek-Elwren shale contact. The Beaver Bend has been reported by Hunt (1988) to be hydraulically isolated from the Beech Creek system by thick shales. The Beaver Bend springs will be monitored for traces of dye as a control.

19. Springs SP1-, SP2-, SP4-, SP5-, SP7-, SP8-, SP9-, SP11- and SP12-90 issue from distinct Beech Creek-Elwren shale contacts and are excellent monitoring stations, providing permission can be obtained from property owners. Spring SP3-90 issues from a pipe below ground level into a sump. The source for SP3-90 is buried by colluvium at the foot of a steep slope in Big Clifty sandstone. The projected position of the Beech Creek limestone places it at the approximate level of the outlet pipe. The remaining off-post springs are better described as seeps which issue from the soil from indistinct openings. The stratigraphic position of the seeps has been determined to be in the Big Clifty/Beech Creek system by outcrops of Big Clifty or Beech Creek formations in the vicinity. The seeps form pools which can be monitored with dye collectors (bugs).

Duration and frequency of monitoring.

20. All springs and other sampling points except springs SP2-, SP3-, SP13-, SP14- and SP15-90 will be monitored daily. That is, bugs will be collected from the stations once a day for the first two weeks after injection of dye. Springs SP2- and SP3-90 will be monitored the first day after injection but then only once weekly because of their distance from the injection point (the ABG). Springs SP13- through SP15-90 will be monitored only weekly. If no positive results have been obtained in the off-post sampling stations after two weeks, weekly monitoring will continue until a decision is made to halt the test. WES plans to dedicate one field party for collecting off-post and one party for on-post bugs. All bugs will be returned to the field lab daily and analyzed for traces of dye as soon as possible, preferably within 24 hours of collection.

21. Background detectors will be placed in all monitoring stations approximately one week prior to dye injection and left in place for at least one week before being collected and analyzed for dye presence. This procedure will allow sufficient time for adsorption in the charcoal of any dyes present in the ground and surface water.

Laboratory procedures.

22. A detailed explanation of laboratory and quality assurance/quality control procedures was presented in the Technical Report of the first dye trace (in preparation). Identical procedures will be followed in the proposed second test. The procedures as presented in the Technical Report are reiterated, in part, here.

23. **General procedures.** Each day's collection of bugs will returned to the field laboratory immediately following collection. Precautions will be taken to minimize potential contamination of collected samples. Disposable latex "surgeon's"

gloves will be used to handle the bugs for examination. Gloves will be discarded after the examination of each sample. Jars used to elute the charcoal bugs will be rinsed thoroughly after each use and examined under UV light for signs of contamination before reuse. A complete discussion of the Quality Assurance/Quality Control (QA/QC) procedures is presented below.

24. **Examination of charcoal packets.** Examination of the charcoal packets requires elution of adsorbed dye from the charcoal. The screen-wire packet for a sample will be cut open and the charcoal halved, one half placed in a canning jar for safekeeping. The other half of the charcoal will be placed in a small lidded jar for eluting. The eluent will be prepared by dissolving about 10 grams of flake potassium hydroxide (KOH) in 100 ml of 70% isopropyl alcohol. The mixture separates into a supersaturated and a lighter saturated solution. The saturated solution will be poured over the charcoal to cover it about 1/4 inch deep. The beaker and its contents will be examined under room light and, if necessary, by shining an intense, focused beam of light from a microscope lamp through the beaker. The eluting charcoal will be allowed to stand until a positive indication or no indication of dye is obtained. In the first tracer test, stand time for the eluting charcoal was as little as a few seconds to several hours to obtain positive indication. For positive indications, a qualitative assessment of the intensity of the dye presence will be made.

25. A classification scheme developed by Aley and Fletcher (1976) for fluorescein dye indications was followed in general during the laboratory analysis of the first test's results and will be used in the proposed second test. The classification scheme is shown in Figure 4. The classifications range from "very strongly positive" to "very weakly positive" to "negative" (no indication of dye presence after standing several hours). It was noted during the analysis of the charcoal bugs for the first test that a finer resolution of "positiveness" could be implemented. For example, some of the samples reacted very strongly to elution with an intense green cloud of dye forming immediately upon addition of the eluent to the charcoal. A distinction could easily be made between such a reaction and the "very strongly positive" classification (Figure 4), which requires up to 15 minutes to obtain a positive indication. Analytical results for the second test will be classified using subdivisions of "positiveness" based on time required to develop an indication and the intensity of the indication.

Quality Assurance/Quality Control Procedures.

26. A rigorous Quality Assurance/Quality Control (QA/QC) program was implemented for the first test to ensure that an adequate amount of quality data was collected throughout the dye trace test of the Beech Creek aquifer. The QA was a planned system of activities whose purpose was to provide assurance of reliability and defensibility of the data. The QC was a routine application of procedures for controlling the monitoring process. Similar QA/QC will be maintained for the proposed second test. The QC will be the responsibility of those performing the hands-on operations in the field and in the laboratory. The following is a description of the dye trace test's QA/QC procedures.

27. **Sampling Procedures.** The dye to be used in this investigation can adhere to skin, clothing, and sampling equipment and can persist for weeks. In order to prevent cross-contamination of the dye, or any other contamination which may have

been present at the springs and wells, utmost care will be exercised. The dye will be prepared and handled only during the day of injection. All detectors (bugs) will be prefabricated in a dedicated portion of the field laboratory away from the dye storage area.

28. Pairs of long sleeve rubber gloves will be dedicated to each of the sampling sites. The gloves will be stored in labelled, dedicated zip-lock bags. The gloves will remain in their storage bags until arrival at each sampling site. Sample collection and replacement will be performed by only one of the investigators at each site to reduce cross contamination. The second investigator will be responsible for logging in the chain-of-custody forms and maintaining the field notebook. At the springs, the bugs will be removed from the field apparatus and immediately placed in pre-labelled dedicated plastic zip-lock bags. The gloves will then be returned to their respective storage bag. Samples will be preserved in a chilled cooler to await laboratory analysis. The field QC implemented at the sampling sites in Little Sulphur Creek will be the same as those described above for the springs. Care will be taken not to walk upstream of the detectors in case dyes may have been adsorbed onto the field rubber boots. This action will prevent washing of potentially adsorbed dye into the vicinity of the detectors.

29. Procedures for safeguarding the integrity of the ground-water monitoring wells will be implemented. Dedicated sampling equipment suspended in the well from the casing cap (described above, paragraphs 14 and 15) will lessen the chances of cross-contamination of wells. Field personnel will use rubber gloves dedicated to each well to handle the suspension cord and charcoal packet. Care will be taken not to let the suspension cord touch the ground or outside of the well casing when extracting the charcoal packet.

30. Pertinent information will be recorded in log books during the dye trace test. Information in the field books will be sufficient to reconstruct field procedures without reliance on memory.

31. The field personnel will wear Level D protective clothing. Gloves will be worn when collecting detectors and handling dye.

32. **Analytical Procedures.** The QA plan ensures that quality data will be generated from the analysis of the dye detectors. The principal investigator was trained in conducting dye tracer tests through a short course presented by James F. Quinlan, National Park Service, Ralph O. Ewers, Eastern Kentucky University, and Thomas J. Aley, Ozark Underground Laboratory, through the National Water Well Association. The investigators performed laboratory tests to familiarize themselves with characteristics of particular dyes and also to recognize weakly positive concentrations of dyes. The investigators also are experienced in conducting a dye trace by their participation in the first ABG dye trace.

33. The dyes will be handled only during the day of the dye injection. The dye solutions will be pre-mixed in an isolated section of the field laboratory. The pre-mixed dye solutions will be stored in plastic or glass jugs and transported to the injection site in a sturdy box. The unused dyes will be stored in a separate room from the detectors and sampling equipment. The detectors (bugs) will be returned daily to the laboratory in a chilled cooler. The zip-lock plastic bags will not be reused after the sample is removed for analysis.

34. The fluorescein dye used as the tracer must be eluted from the coconut charcoal detector in an alcohol solution and inspected visually for a yellow-green color. Preparation of the fluorescein eluent was described earlier. The eluent will be prepared daily due to the limited shelf life of the KOH solution (per

Quinlan, 1987).

35. The detectors (bugs) will be handled with vinyl powder-free gloves which will be discarded after each sample analysis. The charcoal will be eluted in 1.5 ounce, lidded jars purchased specifically for the dye trace. Should the jars need to be reused during the collection/analysis period they will be flushed thoroughly with tap water and rinsed with distilled water. A small amount of KOH eluent will be introduced into each jar before reuse to check for residual fluorescein contamination. This procedure will assure that the jars are free from dye contamination before the next charcoal sample is introduced.

References Cited in the Proposal

1. Aley, T. and M.W. Fletcher, 1976. The Water Tracer's Cookbook, Missouri Speleology, vol 16, no. 3, p 16.

2. Hunt, Richard W., 1988. "Geology and Hydrogeology of the Ammunition Burning Ground, Crane Naval Weapons Support Center," prepared for Naval Weapons Support Center, Crane, Indiana by U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

3. Quinlan, James F., 1987. "Qualitative water-tracing with dyes in karst terranes", in Quinlan, J.F., ed., Practical Karst Hydrogeology, with Emphasis on Groundwater Monitoring (course manual): National Water Well Association, Dublin, Ohio, v 6, p. E1-E24.

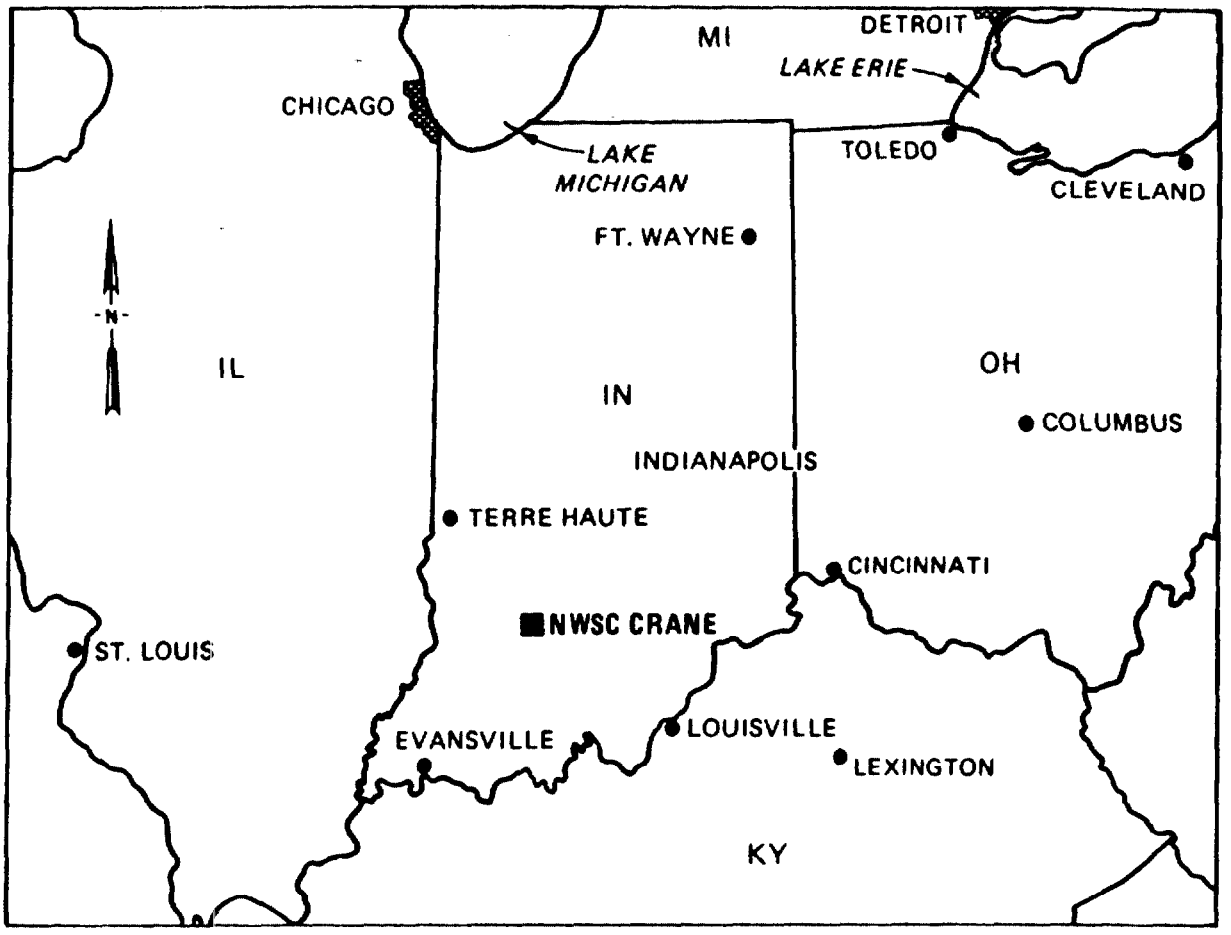

Figure 1. Location of Naval Weapons Support Center (NWSC) Crane (Chesapeake Division Naval Facilities Engineering Command)

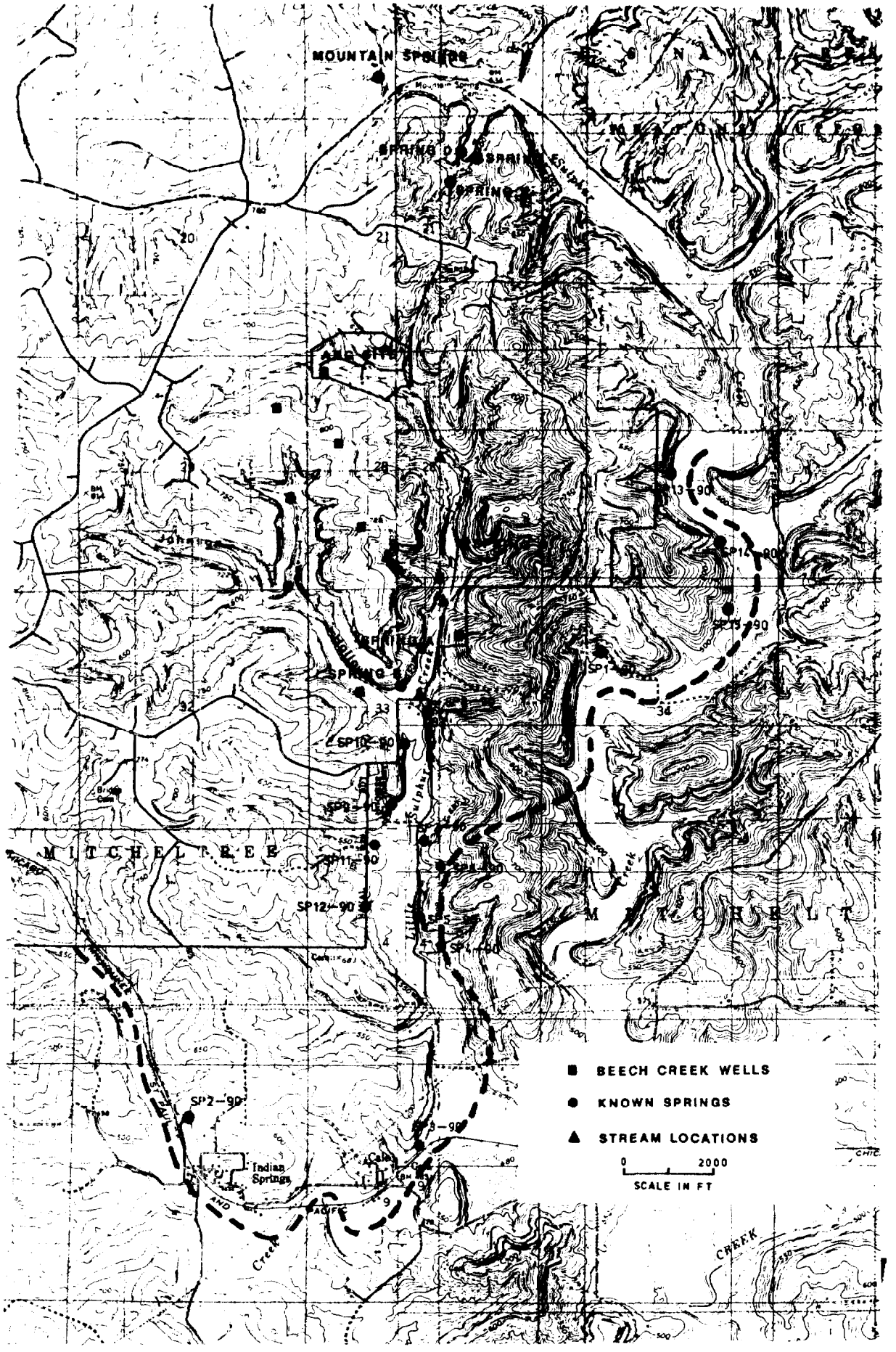

Figure 2. Map of the ABG study area showing locations of wells, springs and stream monitoring points for dye tracer test.

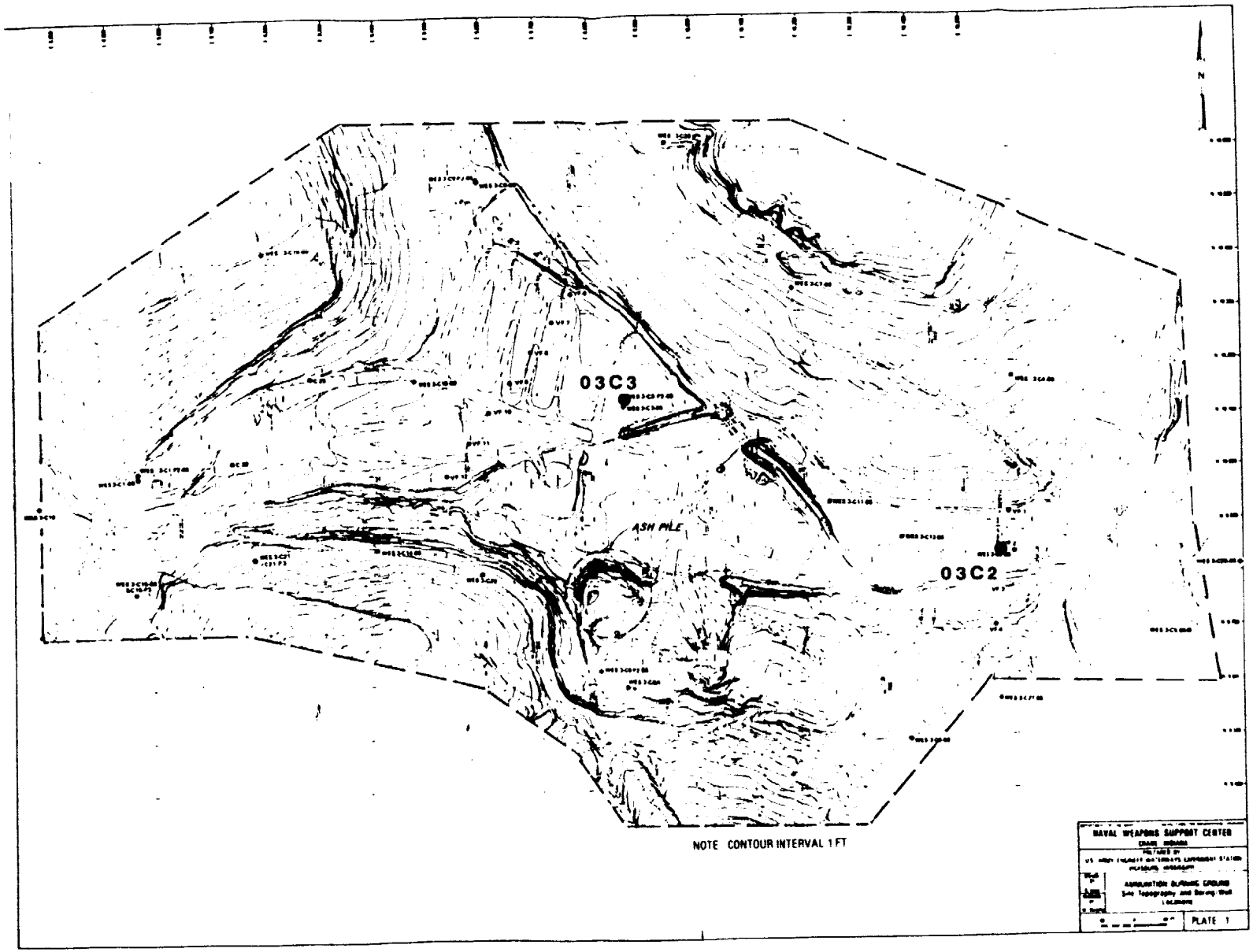

Figure 3. Map of the Ammunition Burning Ground showing injection well locations.

1. Very strongly positive (VSP): Dye can be seen distinctly with the naked eye in sunlight or in an artificially lighted room within 15 minutes of the time that KOH and alcohol are added to the charcoal.

2. Strongly positive (SP): Same as above, but after 15 minutes and before 3 hours.

3. Moderately positive (MP): Dye can be seen with the naked eye in sunlight or in an artificially lighted room, but not until 3 to 24 hours after adding KOH and alcohol. The dye is indistinct, and the observer feels it is necessary to verify the results by beaming a light into the sample jar.

4. Weakly positive (WP): Dye cannot be detected by the naked eye in sunlight or in an artificially lighted room until more than 24 hours after adding KOH and alcohol. Dye can be distinctly seen by the naked eye when a light is beamed through the sample jar.

5. Very weakly positive (VWP): The appearance of the dye is similar to weakly positive tests, but the dye cannot be seen until more than one but less than 10 days after adding KOH and alcohol. The dye can be distincly seen by the naked eye when a light is beamed through the sample jar.

After Aley, T. and M.W. Fletcher, 1976. The Water Tracer's Cookbook, Missouri Speleology, Vol 16, no. 3, p 16.

Figure 4. Classification of fluorescein dye indications.