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

IN REPLY REFER TO:
5090/H11.9
0924

17 OCT 1990

U.S. Environmental Protection Agency,
Region V, 5HR-13
Attn: Ms. Carol Witt-Smith
230 South Dearborn Street
Chicago, Illinois 60604

Gentlemen:

Submitted for review is the draft Interim Measure Work Plan for the Dye Burial Ground, Solid Waste Management Unit (SWMU) #02/11. The requirement for submittal of this report was set forth in the Corrective Actions portion of the Hazardous Waste Part B Permit issued to Naval Weapons Support Center Crane (NWSCC) in January 1990.

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

Sincerely,

USN

Encl:
(1) Draft Interim Measure Work Plan for the Dye Burial Ground, SWMU #02/11.
(2) Certification Statement

Copy to:
NORTHNAVFACENGCOM, Philadelphia (Code 142)
COMNAVSEASYSCOM (SEA-6541)
WES

DRAFT INTERIM MEASURE WORK PLAN

FOR THE

DYE BURIAL GROUND

SOLID WASTE MANAGEMENT UNIT #02/11

Enclosure (1)

Interim Measure Work Plan
Source Location for SWMU #02/11, Dye Burial Ground
Naval Weapons Support Center Crane, Indiana

1. Task A: RFI Miscellaneous Investigation, Source Location

a. Background

An Initial Assessment Study (IAS) of the Dye Burial Ground (DBG), SWMU #02/11, was conducted by NWSC Crane in 1981. The IAS study team reported that an estimated 50 thousand pounds of various dyes and dye-contaminated materials were deposited into open trenches at the DBG from 1952 until 1964. Three main trenches were about 10 feet wide, 6 feet deep and 50 feet long. Deposited materials reportedly included magnesium, boxes and rags contaminated with dyes, and about 60 drums of dyes. Precise location of the burial trenches was not available from records.

The US Army Waterways Experiment Station (WES) will conduct a Source Location of the burial trenches at the Dye Burial Grounds using geophysical techniques. This document describes operations at the SWMU, presents the technical approach to be followed, lists the personnel involved in the investigation, and provides a schedule of work to be performed, QA/QC procedures, and a Health and Safety Plan.

b. Disposal Area Characteristics.

(1) Location of disposal area. The location of NWSC Crane is shown in Figure 1. The Dye Burial Grounds are located in the eastern part of the NWSC just east of the Ammunition Burning Ground (Figure 2). The topographic setting at and near the Dye Burial Grounds is shown in Figure 3. The numbers in Figure 3 represent monitoring wells emplaced for other investigations. Figure 3 indicates that the location of the burial trenches is only approximate.

(2) Operating practices. The DBG is an old burial site reportedly used from the 1940's until 1969 for disposal of scrap materials including dyes. Dye reportedly overflowed the trenches during heavy rains. Some of the dyes may be toxic or carcinogenic. The trenches were backfilled with soil in 1972. Other RFI investigations are addressing contaminant presence and migration.

(3) General physical conditions. The DBG sits atop a northeast trending ridge (Figure 3). Ground water monitoring wells emplaced around the area of the trenches indicate that the uppermost ground water (phreatic) zone is below the base of the trenches. The ridge is relatively flat, however, and can pond precipitation for a period of time. The burial trenches potentially can receive infiltrating water from snow or rainfall and may contain water in the wet season or during periods of high precipitation. The approximate trench area is devoid of trees and is at least partially topped by a roadway. Logs of monitoring well borings indicate that the soil in the area surrounding the trenches is generally a silty clay or silty sand from 5 to 10 ft deep, underlain by sandstone. Therefore, the bottoms of the trenches are expected to be in either soil or weathered rock. None of the borings penetrated fill material.

c. Technical Approach.

The WES will conduct geophysical surveys to locate and define the boundaries of the burial trenches at the DBG, both laterally and in depth, and to assess the trench contents, i.e. metal or non-metal. A number of methods and devices are available to conduct the required geophysical surveys. These include electromagnetic (EM) induction, magnetometer, ground penetrating radar, electrical

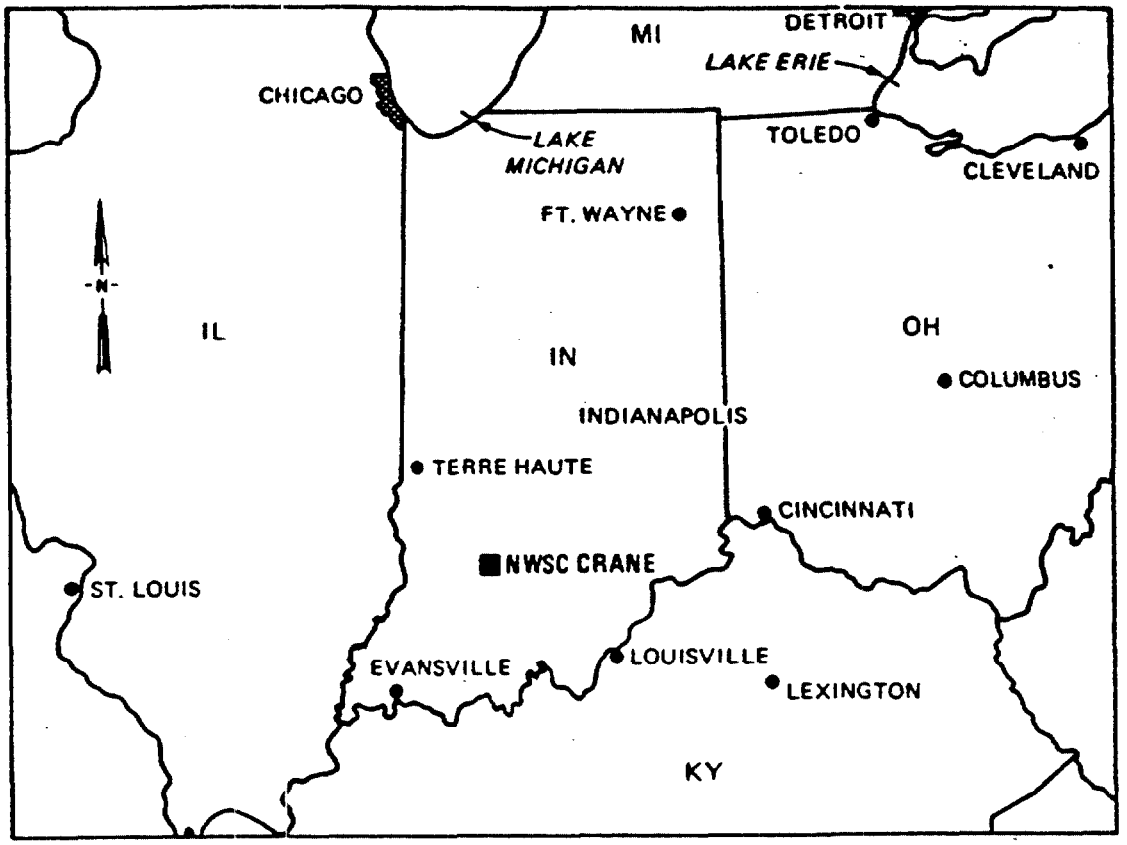


Figure 1. Location of Crane NWSC.

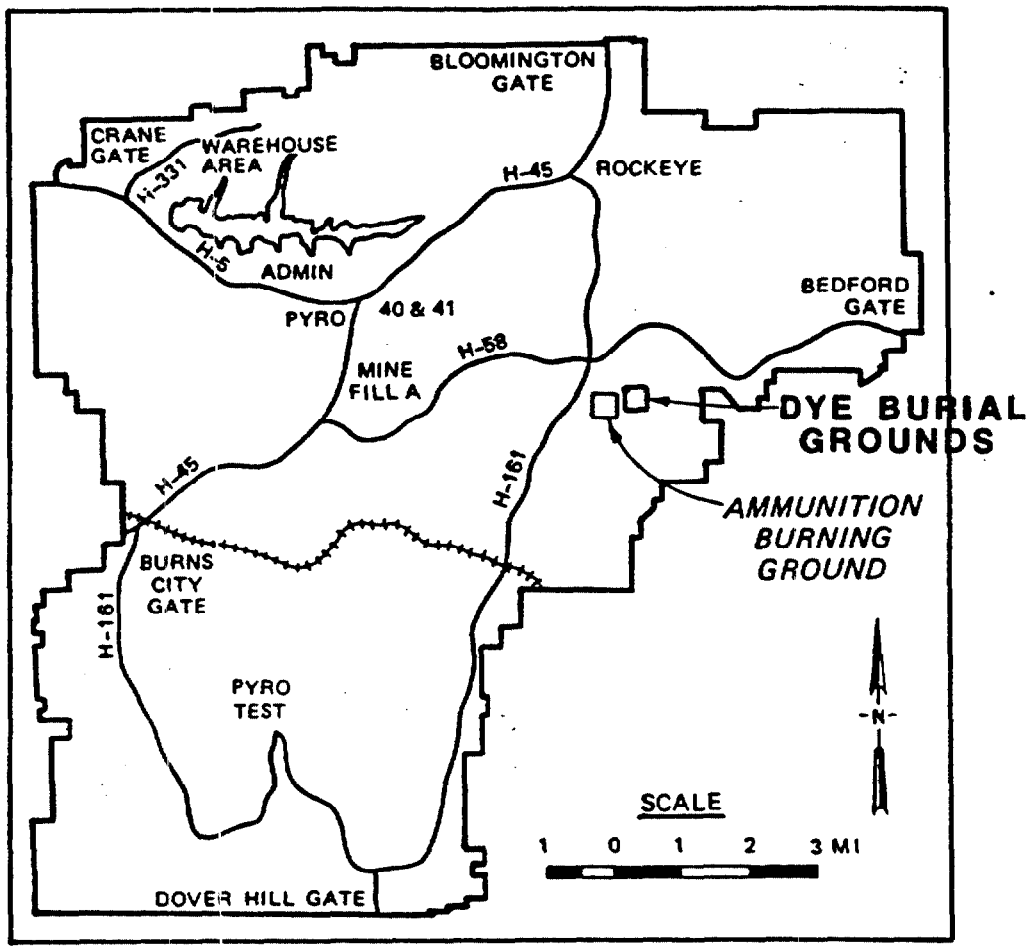


Figure 2. Location of Dye Burial Grounds, NWSC Crane, IN.

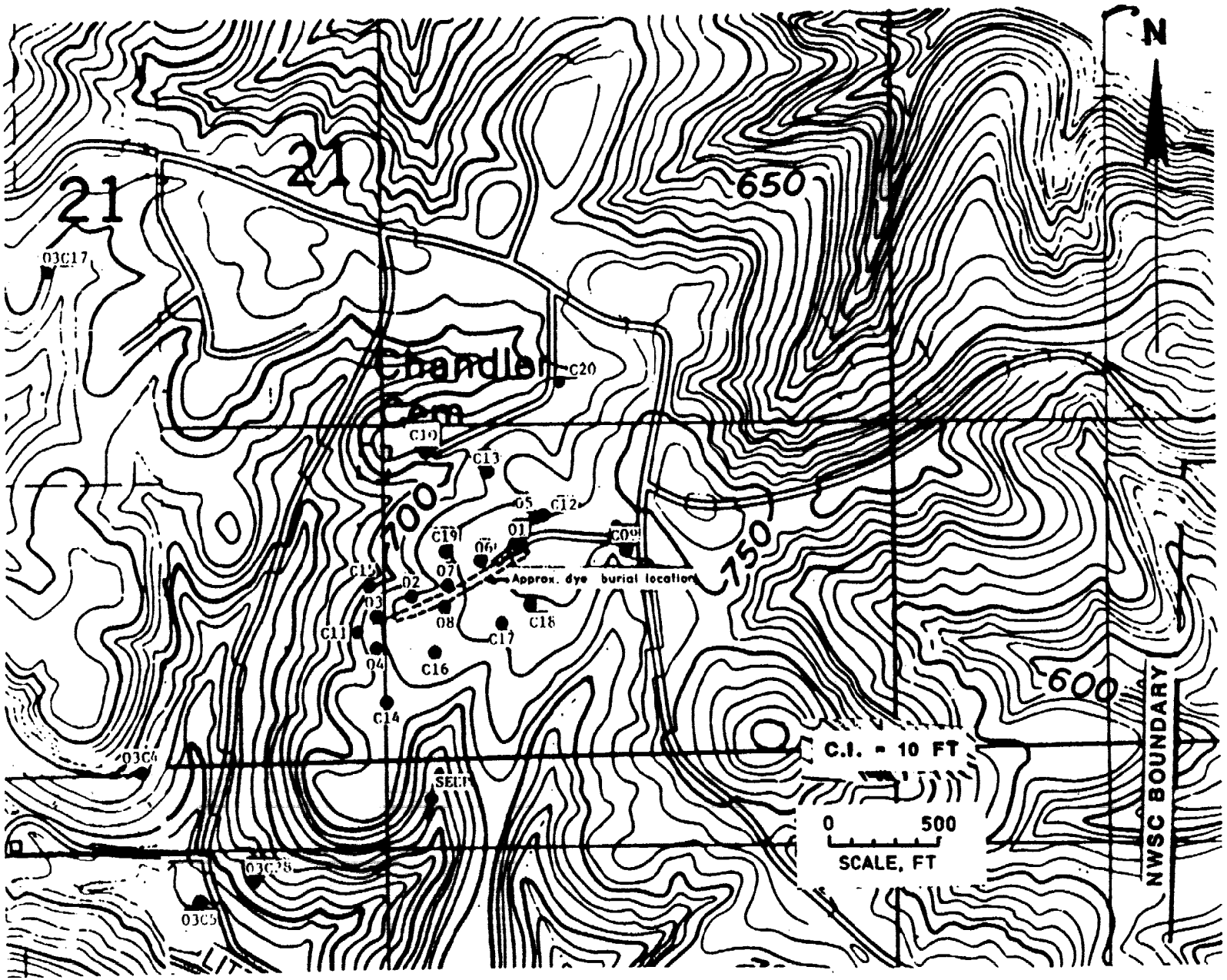


Figure 3. Topography at the Dye Burial Grounds.

resistivity, and seismic refraction. Electromagnetic induction and magnetometer surveys will be conducted first. EM and magnetometer survey results will then be assessed in the field to determine if additional surveys using one or more of the other techniques are warranted. A brief description of the methods is presented below.

(1) Electromagnetic (EM) induction. The EM technique is used to measure differences in terrain conductivity which are affected by changes in soil porosity, water content, and physical and chemical properties of the ground water and soil. The Geonics EM-31 and EM-38 Terrain Conductivity Systems are inductive electromagnetic devices used to measure the earth's apparent ground conductivity. The EM equipment consists of a transmitter and receiver coil connected by a cable of variable length. The transmitter coil is energized with an alternating current to produce a time-varying magnetic field. The magnetic field induces small currents within conductive material below the ground surface. The induced currents produce secondary magnetic fields detectable by the receiver. The measured quantity is expressed as an apparent conductivity, the magnitude of which is dependent on the instrument's coil spacing, transmitter frequency, and the ratio of primary to secondary magnetic fields. The units of conductivity are the Mho per meter or, more conveniently, the millimho/meter. Values of apparent conductivity measured on a grid can be contoured for analysis.

There are two components of the induced magnetic field measured by the EM-31. The first is the quadrature-phase component which gives the ground conductivity measurement. The second is the inphase component, which is used primarily for calibration purposes. However, the inphase component is significantly more sensitive to large metallic objects and hence very useful when looking for buried metal containers. Experiments have indicated that the EM-31 can detect a single 45 gallon oil drum at a depth of about 12 ft using the inphase component of the meter.

The EM-31 has an intercoil spacing of 12 ft and has an effective depth of exploration of about 20 ft (6 m). The EM-31 meter reading is a weighted average of the earth's conductivity as a function of depth. A thorough investigation to a depth of 13 ft is possible, but below that depth the effect of conductive anomalies becomes more difficult to distinguish as their depth increases. The instrument can be operated in both a horizontal and vertical orientation with correspondingly different effective depths of exploration. The instrument is normally carried such that the transmitter and receiver coils are oriented vertically, which gives the maximum penetration depth. It can be used in either a discrete or continuous-read mode.

The EM-38 operates under the same principles as described for the EM-31, measuring the apparent conductivity of the ground in millimho per meter. The instrument has an intercoil spacing of 3 ft, and a maximum depth of investigation of 6 ft. Both quadrature-phase and inphase readings can be taken to measure conductivity and change in metallic susceptibility, as with the EM-31. The EM-38 can also be operated in both the vertical and horizontal dipole mode coil configurations. In the vertical dipole mode, the relative sensitivity to near surface material is very low (being zero at the surface). The sensitivity increases with depth, becomes a maximum at about 1.3 ft, and decreases slowly thereafter. In the horizontal dipole mode of operation the relative sensitivity is greatest to material at the surface, and decreases thereafter with depth. The large difference in the response to near surface material in the two coil configurations allows a quick method for determining whether the near surface material is more or less conductive than is material at depth. Although the EM-38 has a much smaller depth of investigation than the EM-31, it has correspondingly greater horizontal

resolution capability than the EM-31.

(2) Magnetic exploration. Magnetic surveying will be conducted with a proton-precession magnetometer, a device which measures the intensity of the earth's magnetic field. The proton-precession magnetometer measures the absolute value of the total magnetic field intensity with an accuracy of 1 gamma (1 nano Tesla) in the earth's field of approximately 50,000 gammas. The total magnetic field intensity is a scalar measurement of the magnitude of the earth's field vector independent of the field's direction. The total field is a vector sum of the earth's main field and any local anomalous field component in the direction of the earth's main field.

Magnetic anomalies in the earth's magnetic field are caused by two different kinds of magnetism: induced and remanent (permanent) magnetization. Induced magnetization refers to the action of the field on subsurface material, wherein the ambient field is enhanced or diminished depending on the magnetic properties of the material. The resulting magnetization is directly proportional to the intensity of the ambient field and to the magnetic susceptibility of the material. The remanent or permanent magnetization is often the predominant magnetization in many igneous rocks and iron alloys. Permanent magnetization depends upon the metallurgical properties and the thermal, mechanical, and magnetic history of the specimen. This type of magnetism is independent of the field in which it is measured.

A magnetic anomaly represents a local disturbance in the earth's magnetic field which arises from a localized change in magnetization, or magnetization contrast. The observed anomaly expresses the net effect of the induced and remanent magnetization and the earth's field which usually have different directions and intensities of magnetization. Depth of detection of a localized subsurface feature depends on its mass, magnetization, shape and orientation, and state of deterioration.

(3) Ground penetrating radar (GPR). The GPR method responds to changes in soil and rock conditions having sufficiently different electrical properties such as those caused by clay content, soil moisture or ground water, voids, cementation, or man-made objects. GPR uses high frequency electromagnetic waves from approximately 100 megaHertz (MHz) to 1000 MHz to acquire subsurface information. The data collection process involves moving a small antenna across the ground surface and transmitting high frequency radio waves into the subsurface. The signal is reflected off subsurface interfaces and back to the receiving antenna where variations in the return signal are continuously recorded. Analysis and filtering of the recorded signal produce a vertical profile of the shallow subsurface conditions. The depth of exploration using GPR is primarily dependent on the properties of the soil and rock at the site. The best results are attained in dry, sandy or gravelly subsurface material.

(4) Electrical resistivity. This method investigates lateral and vertical changes of resistivity within the earth's subsurface. The technique is useful in mapping geologic features, soil conditions, and contaminant plumes having resistivity contrasts with surrounding material and in detecting subsurface layers of contrasting resistivity. The tests are usually conducted using metal electrodes driven into the ground surface, applying a current in the earth, and measuring the potential difference between the potential electrodes by means of a resistivity meter.

(5) Seismic refraction. This technique consists of measuring the travel times of compressional waves (P-waves) generated by an impact energy source from an origin to detectors (geophones) located at various points along the ground surface. The geophones are usually placed equidistant from each other along a line of investigation. The seismic signal is detected by the geophones and recorded by a

seismograph so that the P-wave arrival at each geophone can be determined. The raw data, therefore, consists of P-wave arrival times and distances to the geophones which are conventionally displayed as plots of arrival time versus distance. Straight line segments are drawn to fit the data points and interpreted using a computer program to compute the seismic velocity of subsurface layers and the depths to the layer interfaces. The raw data can also be useful in determining lateral changes in velocity.

d. Scope of work.

An EM survey using a Geonics EM-31 Terrain Conductivity System will be conducted over the suspected dye burial location. The EM-31 is a reconnaissance instrument having a coil spacing of 12 feet and an effective depth of investigation of 15 feet. The purpose of the initial survey is to measure differences in terrain conductivity at the site and to determine locations and boundaries and identify anomalies associated with the trenches. The EM 31 system will be operated in continuous-read mode with no grid. Anomalous regions will be marked and then studied in more detail using the magnetometer and Geonics EM-38 Conductivity System on a grid. A grid station spacing of five feet will be surveyed with the EM-38 and magnetometer in the cleared area of the ridge top in the vicinity of the burial trenches (approximately 300 by 100 ft). Figure 4 is a map of the Dye Burial Grounds area showing the approximate area of investigation in relation to nearby monitoring wells. The EM-31 reconnaissance survey will first be conducted within the area of investigation. The 5-ft EM-38 grid will then be laid out within the area of investigation from information obtained in the reconnaissance phase of the survey. Modification of the station spacing required to sufficiently map the anomalies will be at the discretion of the project geophysicist. The EM-38 system will more accurately define the location and perimeter boundary of the burial trenches and their contents. The EM-38 system also provides more near-surface (shallow) information. The other geophysical techniques described above will be employed if warranted by the geophysicist in charge and by the project officer.

e. Personnel.

The source location survey will be conducted by members of the Engineering Geophysics Branch (Mr. Joseph R. Curro, Jr., Chief), Earthquake Engineering and Geosciences Division (Dr. Arley G. Franklin, Chief) of the WES Geotechnical Laboratory (Dr. William F. Marcuson, Chief). Direct project supervision will be provided by the WES project officer for NWSC Crane RFI work, Mr. William L. Murphy.

f. Schedule.

The USEPA Regional Administrator will approve, modify and approve, or disapprove and provide comments to the Permittee as to the corrections or modifications needed for the Source Location Work Plan. Within 30 days after receiving comments from the Regional Office the Permittee will modify or submit a new plan for approval. The Work Plan will be initiated within 45 days after it has been approved. Anticipated date for start of field work is 15 November, 1990. Approximately 5 days are anticipated for required field work. A draft report of results and data analysis will be provided within 60 days following completion of the field work.

g. Quality Assurance/Quality Control (QA/QC) Plan.

The purpose of the QA/QC plan is to ensure that all information, data,

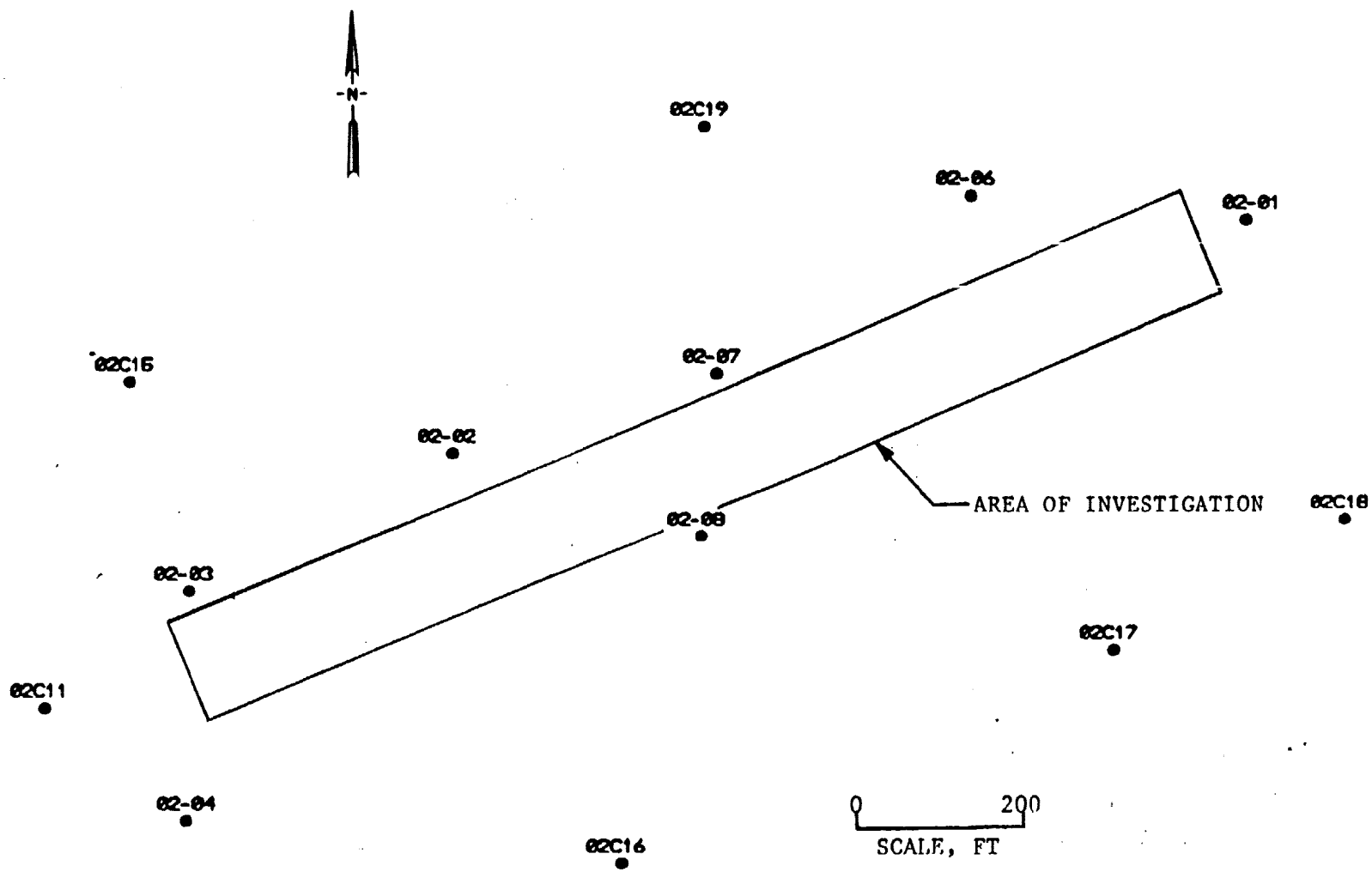


Figure 4 . Approximate area of investigation for geophysical source location surveys, Dye Burial Grounds

analysis of results, conclusions and recommendations obtained and made as a result of performing the Interim Measure Source Location are technically sound, statistically valid, and properly documented. QA/QC procedures to be followed for specific surveying methods are:

(1) Survey grid. Survey grid positions are located from known points, which for the DBG are well casings which have been previously surveyed for map location (northings and eastings). Grid positions are marked with wooden stakes for reference during the geophysical surveying. Grid location will be made by chaining or by transit from the known well positions.

(2) EM surveying. Prior to operating the EM system in the area of interest, a visual reconnaissance of the area is made by the geophysicist to identify potential man-made or natural anomalous electromagnetic sources such as fences, power lines and other utilities. Utility maps of the area are obtained and studied. The EM instrument is then nulled and readings taken either in continuous mode for reconnaissance or at specific grid nodes for detailed mapping. Measurements are recorded on a digital data logger and transferred to a portable field computer at the conclusion of each day. Filters can be employed during computer analysis of the data to enhance specific areas of interest and to reduce the effect of unwanted anomalies such as fences.

The EM 38 instrument is operated in both the vertical and horizontal orientations (see Paragraph c.(1) above) and the results compared as an indication of relative depth of anomalies detected by the surveys. If the vertical and horizontal data are similar, the anomalous features can be assumed to be quite shallow. Figure 5 is a graphical display of data from an EM-38 survey conducted in both horizontal (bottom graph) and vertical orientations over the same area. The graphs are similar, indicating that most of the anomalous features (peaks and valleys) mapped by the system are shallow.

(3) Magnetometer surveying. Magnetometer data are stored in the internal memory of the magnetometer and transferred to a portable field computer at the conclusion of each day. The magnetometer survey is conducted using a "looping" procedure. In looping, one grid point is established as the base and remains as such throughout the survey. The base station is reoccupied at approximately 30 min intervals. In this way, any drift in the earth's magnetic field can be identified and removed for data analysis. The nominal value of the earth's field, 50,000 nano Teslas (nT) is subtracted to provide a reference level for determining significant highs and lows in the survey readings. The data can be filtered by a computer process to reduce the effects of known magnetic anomalies such as fences. The process involves clipping values above and below a selected range relative to the mean value.

(4) Ground penetrating radar. A preliminary test is conducted with the radar unit at the test site. The purpose of the test is to determine which of the available antennas (typically 80 and 300 MHz) are most suitable for the soil conditions. As the main test proceeds, radar range settings are adjusted to obtain data at sufficient resolution to as great a depth as possible. Shape and size of the radar "targets", or reflectors, are clues to the characteristics and identity of the subsurface anomalies they represent. Hyperbolic-shaped reflectors are classified as narrow or wide. Narrow hyperbolic reflectors often indicate relatively small man-made objects such as cannisters, drums, ordnance or debris, or naturally occurring cobbles and boulders. Small reflectors associated with "ringing" of the data record are usually indications of shallow metal targets. Wide hyperbolic reflectors may indicate local changes in geologic conditions or deep man-made features. Figures 6 and 7 are examples of narrow hyperbolic and ringing

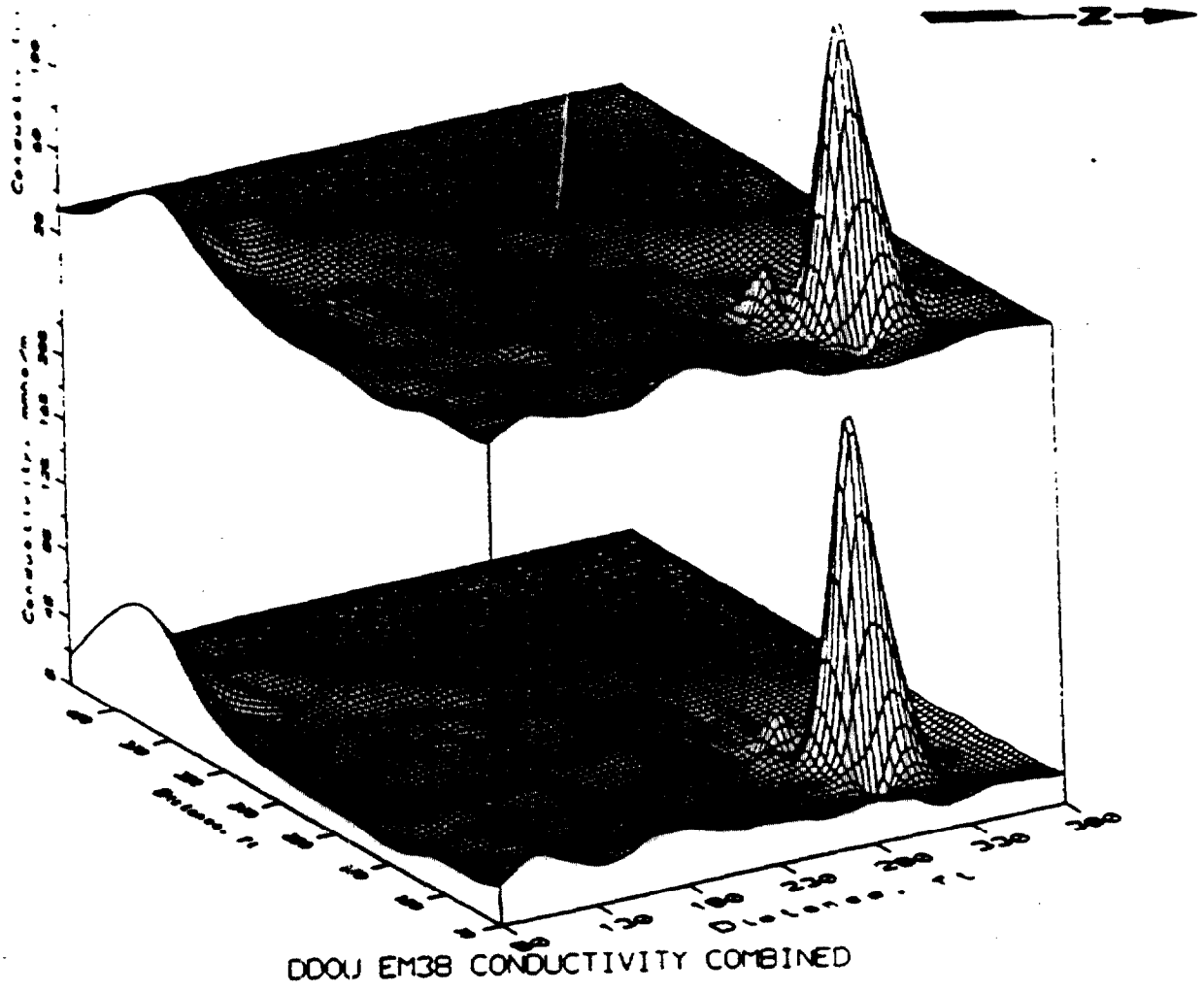
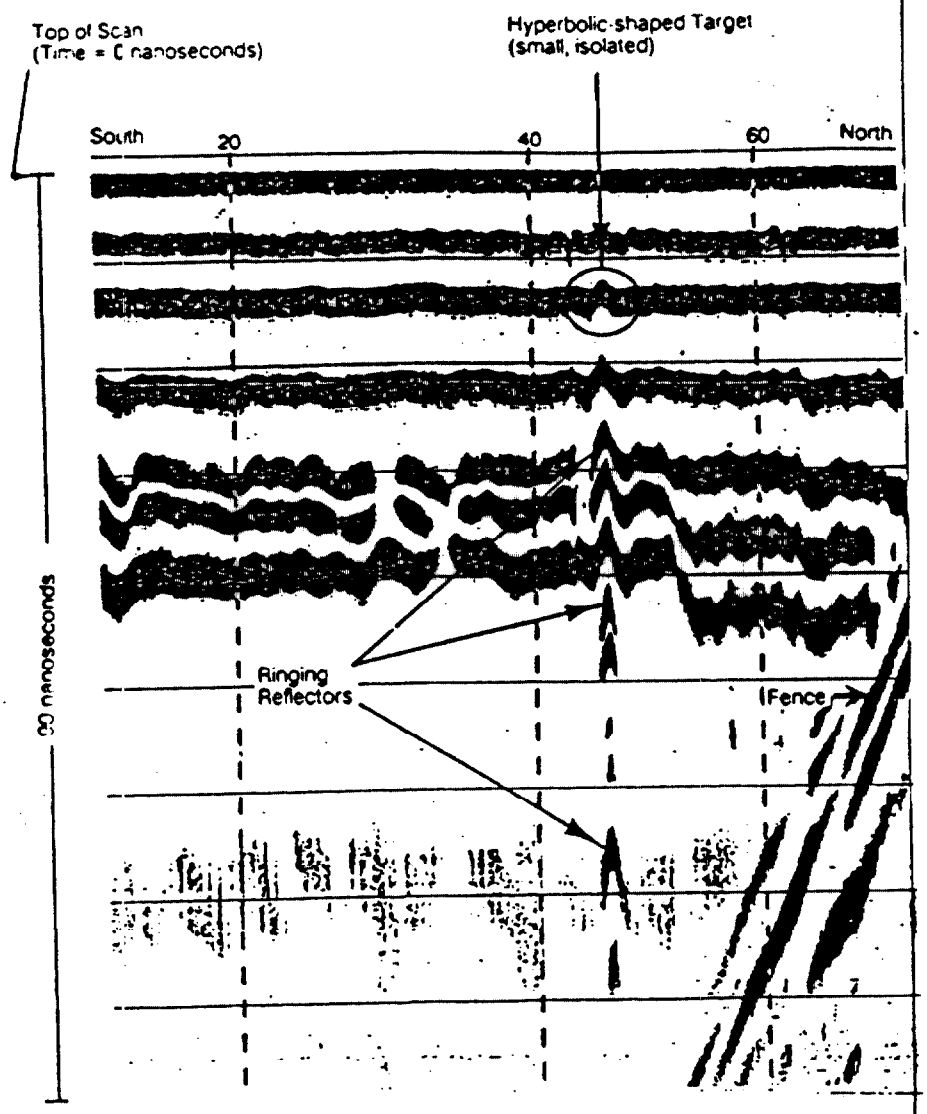
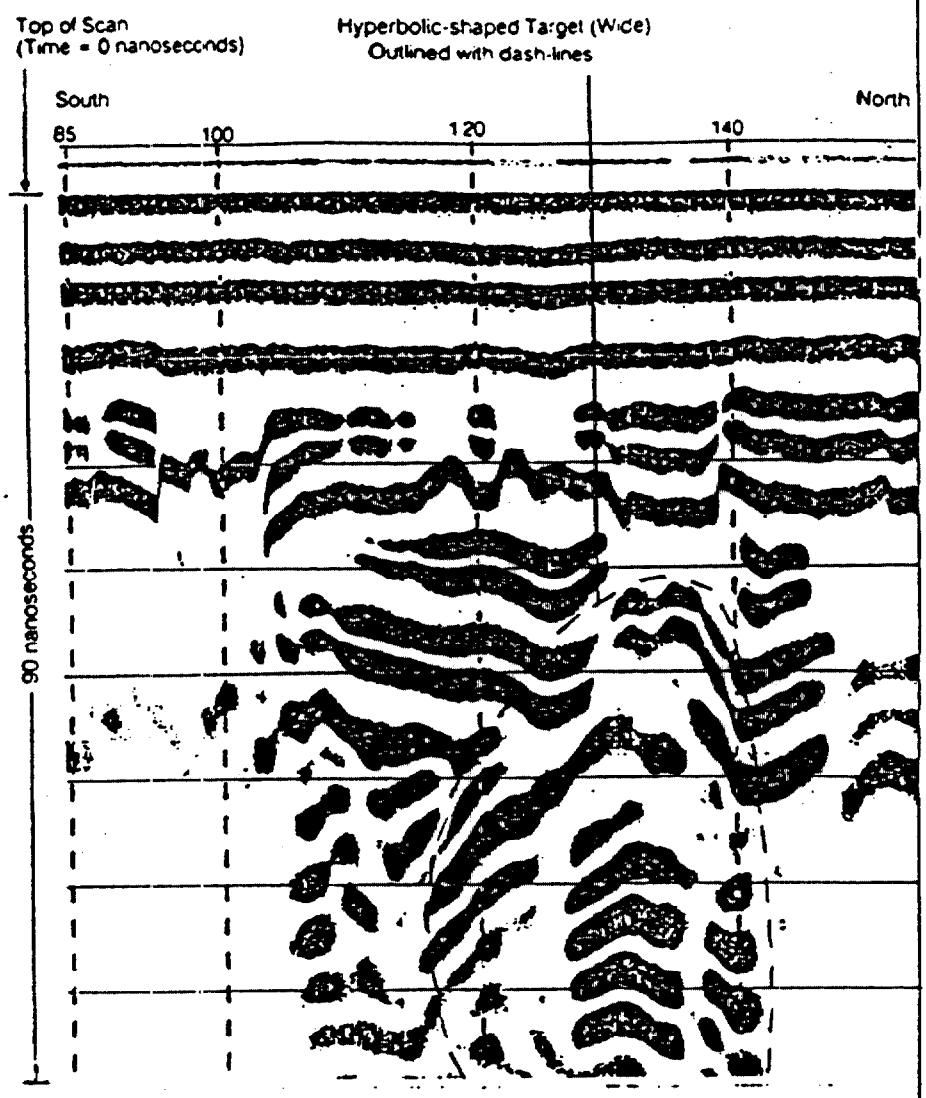


Figure 5 . EM-38 conductivity survey test results with the vertical orientation elevated above the horizontal orientation.



Estimated Total Depth =
9 feet (1 foot/10 nanoseconds)
Horizontal Scale indicated by station marks
Line 3+60, Stations 20 to 60

Figure 6 Representative Radar Record of Small Hyperbolic Target



Estimated Total Depth =
9 feet (1 foot/10 nanoseconds)
Horizontal Scale indicated by station marks
Line 3+10, Stations 85 to 140

Figure 7 Representative Radar Record of Wide Hyperbolic Target

reflectors and wide reflectors, respectively. Dipping radar reflectors can represent the walls of a trench or can be caused by the radar antenna moving toward or away from a steel fence. Pre-survey reconnaissance for potential man-made anomalies is essential to permit proper interpretation of survey data.

Steel fences and electronic "noise" are factors which degrade the radar survey data. Effects of fences can be accommodated by pre-survey mapping of fence locations. Those records showing appreciable electronic noise will be rerun. Another factor in data quality deterioration is failure to maintain a constant survey speed. Care is taken to pull the radar "sled" along the ground surface at a uniform speed.

h. Data Analysis and Presentation of Results.

Aside from application of quantifiable filters and elimination of background levels of the electromagnetic field and the earth's magnetic field, interpretation of the survey data is by qualitative assessment of mapped and graphed magnetic and electromagnetic readings and of radar cross-section records. Depth to radar targets can be obtained from the GPR cross sections. An approximate range of depth can be estimated from the magnetometer and EM data. Contoured values are examined and anomalies identified. Anomalies are interpreted by evaluating their shape, location and magnitude in each of the three surveys so that data from all of the survey techniques contribute to the final interpretation. Anomalies identified in pre-survey reconnaissance as unrelated to the test purposes, such man-made features as fences and utilities, are eliminated from consideration. Ideally, target anomalies will be identified in more than one type of survey to increase the confidence and reliability placed in their interpretations.

The primary targets to be identified and located are the Dye Burial Grounds trenches (boundaries and depth) and features within the trenches such as steel drums and other containers and zones of anomalously high or low conductivity.

Magnetometer and EM data will be presented as contour maps and block diagrams as illustrated by Figure 8 and Figure 5. GPR data are presented as cross-sections produced as direct output in the field during the GPR survey and then annotated (Figures 6 and 7). Interpretations of the data will be summarized in tabulated form.

i. Health and Safety Plan.

This site safety plan (a) establishes the responsibilities, requirements, and procedures for the protection of personnel while on-site during field investigations, (b) is designed to limit the exposure to potentially hazardous situations by specifying protective clothing, safety equipment, and emergency precautions, and (c) provides for the orderly conduct of field activities which include emergency operations in the event of accident.

(1) Dye Burial Grounds hazard assessment. A general description of the Dye Burial Grounds and the dye burial trenches and contents was provided in section 1.a, above. A list of specific dyes and other materials placed in the trenches is not available. The Initial Assessment Study of 1981 stated that the buried materials included toxic and potentially carcinogenic dyes. There are no apparent surface exposures of the dyes at the Dye Burial Grounds. Other investigative operations, including geologic reconnaissance and monitoring well installation and sampling, have taken place at the site since 1982. The NWSC Crane Environmental Protection Branch advises that Level D personal protection clothing will suffice to prevent contamination of workers at the site. The Source Location techniques proposed in this work plan are primarily non-destructive, surface or above-surface procedures

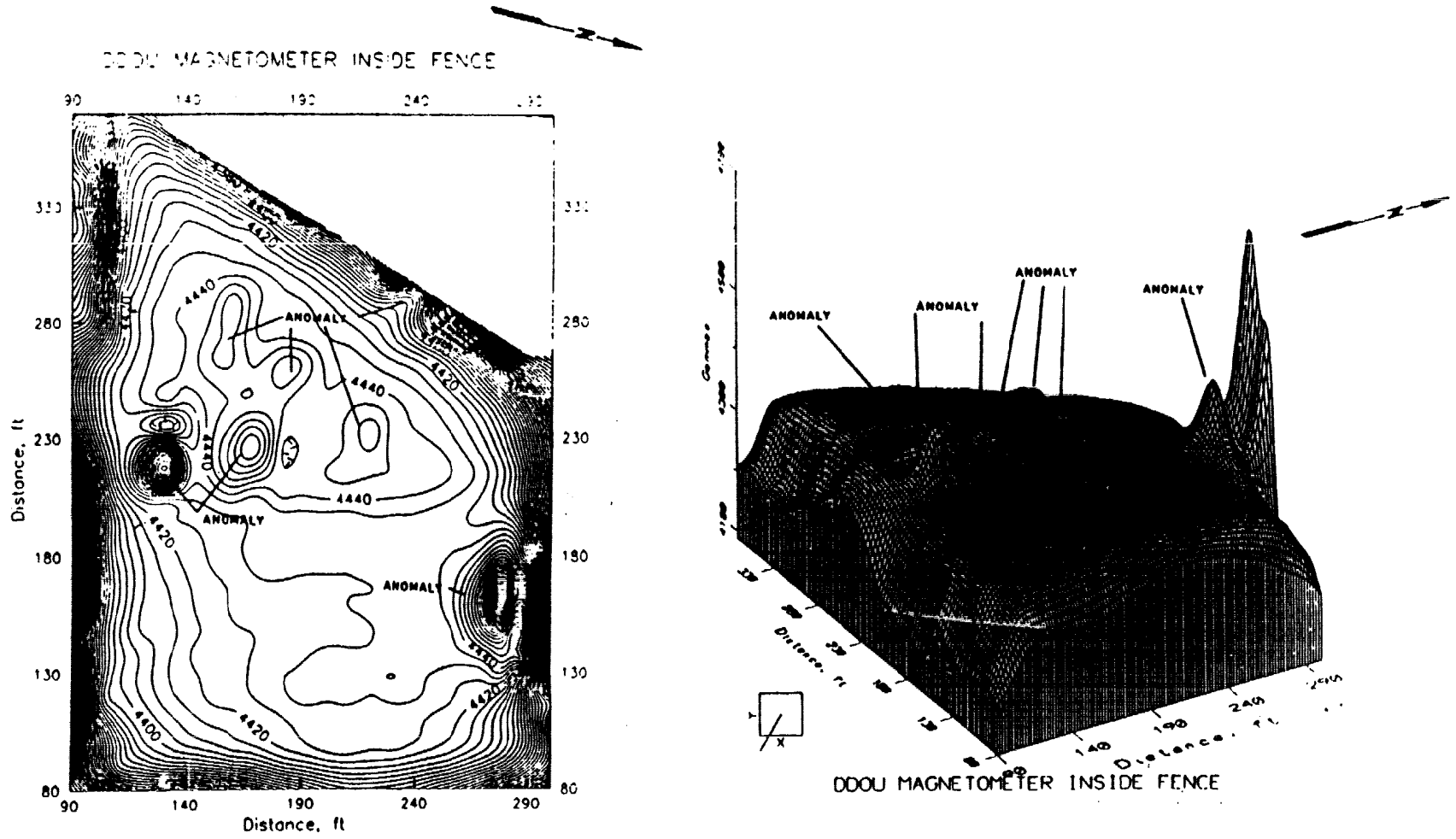


Figure 8. Magnetometer survey data presented as contour map (left) and mesh-type block diagram.

with little or no contact with the soil beneath the ground surface. The electrical resistivity exploration method, proposed as an alternative technique, requires driving metal stakes into the ground but only to a depth of approximately 6 inches. Therefore, potential contact with buried materials is minimal.

(2) Health and safety equipment. Level D protective equipment will be worn by personnel conducting the Source Location survey at the DBG: cotton coveralls or disposable chemical resistant coveralls such as Tyvek or Saranex, leather or chemical resistant waterproof boots, and chemical-resistant gloves. Modifications to the recommended safety clothing, such as eye protection, will be made if suspicious materials are encountered during the survey.

(3) Emergency medical assistance and first aid. Prior to the field investigation, a network for emergency medical assistance will be established. The health facilities at NWSC Crane, fire department, ambulance service, and local clinic or hospital emergency rooms will be identified. Figures 9A and 9B show the locations of the Fire Station and the medical facilities on post. The local telephone extension number for Fire is 1458, for Police 1849, and for Medical 1438. Hospital facilities are located in Bloomington and Bedford, Indiana. Figure 10 shows routes to Bloomington and Bedford, IN from NWSC Crane. Questions concerning safety at the site or other facility matters should be addressed to Mr. James Hunsicker, Chief, Environmental Protection Branch, NWSC Crane, (812)854-3114.

(4) General site safety requirements. All personnel involved in the field operations will be familiar with and adhere to the worksite rules as stated by OSHA, the U.S. Army Corps of Engineers, the WES, and NWSC Crane. Field personnel will not eat, drink, or smoke at the site and shall wash their hands following work and before eating or drinking. The ignition of flammable material (including smoking materials) within the boundaries of NWSC Crane is strictly forbidden.

Field personnel shall wear the proper safety clothing on the work site at all times. Contact with potentially contaminated substances during the investigation is prohibited. On-site workers shall also avoid walking through puddles or pools of liquid, kneeling, leaning, or sitting on the ground, or placing equipment on contaminated soil.

Hazard assessment is a continuous process. Personnel must be constantly aware of their surroundings and the chemical/physical hazards that are present at the site. Field workers should be continually aware of the location and condition of their co-workers. Each individual member of the field crew is responsible for complying with applicable safety requirements, wearing prescribed safety equipment, and preventing avoidable accidents and property damage.

(5) Medical surveillance. All personnel involved with field operations will be familiar with and adhere to the worksite rules as explained in this document. It is the responsibility of the project safety officer to inform field personnel of the site specific safety plan. Each employee working at the site will have had a comprehensive physical examination and chemical screening within the 12 months preceding his/her field involvement to provide background information. At the end of the project or annually the employee will have a routine physical examination.

(6) Assignment of responsibilities. Assignment of responsibilities for the development, coordination, and implementation of the site safety plan and investigative procedures are essential for proper administration and completion of the scope of work. Implementation of the safety plan will be accomplished through an integrated effort of the following personnel:

Principal Investigator:	William L. Murphy, USAEWES	(601)634-3322
Project Geophysicist:	Jose L. Llopis, USAEWES	(601)634-3164

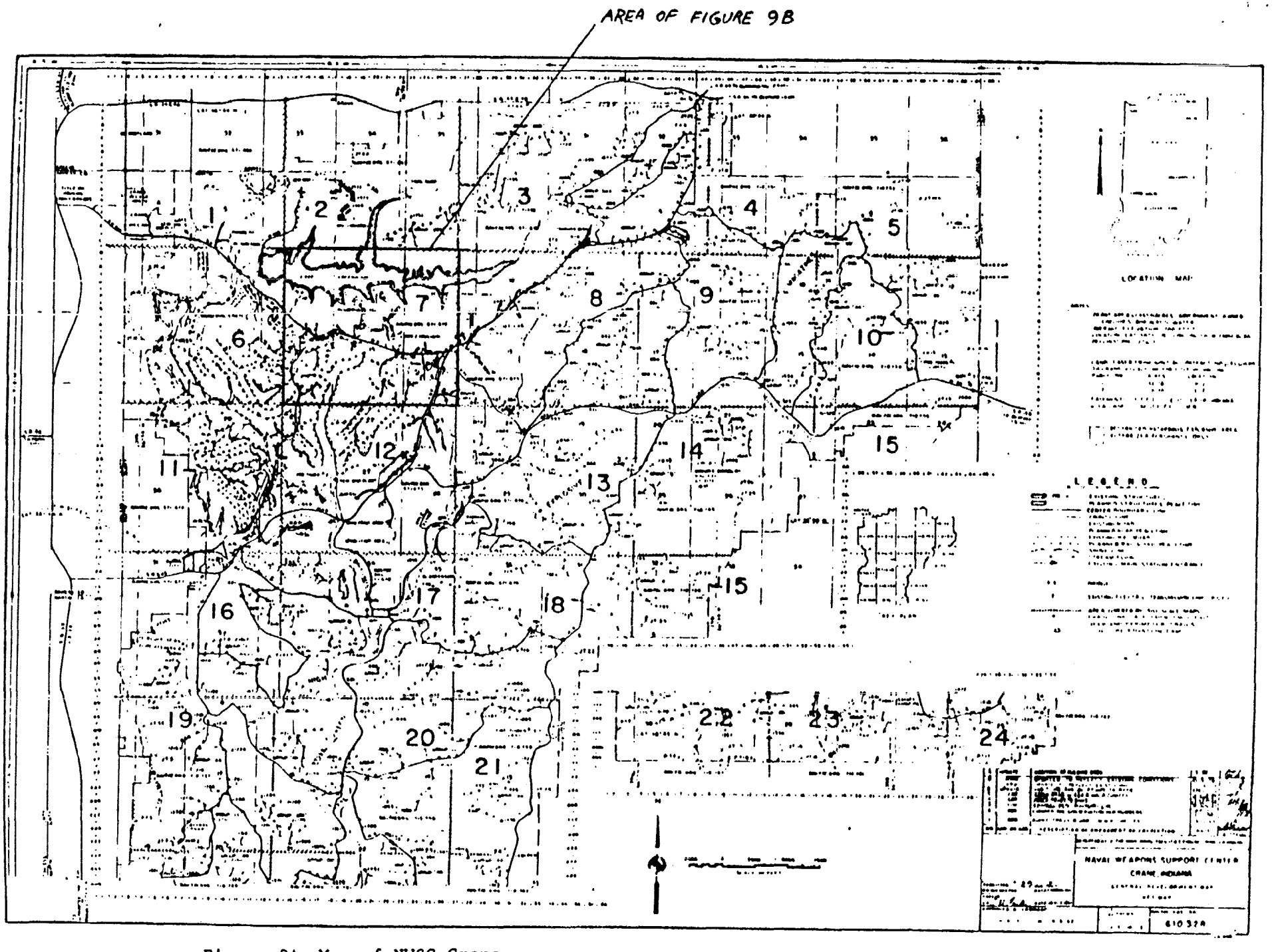


Figure 9A. Map of NWSC Crane

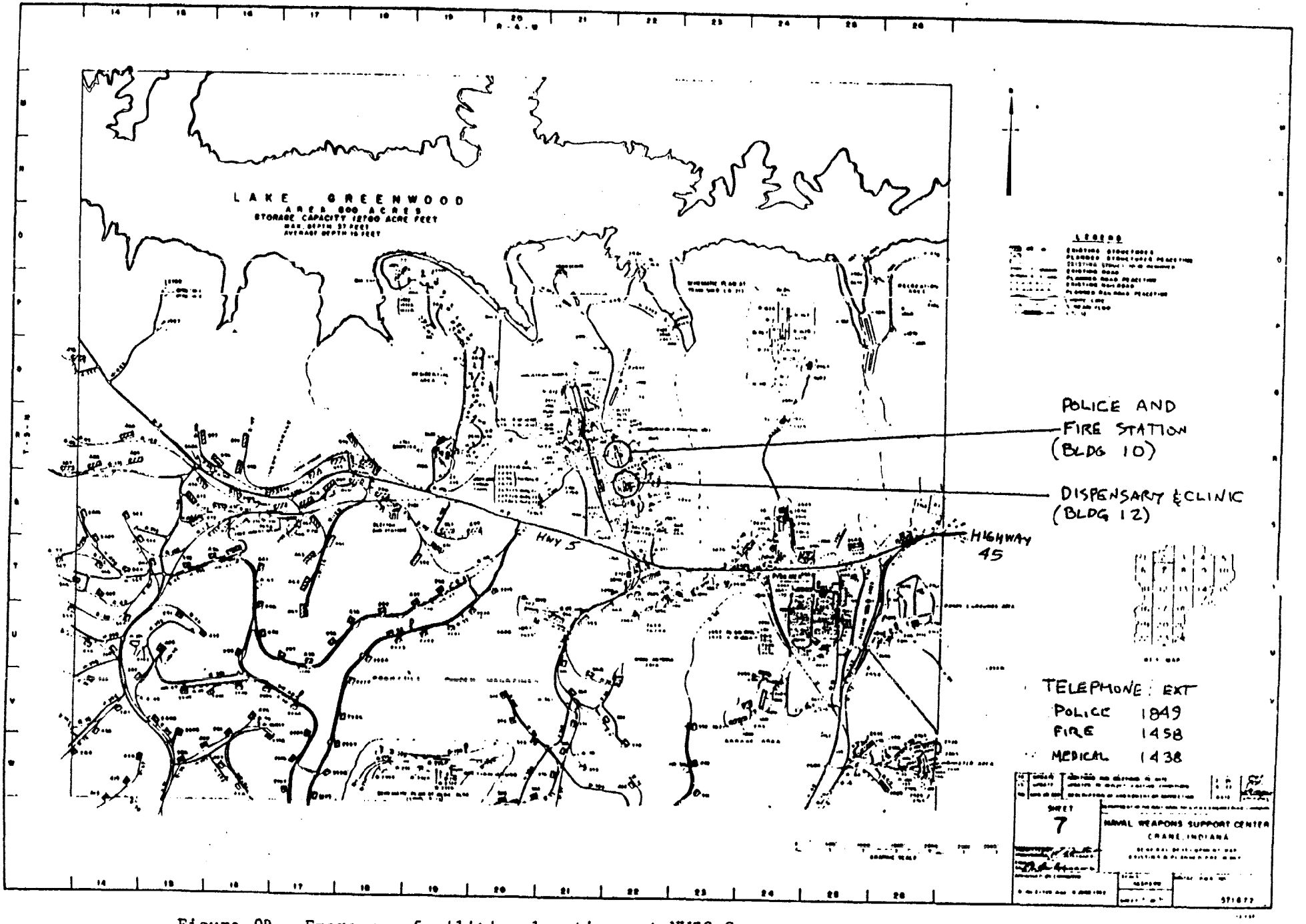


Figure 9B. Emergency facilities locations at NWSC Crane

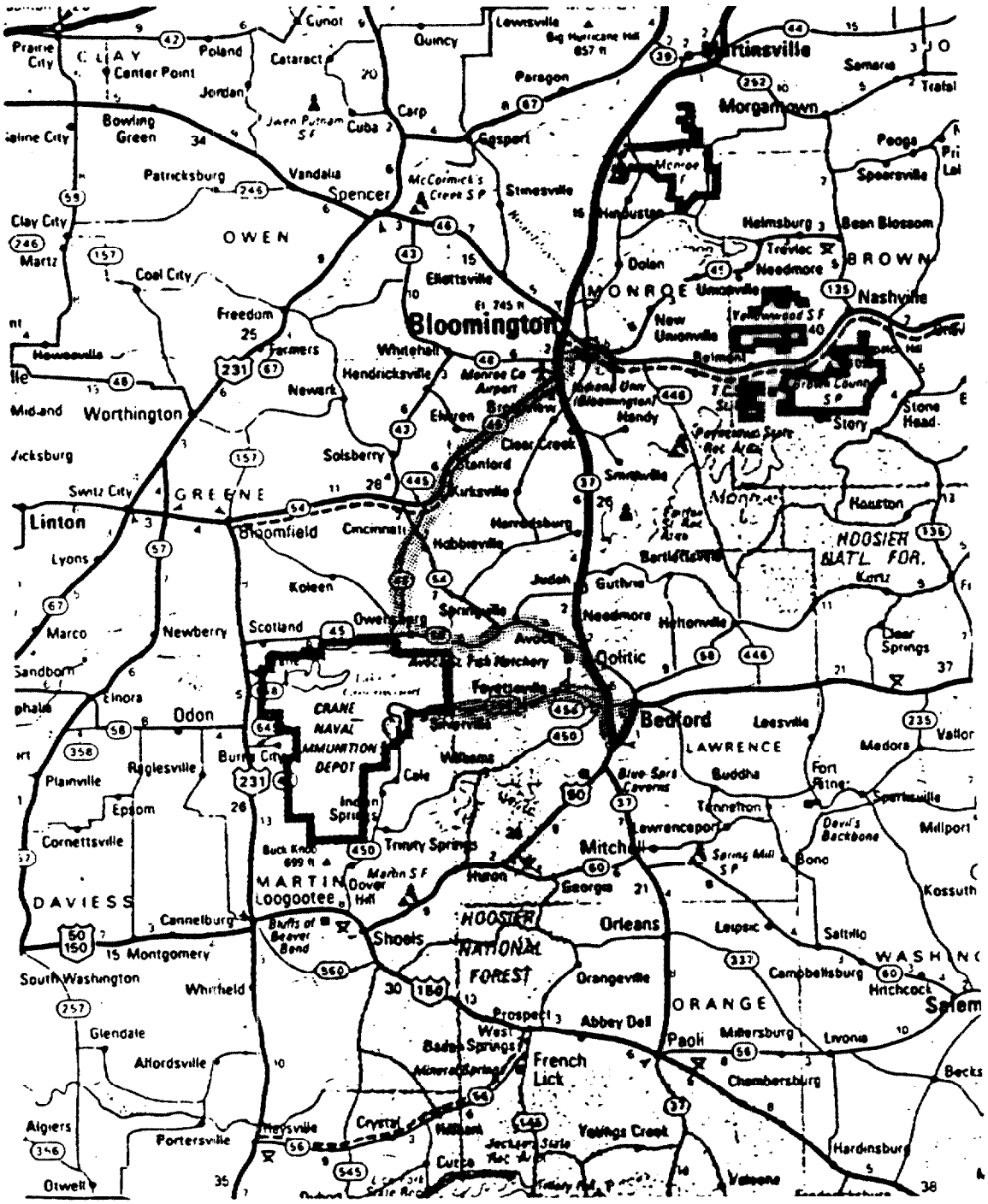


Figure10. Routes to Bloomington and Bedford, IN from NWSC Crane.

Corporate Health and Safety Officer:	Jerry W. Haskins, USAEWES	(601)634-2298
On-site Health and Safety Coordinator:	Jose L. Llopis	(601)634-3164
Geophysical Field Personnel:	Jose L. Llopis and Michael K. Sharp	(601)634-3787

The project geophysicist maintains the overall responsibility for the performance and completion of the field investigation in a safe manner and is the primary contact during this study. Should a health and safety issue develop during the performance of the investigation, the project geophysicist will notify the Chief, Environmental Protection Branch, NWSC Crane and the Principal Investigator (WES).

The on-site health and safety officer is responsible for the implementation of the safety plan. This officer will direct all field activities involved with safety and has the responsibility and authority to halt or modify any working condition considered unsafe.

All field staff are responsible for understanding and complying with all aspects of the site safety plan. Field personnel are also encouraged to bring all perceived unsafe site conditions to the attention of the on-site safety officer and project geophysicist.

CERT. STA

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

_____
SIGNATURE

_____
TITLE DATE

Enclosure (2)

CERT. STA

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE

Public Works Officer 10/17/90

TITLE DATE

Enclosure (2)