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

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CORRESPONDENCE CONTROL

92-EPB-042

Mr. Paul T. Day
Hanford Project Manager
U.S. Environmental Protection Agency
712 Swift Boulevard, Suite 5
Richland, Washington 99352

Mr. David B. Jansen, P.E.
Hanford Project Manager
State of Washington
Department of Ecology
P. O. Box 47600
Olympia, Washington 98504-7600

JUL 1992
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EDMC

Dear Messrs. Day and Jansen:

HANFORD GEOGRAPHICAL INFORMATION SYSTEM (GIS)

Reference: Letter, P. T. Day, EPA, to S. H. Wisness, RL, same subject, dated April 8, 1992

In reply to the referenced letter above, the Hanford GIS information requested is attached. Westinghouse Hanford Company has been working on the assessment of these maps and digital information to determine their use as a base map for the Hanford Environmental Information System Geographical Information System (HEISGIS).

It should be noted that the HEISGIS is being developed as part of the Environmental Restoration (ER) Program to support site investigation, remediation and closure activities. Its usage for the Resource Conservation and Recovery Act activities has not been determined. The Hanford Environmental Information System will access other databases that are relevant to the ER program, including the Hanford Groundwater Data Base.

The information requested is provided in the following Attachments:

Attachment A: Responses to the questions requested in the letter.
Attachment B: Letter from Geonex Cartwright, Inc. This letter outlines the proposal from the private company which conducted the aerial photography, stereoplotting and digitizing.
Attachment C: Specification package for the 1100 Area fly-over.

Attachment D: Specification package for the 200 Area (East and West) fly-over.
Attachment E: Specification package for the 300 Area fly-over.
Attachment F: Specification package for the 400 Area fly-over.
Attachment G: Specification package for the 100 Area fly-over.

Each specification package (Attachments C, D, E, F, and G) contains the following information:

Attachment 1: Mapping specification for the aerial mapping project.
Attachment 2: Method of establishing horizontal data on aerial photo control points.
Attachment 3: Listing of aerial photo points for are mapping - sketch showing target configuration.
Attachment 4: Maps indicating verification by random sampling - check profiles for multiple sheets throughout the project. (Note: Maps are not available for 1100 Area)

Due to the size and bulk in mailing, Attachment 4 will be sent under separate cover.

In order to address the issue of GIS usage on the Hanford Site, a site-wide GIS users group has been formed. This group will establish site-wide standards, coordination and interface with various GIS users.

The U.S. Department of Energy recognizes the importance of establishing a base map to meet the needs for any GIS developed onsite. We will be working closely with you to determine the usage of these maps, and any additional mapping needs. Should you have questions concerning this reply or need additional information, please contact Ms. N. A. Werdel of the Environmental Restoration Division on (509) 376-5500.

Steven H. Wisness
Hanford Project Manager

ERD:NAW

cc w/atts:
J. Denkers, Ecology
D. R. Einan, EPA
EDMC, H4-22

cc w/o atts:
[redacted]
F. T. Calapristi, WHC

RECEIVED MAY 1992 T.B. VENEZIANO

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
S. H. Wisness, RL	P. T. Day, EPA D. B. Jansen, Ecology	Incoming: 9202796

Subject: HANFORD GEOGRAPHICAL INFORMATION SYSTEM (GIS)

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Attachment A: Responses to the Questions on Page 3 of the EPA Letter

All available documents have been reviewed including those from KEH, WHC ER, and procurement. Questions 1-10 (below) have been answered as best they could with the available information. For those areas which are vague or incomplete, WHC may be able collect additional information by contacting each of the vendors who performed the work. Given the amount of time which has elapsed since the work was performed and the uncertainty of whether or not vendors have kept their work files, there may be little value added for the effort required.

(1) The flight elevation at which the photographs were shot;

Photography was flown at 2460' over the terrain (100 areas & 400 area); see attached letter from Geonex Cartwright General Information section.

(2) The focal length of the camera used;

The photography was done with a Zeiss RMK A/15/21 with a 6" focal length; see attached letter from Geonex Cartwright Aerial Photography (for the 100 areas and 400 area).

(3) The photo overlap percentage along the flight lines;

The percentage of endlap (along the flight lines) was to be done as specified in 14.6.2.1 Section 14 Land Surveying, Aerial Photography, and Mapping, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87 (Attachment #1 for each package).

(4) The photo overlap percentage between sequential photographs;

The percentage of sidelap (adjacent photographs) was to be done as specified in 14.6.2.1 Section 14 Land Surveying, Aerial Photography, and Mapping, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87 (Attachment #1 for each package).

(5) The number and location of registration (control) points in each area, the method of locating the registration points (surveying techniques), and the estimated accuracy of the location (x, y, and z coordinates);

See attachment #2 and attachment #3.

(6) The location of the zero point (point of origin) of the coordinate system for each area mapped, and the map projection parameters defining the coordinate system;

See attachment #2 and attachment #3.

(7) The transformation method used for any conversion of coordinate systems;

See attachment #3 for areas where a transformation was required.

(8) The method of edgematching between different map sections (sheets) within each area and the estimated change in accuracy due to the edgematching process;

The method of edgematching was exact by coordinates; no change in accuracy.

(9) Whether orthophotos were produced for each area and where the orthophotos are archived;

There was no requirement to produce orthophotos.

(10) The location and status of the original aerial photographs and documentation of digitizing work order.

The original aerial photographs (contact prints) are located in the Environmental Restoration Technical Library. The negatives are located at the photography laboratory in the 300 area. Services provided by the library include the capability of making additional prints. The 1100 area (the first area flown) is missing from the files (both negatives and prints). KEH has one set of contact prints for the 1100 area.

See attached letter from Geonex Cartwright, Inc. (100 areas and 400 area) section on Stereo Plotting and Digitizing.

Attachment B: Geonex Carwright, Inc. Letter Response on Mapping Estimate

100 A'3

CARTWRIGHT
AERIAL SURVEYS INC.
EXECUTIVE AIRPORT
5979 FREEPORT BOULEVARD
SACRAMENTO, CA 95822

January 19, 1990

Kaiser Engineers Hanford Company
Post Office Box 888
Richland, WA 99352

Reference: Mapping Estimate K49527-W3

Gentlemen:

GEONEX CARTWRIGHT, INC. (formerly Cartwright Aerial Surveys, Inc.) welcomes the opportunity to make this proposal and estimate for topographic mapping. We have operated continuously from our Sacramento installation since our founding in 1946 and have an established reputation for providing quality work and services such as those you require.

Enclosed please find a brochure regarding our services and copies of Standard Forms 254 and 255 which detail our experience in mapping, list our equipment, and provide resumes of our personnel.

PROPOSAL

General Information

The targeting and ground survey requirements that you requested are enclosed. On the taped USGS 15' quads you will find our stereo model layouts and target locations. Horizontal and vertical data is needed for each targeted point. The overlay shows the 800' scale negative flight which will control the mapping flight at 410' scale shown on the quads. The 410' scale mapping photography will be flown at 2,460' over the terrain which facilitates a high degree of accuracy in plotting the contours at 1/2 meter.

Aerial Photography

The aerial photography will be done by our own crew in a Cessna 206B, equipped with a high precision Zeiss RMK A/15/21 which has a 6" focal length. Three hundred stereo spaced exposures will be taken.

Laboratory

The film will be processed, edited and titled for contact prints and glass diapositives.

Stereo Plotting And Digitizing

Santoni IIC stereo plotters in conjunction with CAD-MAP software will be used to plot and gather the digital information which will be furnished to you on 5-1/4" floppy disks in AUTOCAD release 10.0 drawing files. In addition we will provide the mapping on 28" x 40" mylar sheets in your format as specified.

Production Timing

We can perform the aerial photography immediately after the targets have been laid (weather permitting) and the mapping will begin three weeks after receiving your ground survey information. The mapping and digitizing will take approximately 65 working days to complete.

Mapping Proposal Estimate

$ 89,400.00

* * * *

Please feel free to call if you have any questions. We are available to meet with you at your convenience to discuss any aspects of this proposal.

Yours very truly,

GEONEX CARTWRIGHT, INC.

Don Johnson,
Vice President/Marketing

DJ/ef

Enclosures

Attachment C: 1100 Area Fly-over Specifications Package

KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. — — —
Project/W.O. No.	Title: 1100 AREA OPERABLE UNIT AERIAL MAPPING	File No. 1 0 2 8 — 0 4 7
KEH Job No. ER 2704	Prepared By: Kline R. Welsch	Date: 4/7/92
		Reviewer: V. Coyne

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
1100 Area fly-over specifications.	Yes ☐	Survey File	OR
	No ☐	Field Project File	
	NA ☒	R. Fox	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

ATTACHMENT #1: Mapping specifications for the 1100 Area aerial mapping projects.

ATTACHMENT #2: Method of establishing horizontal data on aerial photo control points.

ATTACHMENT #3: Listing of aerial photo points for the 1100 Area mapping. Sketch showing target configuration.

ATTACHMENT #1

AERIAL TOPO ESTIMATE

1) Approximate size, scale and contour interval for each area are given below:

AREA	APPROX DIMENSIONS	SCALE	GIVEN INTERVAL
A	1900 ft X 1300 ft	1 in = 50 ft	1 ft
B	1900 ft X 1300 ft	1 in = 50 ft	1 ft
C	1900 ft X 1300 ft	1 in = 50 ft	1 ft
D	3800 ft X 2600 ft	1 in = 100 ft	1 ft
E	5300 ft X 13000 ft	1 in = 500 ft	5 ft

(See Attachment "D")

2) Map Format:

a) Printed on Hanford standard-sized sheets (28" x 40").

b) Minimum margin of 1" around the borders.

c) Space allowed across the bottom righthand corner (above border) of the map for a WHC standard legen. (Attachment "A")

d) A graphic scale and north arrow shall be provided. In general, north shall be oriented up on the maps (parallel to the short dimension on the map sheets). However other orientations may be allowed to facilitate map presentation.

e) Where necessary, map sheets shall be produced as a series with match lines to adjacent sheets. For map series, an index sheet will be provided to show the relative location of each map sheet.

f) Washington State Coordinate Grid Lines with Hanford Grid Ticks shall be shown on the maps.

g) Maps shall show all buildings, walks, roads, ditches, utility poles, pits, ponds ans other such features visible on the aerial photographs, as well as contours and spot elevations on roads, dikes, and ditch inverts. Where feasible, such features shall be stored in a separate file so that overlays may be created.

h) Maps shall be signed and stamped by a Registered Professional Land Surveyor in the state of Washington as to the accuracy of the maps.

3) Deliverables:

a) One set of maps will be provided on double-matte mylar with one set of sepias.

b) Enlarged photographs of Areas A, B, C, and D at the same scale as mentioned in Item No. 1.

c) Data will be supplied to KEH in Autocad or compatible format such that the maps can be generated or modified by KEH and WHC using Autocad software. (Attachment B)

d) Three sets of contact photographs.

e) All negatives.

4) Premark requirements must be submitted for the following:

a) Size of targets

b) Spacing for horizontal and vertical

c) Configuration of targets

5) Field Work:

a) KEH Survey will provide survey work needed for mapping.

6) Accuracy:

a) Maps will meet minimum standards set for aerial photographic mapping described in Section 14, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87. (Attachment C)

7) Estimate is needed by March 22, 1989.

8) Schedule: Maps are needed by June 16, 1989.

ATTACHMENT #1

ATTACHMENT "B"

SUBJECT: DATA FILES

In order to process data produced by mapping contractors, Kaiser Engineers Hanford (KEH) must receive the data in the following format:

1. "Autocad" Release 9.0 drawing files.

The data files should be limited to a reasonable size, 175-250K (kilobytes) and should be a delivered on one of the two following media:

1. 360K floppy diskette
2. 1.2 Mb (megabyte) 5.25 floppy diskette capable of being processed by an IBM PC/AT compatible personal computer using the MS-DOS Version 3.3

ATTACHMENT #1

~~ATTACHMENT C~~

SECTION 14

LAND SURVEYING, AERIAL PHOTOGRAPHY, AND MAPPING

14.1 SCOPE AND PURPOSE

This section provides information for use in the planning and implementation of land surveying, aerial photography, and mapping for hazardous waste sites.

14.2 DEFINITIONS

Azimuth
A horizontal direction expressed as an angular distance between the direction of a fixed point and the direction of the depth.

Bearing
The direction of one point with respect to another on the compass.

Bench Mark
A mark on a permanent object indicating elevation and serving as a reference in topographic surveys.

Second (")
The 60th part of a minute of angular measurement.

Site Manager (SM)
The individual responsible for the successful completion of a work assignment within budget and schedule. This person is also referred to as the Site Project Manager or the Project Manager and is typically a contractor's employee (see Subsection 1.1).

Third-Order Plane Survey
The lowest level of accuracy used in topographic mapping, usually limited to small-scale projects.

Transit
A theodolite with the telescope mounted so that it can be transited; a surveyor's instrument.

Traverse
A series of connected lines of known length related to one another by known angles.

14.3 APPLICABILITY

This section focuses on the methods of obtaining maps through field surveys, property surveys, surveys of monitoring wells, aerial photography, and photogrammetric mapping. In performing these methods, other survey requirements may need to be fulfilled (e.g., monument construction, boundary surveys, and time / method / accuracy / cost considerations of using an electronic distance meter instrument). Other surveying and mapping methods include plane table and alidade mapping, transit-stadia mapping, three-wire leveling, and trigonometric leveling. While these methods may have applications on a specific site, the methods discussed below apply to all mapping activities conducted for the U.S. EPA at hazardous waste sites.

14.4 RESPONSIBILITIES

It is the responsibility of the survey and mapping task leader to ensure that the proper techniques are followed throughout the project.

14.5 RECORDS

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed / wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Graphite pencils or water proof ballpoint pens should be used. Erasing is not acceptable; use a single strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Palford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work.

Aerial photography film annotation should include, at a minimum, the date of exposure, flight number, and exposure number. Additional information would include radar and barometric altitude, time, latitude, longitude, heading, pitch, roll, and drift angles.

Photogrammetric mapping should be in ink on mylar or scribed; maps should be 22 inches by 34 inches or as directed by the survey and mapping task leader.

14.6 PROCEDURES

14.6.1 Surveying—General

Survey requirements may necessitate survey accuracies of the third order; however, the second order may be required on some occasions and lower accuracies on other occasions. For the majority of sites, all surveys shall be third-order plane surveys as defined in the standards and specifications in Exhibit 14-1.

Third-order plane surveys and horizontal angular measurements should be made with a 20-second or better transit. Angles should be doubled, with the mean of the doubled angle within 10 seconds of the first angle. Distance measurements should be made with a calibrated tape corrected for temperature and tension or with a calibrated electronic distance meter instrument (EDMI). When using EDMI, the manufacturer's parts per million (ppm) error continues to be applied, as well as corrections for curvature and refraction.

14.6.1.1 Third-Order Vertical Survey

Land surveys are to be completed by a surveyor who is licensed and registered in the state where the survey is conducted. When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent bench mark. If possible, level circuits should close on a bench mark whose elevation is known (other than the starting bench mark). If the circuit closes on the original bench mark, the last point in the circuit must be used as a turning point. The following criteria should be met in conducting the survey:

Exhibit 14-1
STANDARDS FOR THIRD-ORDER PLANE SURVEYS

Principal Use:
Small engineering projects and small-scale topographics mapping.

Traverse	
Number of bearing courses between azimuth checks	30 to 30 [30]*
Astronomical bearings: standard error of results	8".0 [6".0]*
Azimuth closure at azimuth checkpoint not to exceed (use the smaller value)	30" $\sqrt{N}$ or 8".0 per [20" $\sqrt{N}$]* station
Standard error of the mean for length measurements	1 in 30,000 [1 in 20,000]*
Position closure per loop in feet after azimuth adjustment	1:5,000 checkpoint or 3.34 $\sqrt{M}$, whichever is smaller
Leveling	
Levels of error of closure per loop in feet	0.05 $\sqrt{M}$

*Figures in brackets are commonly used in preparing specifications for bid.

N = then number of stations for carrying bearing
M = the distance in miles

- Instruments should be pegged regularly.
- Rod levels should be used.
- Foresight and backsight distances should be reasonably balanced.
- No side shot should be used as a turning point in any level loop.
- Elevation readings should be recorded to 0.01 foot and estimated to 0.005 foot using a calibrated rod.

Temporary monuments should be set and referenced for future recovery. All monuments should be described in the field notes and should consist of a permanent mark scribed on facilities such as sidewalks, paved roads, or curbs. Sufficient description should be provided to facilitate their recovery. .

14.6.1.2 Property Surveys

All property surveys should be performed in accordance with good land surveying practices and should conform to all pertinent federal and state laws and regulations governing land surveying in the area where the work is being accomplished. The surveyor shall be licensed and registered in the state where the survey is conducted.

Upon completion of the project, all original field note books, computations, and pertinent reference materials should be delivered to the SM for retention in the site file. The surveyor may keep photostatic copies of the material.

All field note reductions should be checked and marked in such a way that a visual inspection of the field notes will confirm that checks have been made. All office entries in field notebooks should be made in colored pencil.

The office worker who reduces or checks field notes should initial each page worked on in the color used on that page.

14.6.1.3 Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step one—Bearing closures will be computed and adjusted if within limits.
- Step two—Coordinate closures will be computed using adjusted bearings and unadjusted field distances.
- Step three—Coordinate positions will be adjusted if the traverse closes within the specified limits. The method of adjusting shall be determined by the surveyor.
- Step four—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.

- Step five—The direction and length of the unadjusted error of closure, the ratio of error over traverse length, and the method of adjustment should be printed with the final adjusted coordinates.

14.6.1.4 Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for that circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustment.

14.6.1.5 Monitoring Well Surveys

Monitoring well locations are surveyed only after the installation of the tamperproof locking cap well casing cover, which is set in concrete. The horizontal plane survey accuracy is ±1 foot (unless greater accuracy is desired) and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. Three elevations are measured, including the following:

- Top of the inner well casing (on the lip)
- Top of the outer protective casing (on the lip, not the cap)
- Finished concrete pad adjacent to the outer well casing

The point at which the elevation was measured should be scribed so that water level measurements may be taken at the same location. Note: The SM should ensure that the surveying party is given the keys to the locking cap before starting the survey.

14.6.2 Aerial Photography

Aerial photography for nonphotogrammetic use can be obtained from the following agencies:

- Environmental Monitoring System Laboratory (EMSL), Las Vegas, Nevada
- Environmental Photographic Interpretation Center (EPIC), Warrenton, Virginia
- National Cartographic Information Center, Reston, Virginia
- Soil Conservation Service, U.S. Department of Agriculture: Eastern or Western Laboratory, Asheville, North Carolina, or Salt Lake City, Utah, respectively

- Forest Service, U.S. Department of Agriculture, Washington, D.C. (for the eastern United States and Alaska), or the appropriate regional forester in Forest Service Regions 1-6 (Montana, Colorado, New Mexico, Utah, San Francisco, and Portland)

State and local transportation departments, zoning commissions, and planning divisions or local universities may also have useful aerial photographs. The EPA Enviropod, which consists of two 70-mm cameras mounted in a pod that can be attached to a light plane, is available through EPA regional offices. Aerial photographs may be obtained rapidly using the Enviropod and EPA photographic laboratories for developing the film. The photographs are not suitable for photogrammetric use. Photogrammetric aerial photography is usually contracted.

14.6.2.1 Contracting Aerial Photography

The following provisions should be included in the contract:

- **Business Arrangements**—These include such items as the cost of the aerial survey, posting of a performance bond, assumption of risks and damages, provision for periodic inspection of work, reflights, cancellation privileges, schedule for delivery and payments, and ownership and storage of negatives.

- **Area to be Photographed**—This includes location, size, and boundaries. These are ordinarily indicated on flight maps (1:24,000 scale) supplied by the purchaser.

- **Type of Photographic Film and Filter**—This includes such items as ASA exposure rating (ASA 100 is usually specified). The dimensional stability of the film base may also be specified.

- **Negative Scale**—The maximum scale deviation normally allowed is ±5 percent.

- **The Aerial Camera**—A National Bureau of Standards calibration report meeting U.S. Geological Survey standards for photogrammetric mapping is required. Other camera specifications include size of negative format, method of flattening film during exposure, type of shutter, focal length (usually 6 inches), distortion characteristics of the lens, and resolving power.

- **Position of Flight Lines**—Lines are to be parallel, oriented in the correct compass direction, and within a stated distance from positions drawn on flight maps.

- **Overlap**—This is usually set at 55 to 65 percent (the average is 60 percent) along the line of flight and 15 to 45 percent (the average is 30 percent) between adjacent lines. At the ends of each flight line, two photo centers should fall outside the boundary of the tract.

- **Print Alignment**—Crab or drift is not to affect more than 10 percent of the print width for any three consecutive photographs.

- **Tilt**—This should not exceed 2 or 3 degrees for a single exposure, or average more than 1 degree for the entire project.

- **Time of Photography**—The season of the year and the time of day (or minimum sun angle) are usually specified. The aerial photography should be conducted in the spring or fall when deciduous vegetation is bare and the ground is essentially free of snow cover. Ideal flight times are between 10:00 a.m. and 2:00 p.m. local standard time, or when the sun is at a minimum of 30 degrees above the horizon. Cloud or fog cover should not exceed 10 percent.

- **Base Maps**—If base maps or radial line plots are required, responsibility for ground control (field surveying) should be established.

- **Film Processing**—Included here are procedures for developing and drying negatives and for indexing and editing film rolls, plus a description of the type of photographic paper (weight, finish, and contrast) to be used.

- **Quality of Negatives and Prints**—Negatives and prints should be free from stains, scratches, and blemishes that detract from the intended use.

- **Materials to be Delivered**—Two sets of contact prints and one set of index sheets are usually supplied. A copy of the original flight log may also be specified. Additional items such as enlargements, mosaics, maps, or plan -and profile sheets should be listed in detail. One set of contact prints should be delivered to the project manager within 5 days of the date of the photography, unless otherwise spc . ied. The SM should arrange for additional sets of prints to be delivered at the same time if needed.

14.6.2.2 Photogrammetric Mapping

The scale of the mapping photography should be suitable for the preparation of a topographic map by photogrammetric methods at a scale and contour interval requested by the project, usually a 1" = 50' scale and 2-foot contour intervals. Larger a: · or areas with great differences in elevation may require a different scale.

Map accuracy shall meet or exceed the following minimum standards:

- For horizontal accuracy, 90 percent of all defined points should be within 1/ 40 inch of their true position, and 100 percent of all defined points should be within 1/ 20 inch of their true position.

- For vertical accuracy, 90 percent of all contours shall be within one-half of a contour interval, and 100 percent of all contours shall be within one contour interval. Ninety percent of all spot elevations should be accurate to within one-fourth of the contour interval, and all spot elevations should be within one-half of the contour interval.

- Mapping should show all planimetric features including, but not limited to, buildings, walks, roads, fences, ditches, trees, utility poles, tanks, drums, lagoons, pits, ponds, and other such features visible on the photograph, as well as contours and spot elevations on roads, dikes, and ditch inverts. Assemblages of containers (e.g., drums, laboratory bottles) may be indicated by a symbol rather than by depicting individual containers. The height and estimated number of such containers should be depicted within the symbol.

- All horizontal and vertical control points should be shown on the final map along with a tabulation of coordinates and elevations. The description, origin, and elevations of the bench marks used for the mapping control should be shown on the map.

- The horizontal coordinate system should be referenced to a local recoverable baseline at the site. The state plane coordinate system should be used when it is readily available near the site.

- Photographic control points must be kept outside the hazardous areas where possible.

- The map should show the basis of bearing, north arrow, date of photography, names of streets and highways, project number, project name, and a bar scale.

14.6.3 Remote Sensing

The standards for remote sensing imagery will be determined on a project specific and instrument-specific basis. Remote sensing data are used in environmental surveys and risk assessments. Methods include, but are not limited to, the following:

- Satellite photography (LANDSAT, Skylab)
- Radar (side-looking airborne radar, plan positive indicator)
- Thermal imagery (infrared detectors, line scanning, infrared photography)
- Multiband spectral imagery
- Low-altitude helicopter photography (stereograms)
- Continuous strip photography

The National Cartographic Information Center (NCIC) provides information about and access to cartographic data generated by federal, state, and local governmental bodies and by private sources. NCIC does not hold these data; it functions as a link between the user and the desired material. Requests for information may be submitted to the following agency:

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092

Records of aerial photographic coverage of the United States and outlying areas and of space imagery are maintained at the EROS Data Center in Sioux Falls, South Dakota. The Earth Resources Observation Systems (EROS) program gathers and uses remotely sensed data, collected by satellite and aircraft, of natural features and those made by humans on the earth's surface. Reference files, consisting of microfilms of available data primarily from LANDSAT I and II, formerly known as Earth Resources Technology Satellite (ERTS), may be viewed at 20 locations across the United States. Purchases of such data may be made from the following:

EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198

14.6.4 Hydrographic Surveys

Hydrographic surveys deal with the measurement and definition of the configuration of the bottom and adjacent land areas of oceans, lakes, rivers, harbors, and other bodies of water.

The size of the body of water will dictate the type of survey required to perform the necessary mapping. Surveys should conform to the requirements set forth in the *Hydrographic Survey Manual* by the U.S. Department of Commerce.

14.7 REGION-SPECIFIC VARIANCES

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

14.8 INFORMATION SOURCES

American Society of Photogrammetry. *Manual of Photogrammetry*. 4th ed.

Averes, T. Eugene. *Interpretation of Aerial Photographs*. 2nd ed. Minneapolis, Minnesota: Burgens Publishing Company.

Federal Geodetic Control Committee. *Specification to Support Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys*. July 1975. (Revised June 1980.)

Manual of Photographic Interpretation. Menasha, Wisconsin: Banta Publishing Company.

Moffitt, Francis H., and Harry Bouchard. *Surveying*. New York: Mtext Educational Publishers.

Pafford, William F. *Handbook of Survey Notekeeping*.

Umbach, Melvin J. *Hydrographic Survey Manual*. 4th ed. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration.

ESTABLISHMENT OF HORIZONTAL DATA ON 1100 AND 3000 AREAS AERIAL PHOTO CONTROL POINTS

A horizontal control network was established by setting permanent control survey monuments in the vicinity of the 1100 and 3000 areas. A single primary conventional horizontal traverse of 21,279m in length was performed beginning at National Geodetic Survey (NGS) control station GROSSCUP, traversing through the network ending at NGS control station BAXTER. A traverse adjustment was performed by applying the compass rule adjustment method and the Washington State Coordinate System of 1983, South Zone (WCS83S) was assigned. NGS control stations GROSSCUP and BAXTER held as fixed for the traverse adjustment on WCS83S and HORN and RINGOLD were utilized as azimuth marks.

WCS83S closure: dN= -0.128m dE= -0.160 ΣD= 21,279m 1:103,939

A secondary conventional horizontal traverse of 7,853m in length was performed from BM-324, a survey monument of the primary traverse, through some of the aerial photo control points to BUS, a survey monument of the primary traverse.

WCS83S closure: dN= -0.073m dE= 0.183 ΣD= 7,853m

The remainder of the photo control points were surveyed from this traverse and the control network traverse by single sideshot (angle and distance) with WCS83S assigned.

The maps were compiled from WCS83S information then converted to U.S. Survey feet.

ATTACHMENT #3 3/5

KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. — 8 8 4 — 3 8 2
Project/W.O. No. ER8060	Title 1100-EM-1 OPERABLE UNIT	File No. 1 0 2 8 — 0 4 7
KEH Job No. ER8060	Prepared By Grant Brazil / Date 6/5/89	Reviewer [signature] 1 3

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
Pre-Mark control for Aerial Mapping	Yes ☐	Survey File	or
	No ☐	Field Project File	---
	NA ☒	R. McCain	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

PRE-MARK No.	LAMBERT NAD 83 IN U.S. FEET NORTH	EAST	NGS ELEV
1	376,035.10	1,942,509.74	384.71
2	376,044.81	1,944,409.56	386.58
3	376,054.53	1,946,309.39	382.47
4	374,735.21	1,942,516.38	378.59
5	374,744.93	1,944,416.21	376.03
6	374,754.64	1,946,316.04	385.16
7	373,435.63	1,942,522.53	370.56
8	373,445.04	1,944,422.86	388.40
9	373,454.76	1,946,322.69	388.44
10	373,488.02	1,950,300.28	402.16
11	370,807.58	1,945,046.56	376.08
12	368,583.48	1,945,884.13	390.80
13	368,583.46	1,946,834.05	396.18
14	368,583.44	1,947,783.98	398.95
15	367,283.58	1,945,884.10	391.33
16	367,283.56	1,946,834.03	397.35
17	367,283.54	1,947,783.96	402.01
18	366,483.64	1,945,884.09	395.06
19	366,483.62	1,946,824.02	399.27
20	366,483.60	1,947,783.94	402.88
21	366,330.82	1,950,453.39	391.76
22	365,163.82	1,945,884.06	402.08

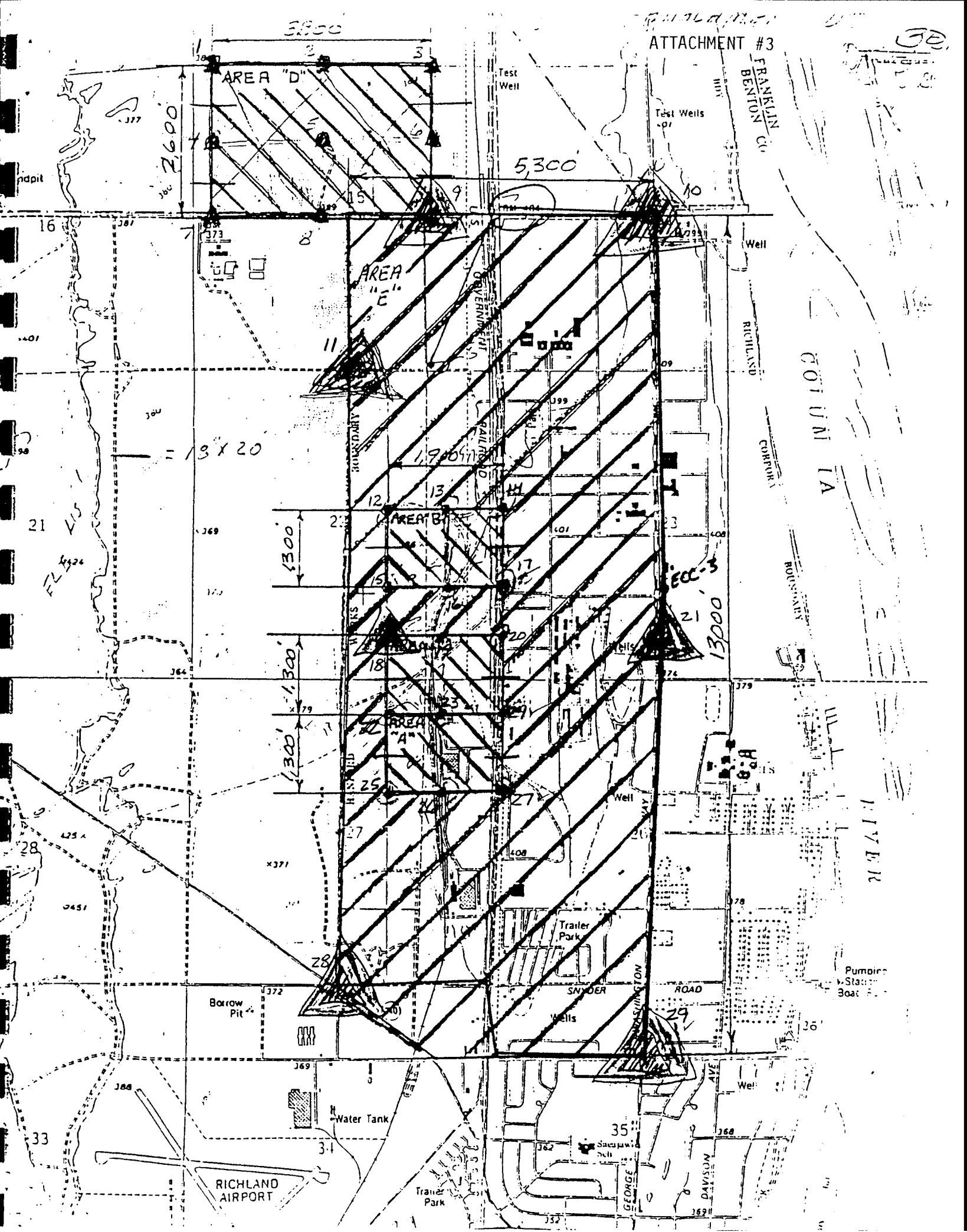
KAISER ENGINEERS
HANFORD

FIELD SKETCH

Attachment To Or Description:
1100-EM-1 OPERABLE UNIT (pre-mark control)

No.	NORTH	EAST	ELEV
23	365,183.72	1,946,833.99	414.29
24	365,183.70	1,947,783.92	403.23
25	363,883.84	1,945,884.04	391.00
26	363,857.65	1,946,900.90	402.48
27	363,883.80	1,947,783.89	405.79
28	360,251.47	1,944,983.59	362.7
29	358,996.80	1,950,334.00	374.61
6/09/89	Additional pt's needed by the Photogrammetrist		
19A	366,483.6	1,946,626.7	404.04
23A	365,179.0	1,946,606.6	404.22
26A	363,883.8	1,946,687.2	401.35

ATTACHMENT #3



Attachment D: 200 East - 200 West Areas Fly-over Specifications Package

KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. — —
Project/W.O. No.	Title: 200 EAST - WEST AERIAL MAPPING	File No. 2 E W A — 0 4 4
KEH Job No. ER 2704	Prepared By: Kline R. Welsch	Date: 3-26-92
		Reviewer: V. Coyne

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
200 East - West fly-over specifications.	Yes ☐	Survey File	OR
	No ☐	Field Project File	
	NA ☐	R. Fox	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

ATTACHMENT #1: Mapping specifications for the 200 East - West aerial mapping projects.

ATTACHMENT #2: Method of establishing horizontal data on aerial photo control points.

ATTACHMENT #3: Listing of aerial photo control points for 200 East - West mapping. Sketch showing target configeration.

ATTACHMENT #4: Maps indicating verification by random sampling. Check profiles were done on several sheets throughout project.

AERIAL MAPPING ESTIMATE

1. Scale: Maps will be at a scale of 1:2000 with a contour interval of .5 meters. Horizontal and vertical will be in meters.

2. Area to be Mapped: 200 East and 200 West areas, see Attachment D.

3. Map Format:

   a. Printed on Hanford standard-sized sheets (28" x 40").

   b. Minimum margin of 1-inch around the borders.

   c. Space allowed across the bottom right-hand corner (above border) of the map for a WHC standard legend. (Attachment A)

   d. North shall be oriented up on the maps (parallel to the short dimension on the map sheets).

   e. Washington State Coordinate Grid Lines (NAD 83) with Hanford Grid Ticks shall be shown on the maps.

   f. One set of maps will be provided on double Matte mylar with one set of sepias.

   g. Maps will be signed and stamped by a licensed Land Surveyor or Engineer as to the accuracy of the maps.

   h. Data will be supplied to KEH in Autocad or compatible format such that maps can be generated or modified by KEH and WHC using Autocad software. (Attachment B)

   i. Three sets of contact photographs.

   j. All negatives.

4. Premark requirements must be submitted for the following:

   1. Size of targets.
   2. Spacing for horizontal and vertical.
   3. Configuration of targets.

5. Field Work: KEH Survey will provide survey work needed for mapping. We would like to keep ground control to a minimum, please use triangulation method as much as possible.

6. Accuracy: Maps will meet minimum standards set for aerial photographic mapping described in Section 14, Compendium of Superfund Field Operations MEthods, U.S. EPA, 12/87. (Attachment C)

7. Schedule: Maps are needed by August 31, 1989.

ATTACHMENT "B"

SUBJECT: DATA FILES

In order to process data produced by mapping contractors, Kaiser Engineers Hanford Company (KEH) must receive the data in one of the two following formats:

1. "Autocad" Release 9.0 drawing files.
2. Drawing interchange files (DXF).

The data files shall be delivered on 20 Mb Bernoulli removable cartridges.

The data files shall be able to be processed by an IBM-AT compatible personal computer using the MS-DOS Version 3.2.

AERIAL MAPPING ESTIMATE

1. SCALE: Maps shall be drawn to a scale of 1:2000 with a contour interval of .5 meters. Horizontal and vertical will be in meters.

2. AREA TO BE MAPPED: 200W. See attachment A1 thru A7.

3. MAP FORMAT:

   a. Printed on Hanford standard-sized sheets (28"x40").

   b. Minimum margin of 1 inch around the borders.

   c. Provide Kaiser Engineers Hanford (KEH) title block across the bottom right hand corner (within border) of the map.

   d. North shall be oriented up on the maps (parallel with the short dimension on the map sheets).

   e. Where necessary, map sheets shall be produced as a series with match lines to adjacent sheets. For map series, an index sheet will be provided to show the relative location of each map sheet. Graphic scale, contour interval, vertical and horizontal datum shall be included.

   f. Washington State Coordinate Grid Lines (NAD 83) with Plant Grid Ticks shall be shown on all maps.

   g. Two sets of maps will be provided on double matte mylar.

   h. Maps will be signed and stamped by a licensed Land Surveyor or Engineer as to the accuracy of the maps.

   i. Data will be supplied to KEH in AutoCAD format such that maps can be modified using AutoCAD software. See Attachment B.

4. PHOTOGRAPHY: Three sets of contact photographs and all negatives shall be delivered to KEH.

5. PREMARK REQUIREMENTS MUST BE SUBMITTED FOR THE FOLLOWING:

   a. Size of targets.
   b. Spacing for horizontal and vertical targets.
   c. Configuration of targets.

   KEH Survey will provide ground control needed, and would like to minimize the number of targets required to do the job. This should be kept in mind when planning the overall job.

6. ACCURACY: Maps shall meet minimum standards as prescribed in the following two documents.

   a. Section 14, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87.
   b. The National Map Accuracy Standards.

   A statement shall placed on the map indicating compliance with these standards.

7. SCHEDULE: Maps are needed by August 31, 1990.

ATTACHMENT "B"

SUBJECT: DATA FILES

In order to process data produced by mapping contractors, Kaiser Engineers Hanford Company (KEH) must receive the data in the following format:

"Autocad" Release 10.0 drawing files.

The data files shall be delivered on 20 Mb Bernoulli removable cartridges or on 360 kb, 1.2 Mb, 5.2" floppy disks, depending on file size.

The data files shall be able to be processed by an IBM-AT compatible personal computer using the MS-DOS Version 3.2.

All coordinate data shall be referenced to the single origin of the coordinate system, not to a local origin for each map sheet or file. The object is to be able to "window" any given area within the entire drawing using "real world" coordinates. Any questions at all about this, please call Alan Lewis, (509) 373-2615.

AERIAL MAPPING ESTIMATE

1. SCALE: Maps shall be drawn to a scale of 1:2000 with a contour interval of .5 meters. Horizontal and vertical will be in meters.

2. AREA TO BE MAPPED: East side of 200E Area. See Attachment A1 through A3.

3. MAP FORMAT:

   a. Printed on Hanford standard-sized sheets (28"x40").

   b. Minimum margin of 1 inch around the borders.

   c. Provide Kaiser Kaiser Engineers Hanford (KEH) title block across the bottom right hand corner (within border) of the map.

   d. North shall be oriented up on the maps (parallel with the short dimension on the map sheets).

   e. Where necessary, map sheets shall be produced as a series with match lines to adjacent sheets. For map series, an index sheet will be provided to show the relative location of each map sheet. Graphic scale, contour interval, vertical and horizontal datum shall be included.

   f. Washington State Coordinate Grid Lines (NAD 83) with Plant Grid Ticks shall be shown on the maps.

   g. Two sets of maps will be provided on double matte mylar.

   h. Maps will be signed and stamped by a licensed Land Surveyor or Engineer as to the accuracy of the maps.

   i. Data will be supplied to KEH in AutoCAD or compatible format such that maps can be generated or modified using AutoCAD software. See Attachment B.

4. PHOTOGRAPHY: Three sets of contact photographs and all negatives shall be delivered to KEH.

5. PREMARK REQUIREMENTS MUST BE SUBMITTED FOR THE FOLLOWING:

   a. Size of targets.
   b. Spacing for horizontal and vertical targets.
   c. Configuration of targets.

   KEH Survey will provide ground control needed, and would like to minimize the number of targets required to do the job. This

should be kept in mind when planning the overall job.

6. ACCURACY: Maps shall meet minimum standards as prescribed in the following two documents.

   a. Section 14, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87.
   b. The National Map Accuracy Standards.

   A statement shall placed on the map indicating compliance with these standards.

7. SCHEDULE: Maps are needed by April 13, 1990.

ATTACHMENT "B"

SUBJECT: DATA FILES

In order to process data produced by mapping contractors, Kaiser Engineers Hanford Company (KEH) must receive the data in the following format:

"Autocad" Release 10.0 drawing files.

The data files shall be delivered on 20 Mb Bernoulli removable cartridges or on 360 kb, 1.2 Mb, 5.2" floppy disks, depending on file size.

The data files shall be able to be processed by an IBM-AT compatible personal computer using the MS-DOS Version 3.2.

All coordinate data shall be referenced to the single origin of the coordinate system, not to a local origin for each map sheet or file. The object is to be able to "window" any given area within the entire drawing using "real world" coordinates. Any questions at all about this, please call Alan Lewis, (509) 373-2615.

ATTACHMENT "C"

SECTION 14

LAND SURVEYING, AERIAL PHOTOGRAPHY, AND MAPPING

14.1 SCOPE AND PURPOSE

This section provides information for use in the planning and implementation of land surveying, aerial photography, and mapping for hazardous waste sites.

14.2 DEFINITIONS

Azimuth
A horizontal direction expressed as an angular distance between the direction of a fixed point and the direction of the depth.

Bearing
The direction of one point with respect to another on the compass.

Bench Mark
A mark on a permanent object indicating elevation and serving as a reference in topographic surveys.

Second (")
The 60th part of a minute of angular measurement.

Site Manager (SM)
The individual responsible for the successful completion of a work assignment within budget and schedule. This person is also referred to as the Site Project Manager or the Project Manager and is typically a contractor's employee (see Subsection 1.1).

Third-Order Plane Survey
The lowest level of accuracy used in topographic mapping, usually limited to small-scale projects.

Transit
A theodolite with the telescope mounted so that it can be transited; a surveyor's instrument.

Traverse
A series of connected lines of known length related to one another by known angles.

14.3 APPLICABILITY

This section focuses on the methods of obtaining maps through field surveys, property surveys, surveys of monitoring wells, aerial photography, and photogrammetric mapping. In performing these methods, other survey requirements may need to be fulfilled (e.g., monument construction, boundary surveys, and time / method / accuracy / cost considerations of using an electronic distance meter instrument). Other surveying and mapping methods include plane table and alidade mapping, transit-stadia mapping, three-wire leveling, and trigonometric leveling. While these methods may have applications on a specific site, the methods discussed below apply to all mapping activities conducted for the U.S. EPA at hazardous waste sites.

14.4 RESPONSIBILITIES

It is the responsibility of the survey and mapping task leader to ensure that the proper techniques are followed throughout the project.

14.5 RECORDS

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed / wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Graphite pencils or water proof ballpoint pens should be used. Erasing is not acceptable; use a single strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work.

Aerial photography film annotation should include, at a minimum, the date of exposure, flight number, and exposure number. Additional information would include radar and barometric altitude, time, latitude, longitude, heading, pitch, roll, and drift angles.

Photogrammetric mapping should be in ink on mylar or scribed; maps should be 22 inches by 34 inches or as directed by the survey and mapping task leader.

14.6 PROCEDURES

14.6.1 Surveying—General

Survey requirements may necessitate survey accuracies of the third order; however, the second order may be required on some occasions and lower accuracies on other occasions. For the majority of sites, all surveys shall be third-order plane surveys as defined in the standards and specifications in Exhibit 14-1.

Third-order plane surveys and horizontal angular measurements should be made with a 20-second or better transit. Angles should be doubled, with the mean of the doubled angle within 10 seconds of the first angle. Distance measurements should be made with a calibrated tape corrected for temperature and tension or with a calibrated electronic distance meter instrument (EDMI). When using EDMI, the manufacturer's parts per million (ppm) error continues to be applied, as well as corrections for curvature and refraction.

14.6.1.1 Third-Order Vertical Survey

Land surveys are to be completed by a surveyor who is licensed and registered in the state where the survey is conducted. When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent bench mark. If possible, level circuits should close on a bench mark whose elevation is known (other than the starting bench mark). If the circuit closes on the original bench mark, the last point in the circuit must be used as a turning point. The following criteria should be met in conducting the survey:

Exhibit 14-1
STANDARDS FOR THIRD-ORDER PLANE SURVEYS

Principal Use:

Small engineering projects and small-scale topographics mapping.

Traverse	
Number of bearing courses between azimuth checks	30 to 30 [30]*
Astronomical bearings: standard error of results	8".0 [6".0]*
Azimuth closure at azimuth checkpoint not to exceed (use the smaller value)	30" $\sqrt{N}$ or 8".0 per [20" $\sqrt{N}$]* station
Standard error of the mean for length measurements	1 in 30,000 [1 in 20,000]*
Position closure per loop in feet after azimuth adjustment	1:5,000 checkpoint or 3.34 $\sqrt{M}$, whichever is smaller
Leveling	
Levels of error of closure per loop in feet	0.05 $\sqrt{M}$

*Figures in brackets are commonly used in preparing specifications for bid.

N = then number of stations for carrying bearing
M = the distance in miles

- Instruments should be pegged regularly.
- Rod levels should be used.
- Foresight and backsight distances should be reasonably balanced.
- No side shot should be used as a turning point in any level loop.
- Elevation readings should be recorded to 0.01 foot and estimated to 0.005 foot using a calibrated rod.

Temporary monuments should be set and referenced for future recovery. All monuments should be described in the field notes and should consist of a permanent mark scribed on facilities such as sidewalks, paved roads, or curbs. Sufficient description should be provided to facilitate their recovery.

14.6.1.2 Property Surveys

All property surveys should be performed in accordance with good land surveying practices and should conform to all pertinent federal and state laws and regulations governing land surveying in the area where the work is being accomplished. The surveyor shall be licensed and registered in the state where the survey is conducted.

Upon completion of the project, all original field note books, computations, and pertinent reference materials should be delivered to the SM for retention in the site file. The surveyor may keep photostatic copies of the material.

All field note reductions should be checked and marked in such a way that a visual inspection of the field notes will confirm that checks have been made. All office entries in field notebooks should be made in colored pencil.

The office worker who reduces or checks field notes should initial each page worked on in the color used on that page.

14.6.1.3 Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step one—Bearing closures will be computed and adjusted if within limits.
- Step two—Coordinate closures will be computed using adjusted bearings and unadjusted field distances.
- Step three—Coordinate positions will be adjusted if the traverse closes within the specified limits. The method of adjusting shall be determined by the surveyor.
- Step four—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.

- Step five—The direction and length of the unadjusted error of closure, the ratio of error over traverse length, and the method of adjustment should be printed with the final adjusted coordinates.

14.6.1.4 Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for that circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustment.

14.6.1.5 Monitoring Well Surveys

Monitoring well locations are surveyed only after the installation of the tamperproof locking cap well casing cover, which is set in concrete. The horizontal plane survey accuracy is ±1 foot (unless greater accuracy is desired) and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. Three elevations are measured, including the following:

- Top of the inner well casing (on the lip)
- Top of the outer protective casing (on the lip, not the cap)
- Finished concrete pad adjacent to the outer well casing

The point at which the elevation was measured should be scribed so that water level measurements may be taken at the same location. **Note:** The SM should ensure that the surveying party is given the keys to the locking cap before starting the survey.

14.6.2 Aerial Photography

Aerial photography for nonphotogrammetic use can be obtained from the following agencies:

- Environmental Monitoring System Laboratory (EMSL), Las Vegas, Nevada
- Environmental Photographic Interpretation Center (EPIC), Warrenton, Virginia
- National Cartographic Information Center, Reston, Virginia
- Soil Conservation Service, U.S. Department of Agriculture; Eastern or Western Laboratory, Asheville, North Carolina, or Salt Lake City, Utah, respectively

- Forest Service, U.S. Department of Agriculture, Washington, D.C. (for the eastern United States and Alaska), or the appropriate regional forester in Forest Service Regions 1-6 (Montana, Colorado, New Mexico, Utah, San Francisco, and Portland)

State and local transportation departments, zoning commissions, and planning divisions or local universities may also have useful aerial photographs. The EPA Enviropod, which consists of two 70-mm cameras mounted in a pod that can be attached to a light plane, is available through EPA regional offices. Aerial photographs may be obtained rapidly using the Enviropod and EPA photographic laboratories for developing the film. The photographs are not suitable for photogrammetric use. Photogrammetric aerial photography is usually contracted.

14.6.2.1 Contracting Aerial Photography

The following provisions should be included in the contract:

- **Business Arrangements**—These include such items as the cost of the aerial survey, posting of a performance bond, assumption of risks and damages, provision for periodic inspection of work, reflights, cancellation privileges, schedule for delivery and payments, and ownership and storage of negatives.
- **Area to be Photographed**—This includes location, size, and boundaries. These are ordinarily indicated on flight maps (1:24,000 scale) supplied by the purchaser.
- **Type of Photographic Film and Filter**—This includes such items as ASA exposure rating (ASA 100 is usually specified). The dimensional stability of the film base may also be specified.
- **Negative Scale**—The maximum scale deviation normally allowed is ±5 percent.
- **The Aerial Camera**—A National Bureau of Standards calibration report meeting U.S. Geological Survey standards for photogrammetric mapping is required. Other camera specifications include size of negative format, method of flattening film during exposure, type of shutter, focal length (usually 6 inches), distortion characteristics of the lens, and resolving power.
- **Position of Flight Lines**—Lines are to be parallel, oriented in the correct compass direction, and within a stated distance from positions drawn on flight maps.
- **Overlap**—This is usually set at 55 to 65 percent (the average is 60 percent) along the line of flight and 15 to 45 percent (the average is 30 percent) between adjacent lines. At the ends of each flight line, two photo centers should fall outside the boundary of the tract.
- **Print Alignment**—Crab or drift is not to affect more than 10 percent of the print width for any three consecutive photographs.
- **Tilt**—This should not exceed 2 or 3 degrees for a single exposure, or average more than 1 degree for the entire project.
- **Time of Photography**—The season of the year and the time of day (or minimum sun angle) are usually specified. The aerial photography should be conducted in the spring or fall when deciduous vegetation is bare and the ground is essentially free of snow cover. Ideal flight times are between 10:00 a.m. and 2:00 p.m. local standard time, or when the sun is at a minimum of 30 degrees above the horizon. Cloud or fog cover should not exceed 10 percent.

- **Base Maps**—If base maps or radial line plots are required, responsibility for ground control (field surveying) should be established.

- **Film Processing**—Included here are procedures for developing and drying negatives and for indexing and editing film rolls, plus a description of the type of photographic paper (weight, finish, and contrast) to be used.

- **Quality of Negatives and Prints**—Negatives and prints should be free from stains, scratches, and blemishes that detract from the intended use.

- **Materials to be Delivered**—Two sets of contact prints and one set of index sheets are usually supplied. A copy of the original flight log may also be specified. Additional items such as enlargements, mosaics, maps, or plan -and profile sheets should be listed in detail. One set of contact prints should be delivered to the project manager within 5 days of the date of the photography, unless otherwise spe ed. The SM should arrange for additional sets of prints to be delivered at the same time if needed.

14.6.2.2 Photogrammetric Mapping

The scale of the mapping photography should be suitable for the preparation of a topographic map by photogrammetric methods at a scale and contour interval requested by the project, usually a 1" = 50' scale and 2-foot contour intervals. Larger a or areas with great differences in elevation may require a different scale.

Map accuracy shall meet or exceed the following minimum standards:

- For horizontal accuracy, 90 percent of all defined points should be within 1/ 40 inch of their true position, and 100 percent of all defined points should be within 1/ 20 inch of their true position.

- For vertical accuracy, 90 percent of all contours shall be within one-half of a contour interval, and 100 percent of all contours shall be within one contour interval. Ninety percent of all spot elevations should be accurate to within one-fourth of the contour interval, and all spot elevations should be within one-half of the contour interval.

- Mapping should show all planimetric features including, but not limited to, buildings, walks, roads, fences, ditches, trees, utility poles, tanks, drums, lagoons, pits, ponds, and other such features visible on the photograph, as well as contours and spot elevations on roads, dikes, and ditch inverts. Assemblages of containers (e.g., drums, laboratory bottles) may be indicated by a symbol rather than by depicting individual containers. The height and estimated number of such containers should be depicted within the symbol.

- All horizontal and vertical control points should be shown on the final map along with a tabulation of coordinates and elevations. The description, origin, and elevations of the bench marks used for the mapping control should be shown on the map.

- The horizontal coordinate system should be referenced to a local recoverable baseline at the site. The state plane coordinate system should be used when it is readily available near the site.

- Photographic control points must be kept outside the hazardous areas where possible.

- The map should show the basis of bearing, north arrow, date of photography, names of streets and highways, project number, project name, and a bar scale.

14.6.3 Remote Sensing

The standards for remote sensing imagery will be determined on a project specific and instrument-specific basis. Remote sensing data are used in environmental surveys and risk assessments. Methods include, but are not limited to, the following:

- Satellite photography (LANDSAT, Skylab)
- Radar (side-looking airborne radar, plan positive indicator)
- Thermal imagery (infrared detectors, line scanning, infrared photography)
- Multiband spectral imagery
- Low-altitude helicopter photography (stereograms)
- Continuous strip photography

The National Cartographic Information Center (NCIC) provides information about and access to cartographic data generated by federal, state, and local governmental bodies and by private sources. NCIC does not hold these data; it functions as a link between the user and the desired material. Requests for information may be submitted to the following agency:

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092

Records of aerial photographic coverage of the United States and outlying areas and of space imagery are maintained at the EROS Data Center in Sioux Falls, South Dakota. The Earth Resources Observation Systems (EROS) program gathers and uses remotely sensed data, collected by satellite and aircraft, of natural features and those made by humans on the earth's surface. Reference files, consisting of microfilms of available data primarily from LANDSAT I and II, formerly known as Earth Resources Technology Satellite (ERTS), may be viewed at 20 locations across the United States. Purchases of such data may be made from the following:

EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198

14.6.4 Hydrographic Surveys

Hydrographic surveys deal with the measurement and definition of the configuration of the bottom and adjacent land areas of oceans, lakes, rivers, harbors, and other bodies of water.

The size of the body of water will dictate the type of survey required to perform the necessary mapping. Surveys should conform to the requirements set forth in the *Hydrographic Survey Manual* by the U.S. Department of Commerce.

14.7 REGION-SPECIFIC VARIANCES

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

14.8 INFORMATION SOURCES

American Society of Photogrammetry. *Manual of Photogrammetryy*. 4th ed.

Averes, T. Eugene. *Interpretation of Aerial Photographs*. 2nd ed. Minneapolis, Minnesota: Burgens Publishing Company.

Federal Geodetic Control Committee. *Specification to Support Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys*. July 1975. (Revised June 1980.)

Manual of Photographic Interpretation. Menasha, Wisconsin: Banta Publishing Company.

Moffitt, Francis H., and Harry Bouchard. *Surveying*. New York: Mtext Educational Publishers.

Pafford, William F. *Handbook of Survey Notekeeping*.

Umbach, Melvin J. *Hydrographic Survey Manual*. 4th ed. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration.

ESTABLISHMENT OF HORIZONTAL DATA ON 200 EAST AND WEST AERIAL PHOTO CONTROL POINTS

200E Area permanent monuments 2E-1 and 2E-2 were used with 200E area ground level coordinate values established by conventional survey methods. A network adjustment was performed applying the Least Squares Adjustment method and the Washington State Coordinate System of 1983, South Zone, (WCS83S) was assigned. National Geodetic Survey (NGS) control stations PUG, McKINLEY, LYNE, HANFORD and GABLE were held as fixed for the network adjustment on WSC83S.

A conventional horizontal traverse of 10,745m in length was performed from monuments 2E-1 and 2E-2, located in the N.W. quadrant of 200E Area, through many of the aerial photo control points to F-322, NGS control station. F-322 is located west of 200W Area near Army Loop road and is in the same WSC83S network as the NGS control stations. The remainder of the photo control points were surveyed from this traverse by single sideshot (angle and distance).

Closure into station F-322 was based on a two point coordinate transformation. 200E Area ground level coordinates and WSC83S values were used for 2E-1 and 2E-2 permanent monuments to transform the traversed 200E Area ground level coordinates of station F-322 to WSC83S values. A comparison was made between coordinates computed for F-322 using the above transformation and published NGS coordinates for F-322.

The following table shows these coordinates and their differences (misclosures). WSC83S closure: dN= +0.423m dE= -0.569m Σd= 10745m.

IN METERS	PUBLISHED	COMPUTED	MISCLOSURE
F-322	N 137,273.568	N 137,273.991	+0.423
-	E 564082.907	E 564,082.338	-0.569

Attachment #3:

Attachment #3 105

KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. —892—104
Project/W.O. No. ER8347	Title 200E & 200W AREA AERIAL MAPPING	File No. 2EWA—044
KEH Job No. ER8347	Prepared By Vern Coyne / Date 7/6/89	Reviewer G F Bryant / 1 5

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
Horizontal & vertical data of aerial photo control points	Yes ☐	Survey File	OR
	No ☐	Field Project File	Ø
	NA ☒	George Evans	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

AERIAL PHOTO CONTROL POINT NO.	COORDINATES		ELEVATION
	HANFORD PLANT 200E AREA DATA US SURVEY FEET	WCS83S	NGVD'29. METERS
1	N:47,600 W:85,400	N:137,959.752 E:563,858.807	238.16
4	N:47,600 W:77,175	N:137,966.846 E:566,365.520	204.88
5	N:47,600 W:73,357.5	N:137,970.136 E:567,528.969	215.08
6	N:47,600 W:69,540	N:137,973.427 E:568,692.418	210.07
7	N:48,000 W:65,722.5	N:138,098.626 E:569,855.523	204.18
8	N:48,000 W:61,905	N:138,101.918 E:571,018.972	197.94
9	N:48,000 W:58,087.5	N:138,105.210 E:572,182.421	189.84
10	N:48,000 W:54,270	N:138,108.502 E:573,345.870	183.31
11	N:48,000 W:50,452.5	N:138,111.794 E:574,509.319	175.58
12	N:48,000 W:46,635	N:138,115.089 E:575,672.770	174.03
13	N:48,000 W:42,833.3	N:138,118.365 E:576,831.410	141.50
14	N:47,987.2 W:39,000	N:138,117.772 E:577,999.679	143.17

KAISER ENGINEERS
HANFORD

FIELD SKETCH

Attachment To Or Description:
VERTICAL DATUM CONTROL POINTS

PM No.	NGVD'29 METERS	PM No.	NGVD'29 METERS	PM No.	NGVD'29 METERS
1	238.16M	29	194.54M	57-A	192.93M
2	233.24M	30	200.03M	57-B	192.83M
3	215.72M	31	218.53M	58	194.10M
4	204.88M	32	207.18M	59	196.97M
5	215.08M	33	218.37M	60	207.43M
6	210.07M	34	223.91M	61	214.60M
7	204.18M	35	225.78M	62	220.81M
8	197.94M	36	220.57M	63	228.55M
9	189.84M	37	218.02M	64	230.62M
10	183.31M	38	212.78M	65	225.49M
11	175.58M	39	204.92M	66	223.05M
12	174.03M	40	182.82M	67	220.65M
13	141.50M	41	176.05M	68	213.01M
14	143.17M	42	155.80M	69	209.80M
15	241.99M	43	194.28M	70	164.37M
16	238.22M	44	195.21M	71	192.75M
17	222.89M	45	203.88M	72	196.39M
18	204.18M	46	206.12M	73	200.75M
19	217.33M	47	216.48M	74	209.62M
20	220.16M	48	223.58M	75	215.00M
21	216.93M	49	228.92M	76	222.07M
22	213.81M	50	228.95M	77	226.87M
23	211.52M	51	218.26M	78-A	226.24M
24	204.12M	52	218.41M	78-B	222.02M
25	188.45M	53	215.49M	79	225.81M
26	181.29M	54	206.95M	80	225.23M
27	176.13M	55	201.19M	81	222.75M
28	145.86M	56	162.94M	82	213.99M

Attachment #3

KAISER ENGINEERS HANFORD	FIELD SKETCH	7/6/89

Attachment To Or Description: 200E & 200W AREA AERIAL MAPPING

Sheet 3 of 5

64	N:38,400 W:61,905	N:135,176.153 E:571,027.252	230.62
66	N:37,998.8 W:54,399.5	N:135,060.352 E:573,315.014	223.05
68	N:38,400 W:46,635	N:135,189.322 E:575,681.047	213.01
70	N:38,400 W:39,000	N:135,195.904 E:578,007.941	164.37
72	N:34,660 W:80,850	N:134,019.988 E:565,256.661	196.39
75	N:35,686.2 W:69,542.8	N:134,342.499 E:568,701.852	215.00
78-A	N:36,300 W:58,000	N:134,539.510 E:572,219.179	226.24
78-B	N:36,000.8 W:58,951.8	N:134,447.488 E:571,929.365	222.02
81	N:36,007.3 W:48,607.3	N:134,458.408 E:575,082.013	222.75
84	N:36,008 W:39,000	N:134,466.901 E:578,010.003	166.89
86	N:32,850 W:77,200	N:133,471.505 E:566,370.621	198.17
89	N:32,841 W:69,540.5	N:133,475.362 E:568,705.004	205.83
90	N:33,600 W:58,000	N:133,716.638 E:572,221.507	219.90
93	N:33,596.1 W:48,610.8	N:133,723.558 E:575,083.021	222.23

KAISER ENGINEERS HANFORD	FIELD SKETCH	7/6/89

Attachment To Or Description: 200E & 200W AREA AERIAL MAPPING

Sheet 2 of 5

15	N:45,600 W:85,400	N:137,350.217 E:563,860.530	241.99
21	N:45,600 W:65,722.5	N:137,367.185 E:569,857.592	216.93
22	N:45,600 W:61,905	N:137,370.477 E:571,021.041	213.81
26	N:45,600 W:46,635	N:137,383.647 E:575,674.838	181.29
28	N:45,600 W:39,000	N:137,390.229 E:578,001.736	145.86
29	N:43,200 W:85,400	N:136,618.775 E:563,862.599	194.54
32	N:43,205.9 W:77,182.5	N:136,627.675 E:566,367.016	207.18
34	N:43,200 W:69,540	N:136,632.452 E:568,696.216	223.91
36	N:43,200 W:61,905	N:136,639.035 E:571,023.111	220.57
38	N:43,200 W:54,270	N:136,645.620 E:573,350.009	212.78
40	N:43,200 W:46,635	N:136,652.203 E:575,676.909	182.82
42	N:43,200 W:39,000	N:136,658.787 E:578,003.804	155.80
43	N:40,800 W:85,400	N:135,887.335 E:563,864.669	194.28
56	N:40,800 W:39,000	N:135,927.345 E:578,005.873	162.94
57-A	N:38,400 W:85,400	N:135,155.893 E:563,866.740	192.93
57-B	N:36,900 W:84,700	N:134,699.345 E:564,081.368	192.83
60	N:38,400 W:77,175	N:135,162.985 E:566,373.455	207.43
62	N:38,391.5 W:69,540.1	N:135,166.988 E:568,700.334	220.81

Attachment #3

KAISER ENGINEERS HANFORD	FIELD SKETCH

Attachment To Or Description:
VERTICAL DATUM CONTROL POINTS

Sheet 5 of 5

PM No.	NGVD'29 METERS				
83	190.12M				
84	166.89M				
85	195.81M				
86	198.17M				
87	205.72M				
88	203.88M				
89	205.83M				
90	219.90M				
91	219.79M				
92	223.02M				
93	222.23M				

Attachment #3

KAISER ENGINEERS HANFORD	FIELD SKETCH

Attachment To Or Description:

Sheet 2 3

Attachment #3 | 4C

KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. -190 1-067

Project/W.O. No.	Title	File No.
ER0633	EAST OF 200E AERIAL MAPPING	2EWA-044

KEH Job No.	Prepared By	Date	Reviewer	
ER0633	Grant Brazil	5/05/90	Vern Coyne 5-5-90	1 3

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
Horizontal and vertical data for aerial photo control points.	Yes ☐	Survey File	or
	No ☐	Field Project File	---
	NA ☒	G. C. Evans	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

AERIAL PHOTO CONTROL POINT NO.	HANFORD PLANT 200E AREA DATA U.S.SURVEY FEET COORDINATES NORTH	WEST	WCS83S NORTH	EAST	NGVD 29 ELEVATION (METERS)
100	N49,300 -	W48,000	N138,510.102 -	E575,255.656	169.33
101	N49,300 -	W45,000	N138,512.690 -	E576,169.953	142.80
102	N49,300 -	W42,000	N138,515.280 -	E577,084.250	139.78
103	N49,300 -	W39,000	N138,517.868 -	E577,998.546	145.67
104	N49,300 -	W38,000	N138,518.731 -	E578,303.312	147.65
105	N48,000 -	W48,000	N138,113.906 -	E575,256.778	175.05
106	N48,000 -	W45,000	N138,116.495 -	E576,171.074	172.55
107	N48,000 -	W42,000	N138,119.084 -	E577,085.371	141.20
108	N48,000 -	W38,000	N138,122.536 -	E578,304.434	144.38
109	N45,000 -	W39,000	N137,207.376 -	E578,002.257	149.43
110	N45,000 -	W38,000	N137,208.239 -	E578,307.022	146.80
111	N42,000 -	W39,000	N136,293.079 -	E578,004.846	160.07
112	N42,000 -	W38,000	N136,293.942 -	E578,309.611	157.50

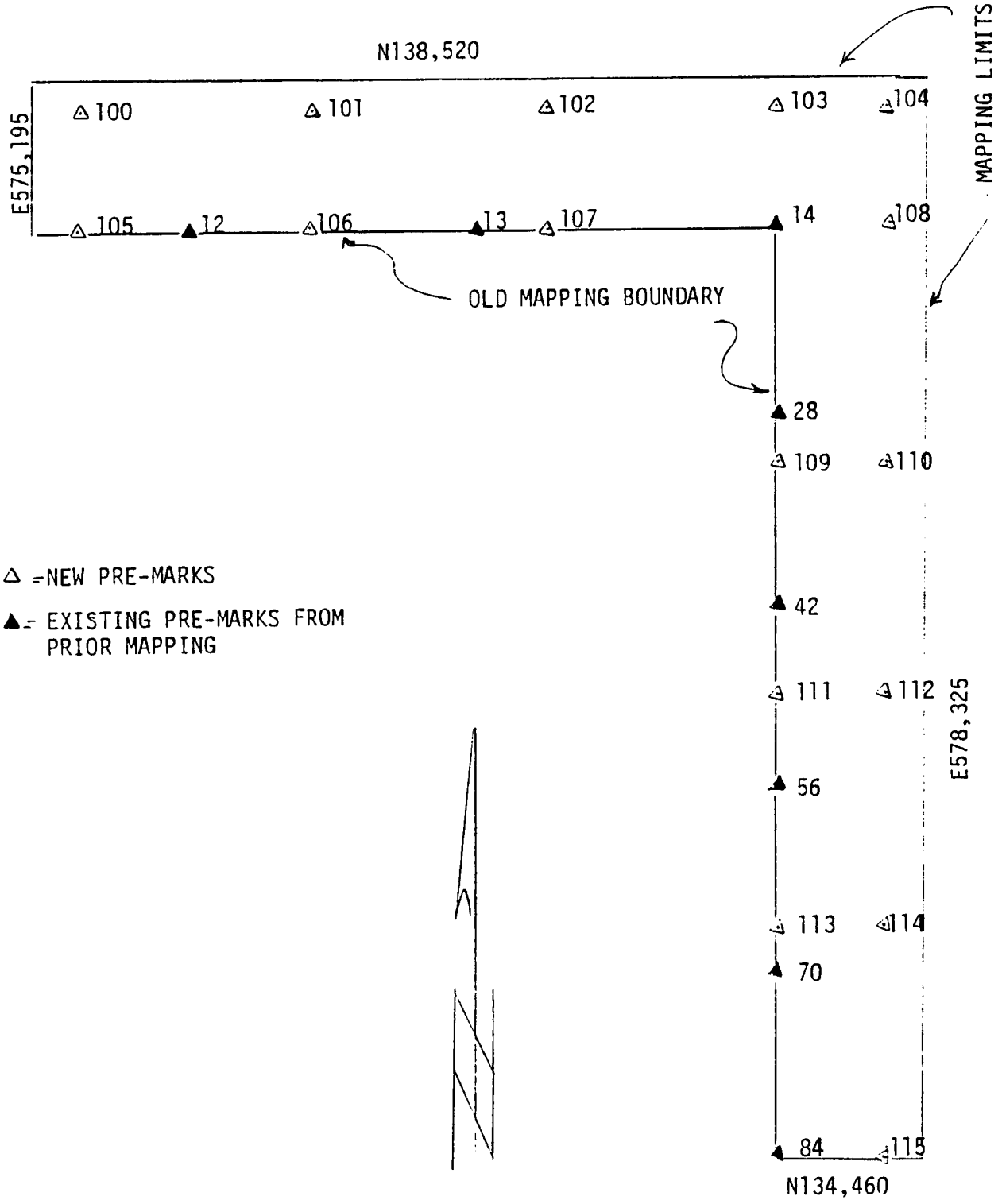
Attachment #3

KAISER ENGINEERS HANFORD	FIELD SKETCH

Attachment To Or Description:

EAST OF 200E AERIAL MAPPING Aerial photo control points

Sheet 3 of 3



Attachment #3

KAISER ENGINEERS HANFORD

SURVEY DATA REPORT

— 9 0 2 — 1 1 5

Project/W.O. No.	Title	File No.
ER-0775	SOUTHWEST OF 200W AERIAL MAPPING	2 E W A — 0 4 4

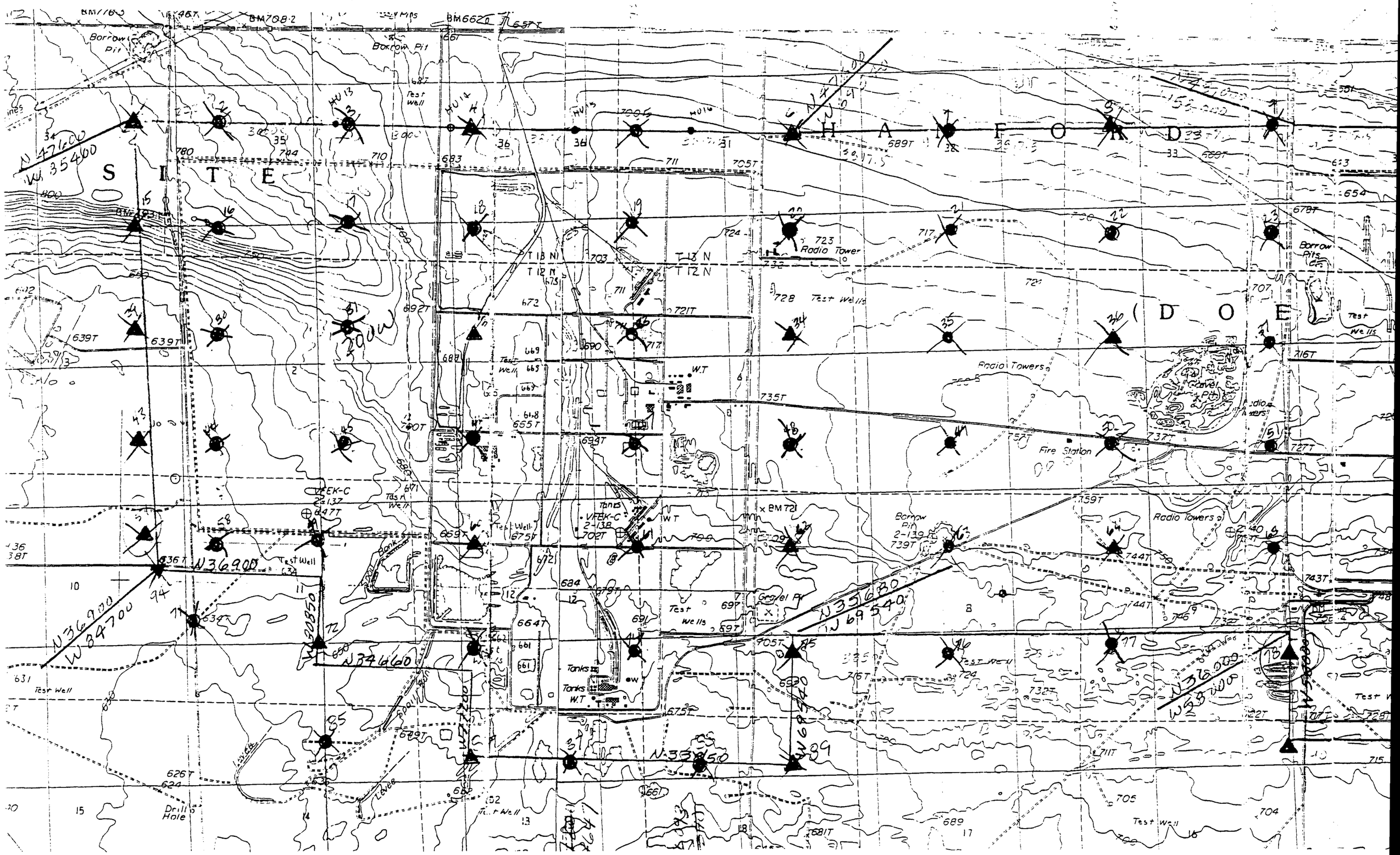
KEH Job No.	Prepared By	Date	Reviewer	
ER-0775-11	R.L. HACKWITH	7/9/90	[signature]	1 1 1

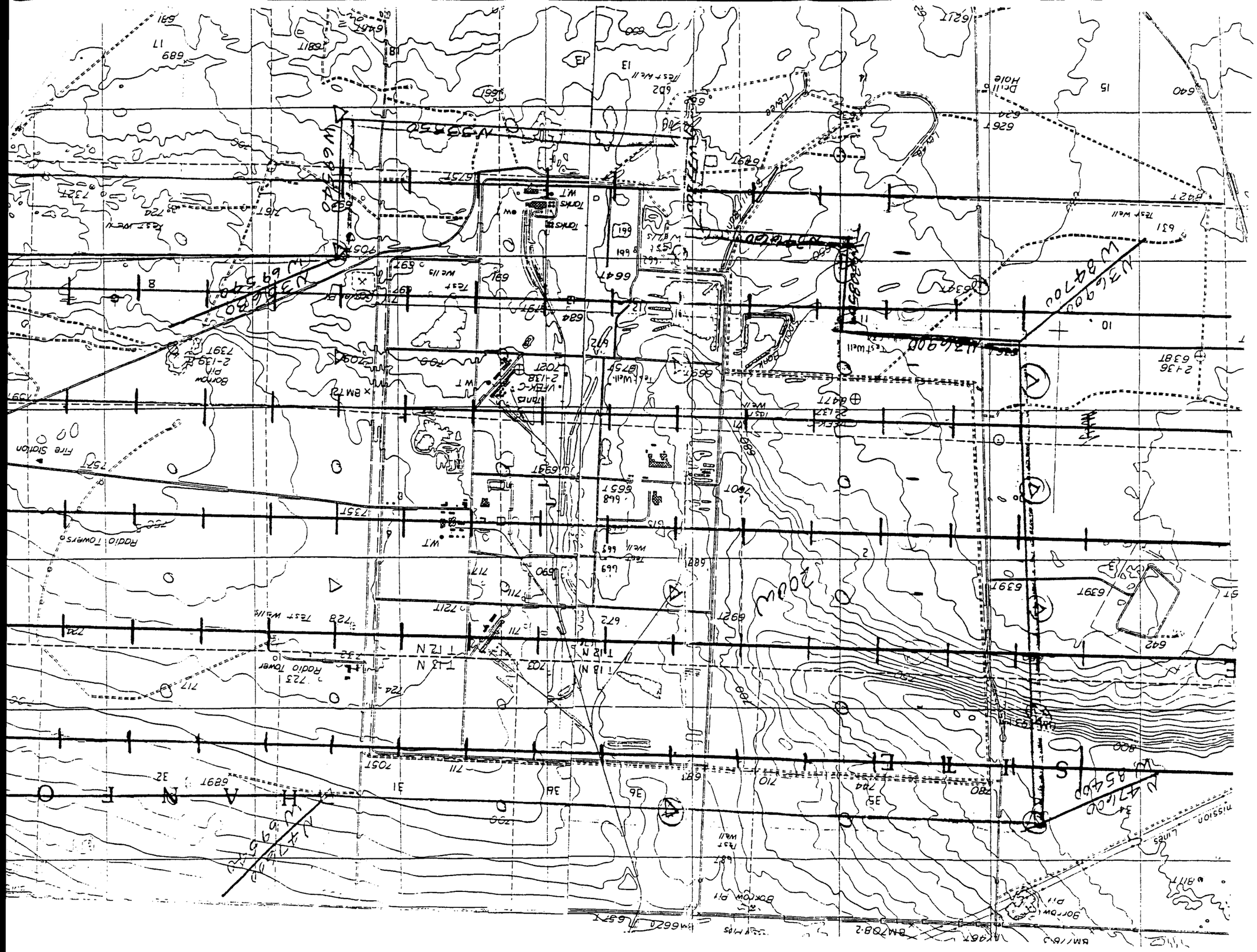
DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
	Yes —	Survey File	or
Horizontal and vertical data for aerial	No —	Field Project File	0
photo control points.	NA X	C. C. Evans	1
	TBD by	G. Degross	1
	Requestor —		

SURVEY RESULTS AND COMMENTS

AERIAL PHOTO CONTROL POINT NO.	COORDINATES: HANFORD PLANT 200E AREA DATA U.S.SURVEY FEET	COORDINATES: WCS83S	ELEVATIONS: NGVD'29 METERS
1	N 32,841.0 W 69,540.5	N 133,475.362 E 568,705.005	205.83
2	N 30,004.0 W 69,544.1	N 132,610.733 E 568,706.346	197.25
3	N 30,003.2 W 73,303.3	N 132,607.255 E 567,560.655	199.13
4	N 30,004.1 W 77,104.0	N 132,604.261 E 566,402.347	200.50
5	N 30,003.3 W 80,859.5	N 132,600.755 E 565,257.770	191.4
6	N 30,005.2 W 82,782.7	N 132,599.691 E 564,671.652	189.64
7	N 30,007.2 W 84,705.7	N 132,598.627 E 564,085.583	191.43
8	N 33,457.2 W 84,703.1	N 133,650.077 E 564,083.396	190.99
9	N 36,900.0 W 84,700.0	N 134,699.345 E 564,081.368	192.83
10	N 36,919.8 W 82,786.1	N 134,707.027 E 564,664.645	193.29
11	N 33,456.5 W 82,777.0	N 133,651.527 E 564,670.401	190.93
12	N 36,905.4 W 80,851.2	N 134,704.325 E 565,254.343	195.19
13	N 32,855.4 W 80,852.4	N 133,470.013 E 565,257.474	195.12
14	N 32,850.0 W 77,200.0	N 133,471.412 E 566,370.589	198.15
15	N 32,85[illegible]7 W 73,302.9	N 133,475.680 E 567,558.334	204.98

ATTACHMENT #3





Fire Station
Radio Towers
Radio Tower
Borrow Pit
Test Wells
Tanks
Drill Hole
Lines

Attachment E: 300 Area Fly-over Specifications Package

KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. — — — —
Project/W.O. No.	Title: 300 AREA AERIAL MAPPING	File No. 3 A N E — 0 2 6
KEH Job No. ER 2704	Prepared By: Kline R. Welsch	Date: 4/7/92
		Reviewer: V. Coyne

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
300 Area fly-over specifications.	Yes ☐	Survey File	OR
	No ☐	Field Project File	-
	NA ☒	R. Fox	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

ATTACHMENT #1: Mapping specifications for the 300 Area aerial mapping projects.

ATTACHMENT #2: Method of establishing horizontal data on aerial photo control points.

ATTACHMENT #3: Listing of aerial photo points for the 300 Area mapping. Sketch showing target configuration.

ATTACHMENT #4: Maps indicating verification by random sampling. Check profiles were done on several sheets throughout project.

AERIAL MAPPING ESTIMATE

1. Scale: Maps will be at a scale of 1:2000 with a contour interval of .5 meters. Horizontal and vertical will be in meters.

2. Area to be Mapped: 300 Area, see Attachment D.

3. Map Format:

   a. Printed on Hanford standard-sized sheets (28"x40").

   b. Minimum margin of 1-inch around the borders.

   c. Space allowed across the bottom right-hand corner (above border) of the map for a WHC standard legend. (Attachment A)

   d. North shall be oriented up on the maps (parallel to the short dimension on the map sheets).

   e. Washington State Coordinate Grid Lines (NAD83) with Hanford Grid Ticks shall be shown on the maps.

   f. One set of maps will be provided on double Matte mylar with one set of sepias.

   g. Maps will be signed and stamped by a licensed Land Surveyor or Engineer as to the accuracy of the maps.

   h. Data will be supplied to KEH in AutoCAD or compatible format such that maps can be generated or modified by KEH and WHC using AutoCAD software. (Attachment B).

   i. Three sets of contact photographs.

   j. All negatives.

4. Premark requirements must be submitted for the following:

   1. Size of targets.
   2. Spacing for horizontal and vertical.
   3. Configuration of targets.

5. Field Work: KEH Survey will provide survey work needed for mapping. We would like to keep ground control to a minimum, please use triangulation method as much as possible.

6. Accuracy: Maps will meet minimum standards set for aerial photographic mapping described in Section 14, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87. (Attachment C).

7. Schedule: Maps are needed by 1/1/90.

ATTACHMENT #1

ATTACHMENT "B"

SUBJECT: DATA FILES

In order to process data produced by mapping contractors, Kaiser Engineers Hanford Company (KEH) must receive the data in one of the following two formats:

1. "AutoCAD" release 9.0 drawing files.
2. Drawing interchange files (DXF).

The data files shall be delivered on 20 Mb Bernoulli removable cartridges.

The data files shall be able to be processed by an IBM-AT compatible personal computer using the MS-DOS Version 3.2.

SECTION 14

LAND SURVEYING, AERIAL PHOTOGRAPHY, AND MAPPING

14.1 SCOPE AND PURPOSE

This section provides information for use in the planning and implementation of land surveying, aerial photography, and mapping for hazardous waste sites.

14.2 DEFINITIONS

Azimuth
A horizontal direction expressed as an angular distance between the direction of a fixed point and the direction of the depth.

Bearing
The direction of one point with respect to another on the compass.

Bench Mark
A mark on a permanent object indicating elevation and serving as a reference in topographic surveys.

Second (")
The 60th part of a minute of angular measurement.

Site Manager (SM)
The individual responsible for the successful completion of a work assignment within budget and schedule. This person is also referred to as the Site Project Manager or the Project Manager and is typically a contractor's employee (see Subsection 1.1).

Third-Order Plane Survey
The lowest level of accuracy used in topographic mapping, usually limited to small-scale projects.

Transit
A theodolite with the telescope mounted so that it can be transited; a surveyor's instrument.

Traverse
A series of connected lines of known length related to one another by known angles.

14.3 APPLICABILITY

This section focuses on the methods of obtaining maps through field surveys, property surveys, surveys of monitoring wells, aerial photography, and photogrammetric mapping. In performing these methods, other survey requirements may need to be fulfilled (e.g., monument construction, boundary surveys, and time / method / accuracy / cost considerations of using an electronic distance meter instrument). Other surveying and mapping methods include plane table and alidade mapping, transit-stadia mapping, three-wire leveling, and trigonometric leveling. While these methods may have applications on a specific site, the methods discussed below apply to all mapping activities conducted for the U.S. EPA at hazardous waste sites.

14.4 RESPONSIBILITIES

It is the responsibility of the survey and mapping task leader to ensure that the proper techniques are followed throughout the project.

14.5 RECORDS

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed / wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Graphite pencils or water proof ballpoint pens should be used. Erasing is not acceptable; use a single strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work.

Aerial photography film annotation should include, at a minimum, the date of exposure, flight number, and exposure number. Additional information would include radar and barometric altitude, time, latitude, longitude, heading, pitch, roll, and drift angles.

Photogrammetric mapping should be in ink on mylar or scribed; maps should be 22 inches by 34 inches or as directed by the survey and mapping task leader.

14.6 PROCEDURES

14.6.1 Surveying—General

Survey requirements may necessitate survey accuracies of the third order; however, the second order may be required on some occasions and lower accuracies on other occasions. For the majority of sites, all surveys shall be third-order plane surveys as defined in the standards and specifications in Exhibit 14-1.

Third-order plane surveys and horizontal angular measurements should be made with a 20-second or better transit. Angles should be doubled, with the mean of the doubled angle within 10 seconds of the first angle. Distance measurements should be made with a calibrated tape corrected for temperature and tension or with a calibrated electronic distance meter instrument (EDMI). When using EDMI, the manufacturer's parts per million (ppm) error continues to be applied, as well as corrections for curvature and refraction.

14.6.1.1 Third-Order Vertical Survey

Land surveys are to be completed by a surveyor who is licensed and registered in the state where the survey is conducted. When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent bench mark. If possible, level circuits should close on a bench mark whose elevation is known (other than the starting bench mark). If the circuit closes on the original bench mark, the last point in the circuit must be used as a turning point. The following criteria should be met in conducting the survey:

Exhibit 14-1
STANDARDS FOR THIRD-ORDER PLANE SURVEYS

Principal Use:
Small engineering projects and small-scale topographics mapping.

Traverse	
Number of bearing courses between azimuth checks	30 to 30 [30]*
Astronomical bearings: standard error of results	8".0 [6".0]*
Azimuth closure at azimuth checkpoint not to exceed (use the smaller value)	30" $\sqrt{N}$ or 8".0 per [20" $\sqrt{N}$]* station
Standard error of the mean for length measurements	1 in 30,000 [1 in 20,000]*
Position closure per loop in feet after azimuth adjustment	1:5,000 checkpoint or 3.34 $\sqrt{M}$, whichever is smaller
Leveling	
Levels of error of closure per loop in feet	0.05 $\sqrt{M}$

*Figures in brackets are commonly used in preparing specifications for bid.

N = then number of stations for carrying bearing
M = the distance in miles

- Instruments should be pegged regularly.
- Rod levels should be used.
- Foresight and backsight distances should be reasonably balanced.
- No side shot should be used as a turning point in any level loop.
- Elevation readings should be recorded to 0.01 foot and estimated to 0.005 foot using a calibrated rod.

Temporary monuments should be set and referenced for future recovery. All monuments should be described in the field notes and should consist of a permanent mark scribed on facilities such as sidewalks, paved roads, or curbs. Sufficient description should be provided to facilitate their recovery.

14.6.1.2 Property Surveys

All property surveys should be performed in accordance with good land surveying practices and should conform to all pertinent federal and state laws and regulations governing land surveying in the area where the work is being accomplished. The surveyor shall be licensed and registered in the state where the survey is conducted.

Upon completion of the project, all original field note books, computations, and pertinent reference materials should be delivered to the SM for retention in the site file. The surveyor may keep photostatic copies of the material.

All field note reductions should be checked and marked in such a way that a visual inspection of the field notes will confirm that checks have been made. All office entries in field notebooks should be made in colored pencil.

The office worker who reduces or checks field notes should initial each page worked on in the color used on that page.

14.6.1.3 Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step one—Bearing closures will be computed and adjusted if within limits.
- Step two—Coordinate closures will be computed using adjusted bearings and unadjusted field distances.
- Step three—Coordinate positions will be adjusted if the traverse closes within the specified limits. The method of adjusting shall be determined by the surveyor.
- Step four—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.

- Step five—The direction and length of the unadjusted error of closure, the ratio of error over traverse length, and the method of adjustment should be printed with the final adjusted coordinates.

14.6.1.4 Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for that circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustment.

14.6.1.5 Monitoring Well Surveys

Monitoring well locations are surveyed only after the installation of the tamperproof locking cap well casing cover, which is set in concrete. The horizontal plane survey accuracy is ±1 foot (unless greater accuracy is desired) and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. Three elevations are measured, including the following:

- Top of the inner well casing (on the lip)
- Top of the outer protective casing (on the lip, not the cap)
- Finished concrete pad adjacent to the outer well casing

The point at which the elevation was measured should be scribed so that water level measurements may be taken at the same location. Note: The SM should ensure that the surveying party is given the keys to the locking cap before starting the survey.

14.6.2 Aerial Photography

Aerial photography for nonphotogrammetic use can be obtained from the following agencies:

- Environmental Monitoring System Laboratory (EMSL), Las Vegas, Nevada
- Environmental Photographic Interpretation Center (EPIC), Warrenton, Virginia
- National Cartographic Information Center, Reston, Virginia
- Soil Conservation Service, U.S. Department of Agriculture; Eastern or Western Laboratory, Asheville, North Carolina, or Salt Lake City, Utah, respectively

- Forest Service, U.S. Department of Agriculture, Washington, D.C. (for the eastern United States and Alaska), or the appropriate regional forester in Forest Service Regions 1-6 (Montana, Colorado, New Mexico, Utah, San Francisco, and Portland)

State and local transportation departments, zoning commissions, and planning divisions or local universities may also have useful aerial photographs. The EPA Enviropod, which consists of two 70-mm cameras mounted in a pod that can be attached to a light plane, is available through EPA regional offices. Aerial photographs may be obtained rapidly using the Enviropod and EPA photographic laboratories for developing the film. The photographs are not suitable for photogrammetric use. Photogrammetric aerial photography is usually contracted.

14.6.2.1 Contracting Aerial Photography

The following provisions should be included in the contract:

- **Business Arrangements**—These include such items as the cost of the aerial survey, posting of a performance bond, assumption of risks and damages, provision for periodic inspection of work, reflights, cancellation privileges, schedule for delivery and payments, and ownership and storage of negatives.

- **Area to be Photographed**—This includes location, size, and boundaries. These are ordinarily indicated on flight maps (1:24,000 scale) supplied by the purchaser.

- **Type of Photographic Film and Filter**—This includes such items as ASA exposure rating (ASA 100 is usually specified). The dimensional stability of the film base may also be specified.

- **Negative Scale**—The maximum scale deviation normally allowed is ±5 percent.

- **The Aerial Camera**—A National Bureau of Standards calibration report meeting U.S. Geological Survey standards for photogrammetric mapping is required. Other camera specifications include size of negative format, method of flattening film during exposure, type of shutter, focal length (usually 6 inches), distortion characteristics of the lens, and resolving power.

- **Position of Flight Lines**—Lines are to be parallel, oriented in the correct compass direction, and within a stated distance from positions drawn on flight maps.

- **Overlap**—This is usually set at 55 to 65 percent (the average is 60 percent) along the line of flight and 15 to 45 percent (the average is 30 percent) between adjacent lines. At the ends of each flight line, two photo centers should fall outside the boundary of the tract.

- **Print Alignment**—Crab or drift is not to affect more than 10 percent of the print width for any three consecutive photographs.

- **Tilt**—This should not exceed 2 or 3 degrees for a single exposure, or average more than 1 degree for the entire project.

- **Time of Photography**—The season of the year and the time of day (or minimum sun angle) are usually specified. The aerial photography should be conducted in the spring or fall when deciduous vegetation is bare and the ground is essentially free of snow cover. Ideal flight times are between 10:00 a.m. and 2:00 p.m. local standard time, or when the sun is at a minimum of 30 degrees above the horizon. Cloud or fog cover should not exceed 10 percent.

- **Base Maps**—If base maps or radial line plots are required, responsibility for ground control (field surveying) should be established.

- **Film Processing**—Included here are procedures for developing and drying negatives and for indexing and editing film rolls, plus a description of the type of photographic paper (weight, finish, and contrast) to be used.

- **Quality of Negatives and Prints**—Negatives and prints should be free from stains, scratches, and blemishes that detract from the intended use.

- **Materials to be Delivered**—Two sets of contact prints and one set of index sheets are usually supplied. A copy of the original flight log may also be specified. Additional items such as enlargements, mosaics, maps, or plan -and profile sheets should be listed in detail. One set of contact prints should be delivered to the project manager within 5 days of the date of the photography, unless otherwise spc. ied. The SM should arrange for additional sets of prints to be delivered at the same time if needed.

14.6.2.2 Photogrammetric Mapping

The scale of the mapping photography should be suitable for the preparation of a topographic map by photogrammetric methods at a scale and contour interval requested by the project, usually a 1" = 50' scale and 2-foot contour intervals. Larger a: · or areas with great differences in elevation may require a different scale.

Map accuracy shall meet or exceed the following minimum standards:

- For horizontal accuracy, 90 percent of all defined points should be within 1/ 40 inch of their true position, and 100 percent of all defined points should be within 1/ 20 inch of their true position.

- For vertical accuracy, 90 percent of all contours shall be within one-half of a contour interval, and 100 percent of all contours shall be within one contour interval. Ninety percent of all spot elevations should be accurate to within one-fourth of the contour interval, and all spot elevations should be within one-half of the contour interval.

- Mapping should show all planimetric features including, but not limited to, buildings, walks, roads, fences, ditches, trees, utility poles, tanks, drums, lagoons, pits, ponds, and other such features visible on the photograph, as well as contours and spot elevations on roads, dikes, and ditch inverts. Assemblages of containers (e.g., drums, laboratory bottles) may be indicated by a symbol rather than by depicting individual containers. The height and estimated number of such containers should be depicted within the symbol.

- All horizontal and vertical control points should be shown on the final map along with a tabulation of coordinates and elevations. The description, origin, and elevations of the bench marks used for the mapping control should be shown on the map.

- The horizontal coordinate system should be referenced to a local recoverable baseline at the site. The state plane coordinate system should be used when it is readily available near the site.

- Photographic control points must be kept outside the hazardous areas where possible.

- The map should show the basis of bearing, north arrow, date of photography, names of streets and highways, project number, project name, and a bar scale.

14.6.3 Remote Sensing

The standards for remote sensing imagery will be determined on a project specific and instrument-specific basis. Remote sensing data are used in environmental surveys and risk assessments. Methods include, but are not limited to, the following:

- Satellite photography (LANDSAT, Skylab)
- Radar (side-looking airborne radar, plan positive indicator)
- Thermal imagery (infrared detectors, line scanning, infrared photography)
- Multiband spectral imagery
- Low-altitude helicopter photography (stereograms)
- Continuous strip photography

The National Cartographic Information Center (NCIC) provides information about and access to cartographic data generated by federal, state, and local governmental bodies and by private sources. NCIC does not hold these data; it functions as a link between the user and the desired material. Requests for information may be submitted to the following agency:

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092

Records of aerial photographic coverage of the United States and outlying areas and of space imagery are maintained at the EROS Data Center in Sioux Falls, South Dakota. The Earth Resources Observation Systems (EROS) program gathers and uses remotely sensed data, collected by satellite and aircraft, of natural features and those made by humans on the earth's surface. Reference files, consisting of microfilms of available data primarily from LANDSAT I and II, formerly known as Earth Resources Technology Satellite (ERTS), may be viewed at 20 locations across the United States. Purchases of such data may be made from the following:

EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198

14.6.4 Hydrographic Surveys

Hydrographic surveys deal with the measurement and definition of the configuration of the bottom and adjacent land areas of oceans, lakes, rivers, harbors, and other bodies of water.

The size of the body of water will dictate the type of survey required to perform the necessary mapping. Surveys should conform to the requirements set forth in the *Hydrographic Survey Manual* by the U.S. Department of Commerce.

14.7 REGION-SPECIFIC VARIANCES

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

14.8 INFORMATION SOURCES

American Society of Photogrammetry. *Manual of Photogrammetry*. 4th ed.

Averes, T. Eugene. *Interpretation of Aerial Photographs*. 2nd ed. Minneapolis, Minnesota: Burgens Publishing Company.

Federal Geodetic Control Committee. *Specification to Support Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys*. July 1975. (Revised June 1980.)

Manual of Photographic Interpretation. Menasha, Wisconsin: Banta Publishing Company.

Moffitt, Francis H., and Harry Bouchard. *Surveying*. New York: Mtext Educational Publishers.

Pafford, William F. *Handbook of Survey Notekeeping*.

Umbach, Melvin J. *Hydrographic Survey Manual*. 4th ed. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration.

ESTABLISHMENT OF HORIZONTAL DATA ON 300 AREA AERIAL PHOTO CONTROL POINTS

Two permanent control monuments were chosen within the 300 Area grid system. These existing control monuments, 300-1 and 300-2, have old Richland coordinate system values. Washington State Coordinate System of 1983, South Zone (WCS83S) values were assigned by Global Positioning System (GPS) method holding National Geodetic Survey (NGS) station McKINLEY by a single-loop traverse.

WCS83S closure: dN= 0.054m dE= 0.024m Σd= 31,940m 1:250,000

Photo control points were set in position as required by the photogrammetrist by using topographic features. The photo control points were surveyed from this traverse by single sideshot (angle and distance) with WCS83S assigned.

The old Richland coordinate values were assigned to the photo control points by a two-point coordinate transformation. The 300 Area ground level coordinates and WCS83S values were used for 300-1 and 300-2 permanent monuments to transform WCS83S of the photo control points to 300 Area ground level system values.

ATTACHMENT #3

14

KAISER ENGINEERS HANFORD

SURVEY DATA REPORT

Request No. — 8 9 4 — 2 3 8

File No. 3 A N E — 0 2 6

Project/W.O. No.	Title		
B80978	300-FF-1 OPERABLE UNIT		
KEH Job No.	Prepared By	Date	Reviewer
B80978	Vern Coyne	11/13/89	G.F. Bryant 1 1

DESCRIPTION OF WORK

Horizontal & vertical control for the aerial mapping of the 300-FF-5 operable unit

ACCEPTABILITY (Within Plan Tolerance)

- Yes ☐
- No ☐
- NA ☒
- TBD by Requestor ☐

DISTRIBUTION

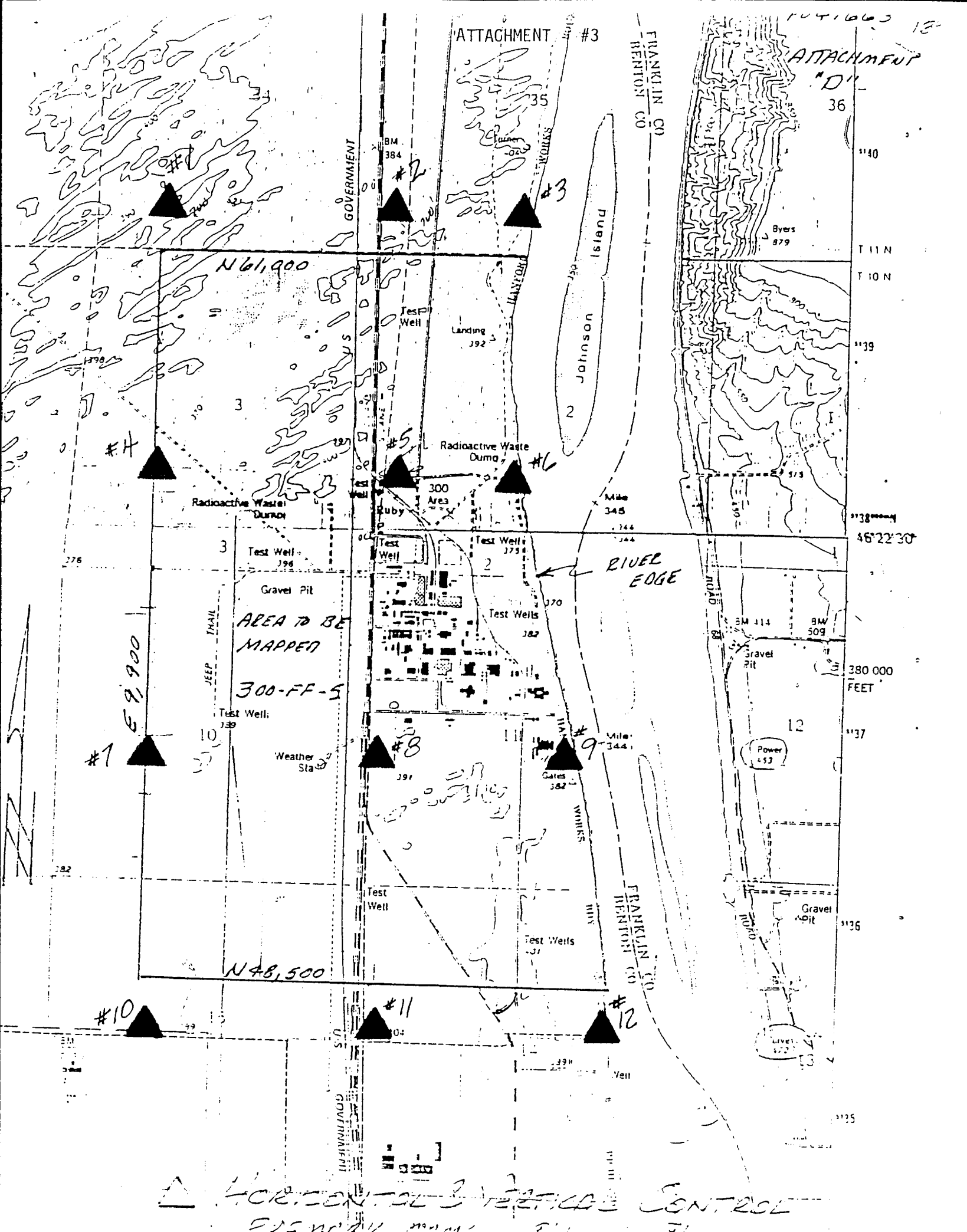
Survey File	OR
Field Project File	0
M.A. Chamness	1
CASCADE MAPPING	1

SURVEY RESULTS AND COMMENTS

PHOTO CONTROL NO.	COORDINATES WCS83S NORTHINGS	WCS83S EASTINGS	OLD RICHLAND SYSTEM FEET NORTHINGS	OLD RICHLAND SYSTEM FEET EASTINGS	ELEVATION NGVD - 29 METERS
1	118,113.294	592,461.194	61,699.5	9,899.4	120.604
2	118,131.469	593,663.273	61,701.4	13,844.0	118.884
3	118,236.736	594,350.139	62,013.8	16,102.6	117.519
4	116,791.364	592,448.101	57,363.1	9,792.9	112.996
5	116,763.960	593,660.319	57,215.0	13,768.7	118.506
6	116,779.270	594,339.075	57,232.6	15,996.3	112.907
7	115,276.956	592,445.934	52,394.7	9,713.0	115.611
8	115,306.468	593,721.662	52,430.3	13,899.9	119.101
9	115,307.920	594,657.244	52,390.1	16,969.4	114.450
10	113,825.068	592,413.564	47,632.9	9,537.1	112.913
11	113,872.699	593,645.485	47,730.0	13,581.1	122.603
12	113,892.540	594,742.191	47,742.4	17,180.1	119.729

ATTACHMENT #3

ATTACHMENT "D"



KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. — —
Project/W.O. No.	Title: 400 AREA AERIAL MAPPING	File No. 1 2 2 7 — 0 0 6
KEH Job No.: ER 2704	Prepared By: Kline R. Welsch	Date: 4/7/92
		Reviewer: V. Coyne

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
400 Area fly-over specifications.	Yes ☐	Survey File	OR
	No ☐	Field Project File	
	NA ☒	R. Fox	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

ATTACHMENT #1: Mapping specifications for the 400 Area aerial mapping projects.

ATTACHMENT #2: Method of establishing horizontal data on aerial photo control points.

ATTACHMENT #3: Listing of aerial photo points for the 400 Area mapping. Sketch showing target configuration.

ATTACHMENT #4: Maps indicating verification by random sampling. Check profiles were done on several sheets throughout project.

ATTACHMENT #1

AERIAL MAPPING ESTIMATE

1. SCALE: Maps shall be drawn to a scale of 1:2000 with a contour interval of .5 meters. Horizontal and vertical will be in meters.

2. AREA TO BE MAPPED: 400 areas. See attachment A1 thru A4.
3. MAP FORMAT:

   a. Printed on Hanford standard-sized sheets (28"x40").

   b. Minimum margin of 1 inch around the borders.

   c. Provide Kaiser Kaiser Engineers Hanford (KEH) title block across the bottom right hand corner (within border) of the map.

   d. North shall be oriented up on the maps (parallel with the short dimension on the map sheets).

   e. Where necessary, map sheets shall be produced as a series with match lines to adjacent sheets. For map series, an index sheet will be provided to show the relative location of each map sheet. Graphic scale, contour interval, vertical and horizontal datum shall be included.

   f. Washington State Coordinate Grid Lines (NAD 83) with Plant Grid Ticks shall be shown on all maps.

   g. Two sets of maps will be provided on double matte mylar.

   h. Maps will be signed and stamped by a licensed Land Surveyor or Engineer as to the accuracy of the maps.

   i. Data will be supplied to KEH in AutoCAD or compatible format such that maps can be generated or modified using AutoCAD software. See Attachment B.

4. PHOTOGRAPHY: Three sets of contact photographs and all negatives shall be delivered to KEH.

5. PREMARK REQUIREMENTS MUST BE SUBMITTED FOR THE FOLLOWING:

   a. Size of targets.
   b. Spacing for horizontal and vertical targets.
   c. Configuration of targets.

   KEH Survey will provide ground control needed, and would like to minimize the number of targets required to do the job. This should be kept in mind when planning the overall job.

6. ACCURACY: Maps shall meet minimum standards as prescribed in the following two documents.

   a. Section 14, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87.
   b. The National Map Accuracy Standards.

   A statement shall placed on the map indicating compliance with these standards.

7. SCHEDULE: Maps are needed by August 31, 1990.

ATTACHMENT #1

ATTACHMENT "B"

SUBJECT: DATA FILES

In order to process data produced by mapping contractors, Kaiser Engineers Hanford Company (KEH) must receive the data in one of the two following formats:

1. "Autocad" Release 10.0 drawing files.
2. Drawing interchange files (DXF).

The data files shall be delivered on 20 Mb Bernoulli removable cartridges or on 360 kb, 1.2 Mb, 5.25" floppy disks, depending on file size.

The data files shall be able to be processed by an IBM-AT compatible personal computer using the MS-DOS Version 3.2.

All coordinate data shall be referenced to the single origin of the coordinate system, not to a local origin for each map sheet or file. The object is to be able to "window" any given area within the entire drawing using "real world" coordinates. Any questions at all about this, please call Alan Lewis, (509) 373-2615.

ATTACHMENT #1

~~ATTACHMENT C~~

SECTION 14

LAND SURVEYING, AERIAL PHOTOGRAPHY, AND MAPPING

14.1 SCOPE AND PURPOSE

This section provides information for use in the planning and implementation of land surveying, aerial photography, and mapping for hazardous waste sites.

14.2 DEFINITIONS

Azimuth
: A horizontal direction expressed as an angular distance between the direction of a fixed point and the direction of the depth.

Bearing
: The direction of one point with respect to another on the compass.

Bench Mark
: A mark on a permanent object indicating elevation and serving as a reference in topographic surveys.

Second (")
: The 60th part of a minute of angular measurement.

Site Manager (SM)
: The individual responsible for the successful completion of a work assignment within budget and schedule. This person is also referred to as the Site Project Manager or the Project Manager and is typically a contractor's employee (see Subsection 1.1).

Third-Order Plane Survey
: The lowest level of accuracy used in topographic mapping, usually limited to small-scale projects.

Transit
: A theodolite with the telescope mounted so that it can be transited; a surveyor's instrument.

Traverse
: A series of connected lines of known length related to one another by known angles.

14.3 APPLICABILITY

This section focuses on the methods of obtaining maps through field surveys, property surveys, surveys of monitoring wells, aerial photography, and photogrammetric mapping. In performing these methods, other survey requirements may need to be fulfilled (e.g., monument construction, boundary surveys, and time / method / accuracy / cost considerations of using an electronic distance meter instrument). Other surveying and mapping methods include plane table and alidade mapping, transit-stadia mapping, three-wire leveling, and trigonometric leveling. While these methods may have applications on a specific site, the methods discussed below apply to all mapping activities conducted for the U.S. EPA at hazardous waste sites.

14.4 RESPONSIBILITIES

It is the responsibility of the survey and mapping task leader to ensure that the proper techniques are followed throughout the project.

14.5 RECORDS

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed / wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Graphite pencils or water proof ballpoint pens should be used. Erasing is not acceptable; use a single strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Palford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work.

Aerial photography film annotation should include, at a minimum, the date of exposure, flight number, and exposure number. Additional information would include radar and barometric altitude, time, latitude, longitude, heading, pitch, roll, and drift angles.

Photogrammetric mapping should be in ink on mylar or scribed; maps should be 22 inches by 34 inches or as directed by the survey and mapping task leader.

14.6 PROCEDURES

14.6.1 Surveying—General

Survey requirements may necessitate survey accuracies of the third order; however, the second order may be required on some occasions and lower accuracies on other occasions. For the majority of sites, all surveys shall be third-order plane surveys as defined in the standards and specifications in Exhibit 14-1.

Third-order plane surveys and horizontal angular measurements should be made with a 20-second or better transit. Angles should be doubled, with the mean of the doubled angle within 10 seconds of the first angle. Distance measurements should be made with a calibrated tape corrected for temperature and tension or with a calibrated electronic distance meter instrument (EDMI). When using EDMI, the manufacturer's parts per million (ppm) error continues to be applied, as well as corrections for curvature and refraction.

14.6.1.1 Third-Order Vertical Survey

Land surveys are to be completed by a surveyor who is licensed and registered in the state where the survey is conducted. When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent bench mark. If possible, level circuits should close on a bench mark whose elevation is known (other than the starting bench mark). If the circuit closes on the original bench mark, the last point in the circuit must be used as a turning point. The following criteria should be met in conducting the survey:

Exhibit 14-1
STANDARDS FOR THIRD-ORDER PLANE SURVEYS

Principal Use:
Small engineering projects and small-scale topographics mapping.

Traverse	
Number of bearing courses between azimuth checks	30 to 30 [30]*
Astronomical bearings: standard error of results	8".0 [6".0]*
Azimuth closure at azimuth checkpoint not to exceed (use the smaller value)	30" $\sqrt{N}$ or 8".0 per station [20" $\sqrt{N}$]*
Standard error of the mean for length measurements	1 in 30,000 [1 in 20,000]*
Position closure per loop in feet after azimuth adjustment	1:5,000 checkpoint or 3.34 $\sqrt{M}$, whichever is smaller
Leveling	
Levels of error of closure per loop in feet	0.05 $\sqrt{M}$

*Figures in brackets are commonly used in preparing specifications for bid.

N = then number of stations for carrying bearing
M = the distance in miles

- Instruments should be pegged regularly.
- Rod levels should be used.
- Foresight and backsight distances should be reasonably balanced.
- No side shot should be used as a turning point in any level loop.
- Elevation readings should be recorded to 0.01 foot and estimated to 0.005 foot using a calibrated rod.

Temporary monuments should be set and referenced for future recovery. All monuments should be described in the field notes and should consist of a permanent mark scribed on facilities such as sidewalks, paved roads, or curbs. Sufficient description should be provided to facilitate their recovery.

14.6.1.2 Property Surveys

All property surveys should be performed in accordance with good land surveying practices and should conform to all pertinent federal and state laws and regulations governing land surveying in the area where the work is being accomplished. The surveyor shall be licensed and registered in the state where the survey is conducted.

Upon completion of the project, all original field note books, computations, and pertinent reference materials should be delivered to the SM for retention in the site file. The surveyor may keep photostatic copies of the material.

All field note reductions should be checked and marked in such a way that a visual inspection of the field notes will confirm that checks have been made. All office entries in field notebooks should be made in colored pencil.

The office worker who reduces or checks field notes should initial each page worked on in the color used on that page.

14.6.1.3 Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step one—Bearing closures will be computed and adjusted if within limits.
- Step two—Coordinate closures will be computed using adjusted bearings and unadjusted field distances.
- Step three—Coordinate positions will be adjusted if the traverse closes within the specified limits. The method of adjusting shall be determined by the surveyor.
- Step four—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.

- Step five—The direction and length of the unadjusted error of closure, the ratio of error over traverse length, and the method of adjustment should be printed with the final adjusted coordinates.

14.6.1.4 Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for that circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustment.

14.6.1.5 Monitoring Well Surveys

Monitoring well locations are surveyed only after the installation of the tamperproof locking cap well casing cover, which is set in concrete. The horizontal plane survey accuracy is ±1 foot (unless greater accuracy is desired) and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. Three elevations are measured, including the following:

- Top of the inner well casing (on the lip)
- Top of the outer protective casing (on the lip, not the cap)
- Finished concrete pad adjacent to the outer well casing

The point at which the elevation was measured should be scribed so that water level measurements may be taken at the same location. Note: The SM should ensure that the surveying party is given the keys to the locking cap before starting the survey.

14.6.2 Aerial Photography

Aerial photography for nonphotogrammetic use can be obtained from the following agencies:

- Environmental Monitoring System Laboratory (EMSL), Las Vegas, Nevada
- Environmental Photographic Interpretation Center (EPIC), Warrenton, Virginia
- National Cartographic Information Center, Reston, Virginia
- Soil Conservation Service, U.S. Department of Agriculture; Eastern or Western Laboratory, Asheville, North Carolina, or Salt Lake City, Utah, respectively

- Forest Service, U.S. Department of Agriculture, Washington, D.C. (for the eastern United States and Alaska), or the appropriate regional forester in Forest Service Regions 1-6 (Montana, Colorado, New Mexico, Utah, San Francisco, and Portland)

State and local transportation departments, zoning commissions, and planning divisions or local universities may also have useful aerial photographs. The EPA Enviropod, which consists of two 70-mm cameras mounted in a pod that can be attached to a light plane, is available through EPA regional offices. Aerial photographs may be obtained rapidly using the Enviropod and EPA photographic laboratories for developing the film. The photographs are not suitable for photogrammetric use. Photogrammetric aerial photography is usually contracted.

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- **Area to be Photographed**—This includes location, size, and boundaries. These are ordinarily indicated on flight maps (1:24,000 scale) supplied by the purchaser.

- **Type of Photographic Film and Filter**—This includes such items as ASA exposure rating (ASA 100 is usually specified). The dimensional stability of the film base may also be specified.

- **Negative Scale**—The maximum scale deviation normally allowed is ±5 percent.

- **The Aerial Camera**—A National Bureau of Standards calibration report meeting U.S. Geological Survey standards for photogrammetric mapping is required. Other camera specifications include size of negative format, method of flattening film during exposure, type of shutter, focal length (usually 6 inches), distortion characteristics of the lens, and resolving power.

- **Position of Flight Lines**—Lines are to be parallel, oriented in the correct compass direction, and within a stated distance from positions drawn on flight maps.

- **Overlap**—This is usually set at 55 to 65 percent (the average is 60 percent) along the line of flight and 15 to 45 percent (the average is 30 percent) between adjacent lines. At the ends of each flight line, two photo centers should fall outside the boundary of the tract.

- **Print Alignment**—Crab or drift is not to affect more than 10 percent of the print width for any three consecutive photographs.

- **Tilt**—This should not exceed 2 or 3 degrees for a single exposure, or average more than 1 degree for the entire project.

- **Time of Photography**—The season of the year and the time of day (or minimum sun angle) are usually specified. The aerial photography should be conducted in the spring or fall when deciduous vegetation is bare and the ground is essentially free of snow cover. Ideal flight times are between 10:00 a.m. and 2:00 p.m. local standard time, or when the sun is at a minimum of 30 degrees above the horizon. Cloud or fog cover should not exceed 10 percent.

- **Base Maps**—If base maps or radial line plots are required, responsibility for ground control (field surveying) should be established.

- **Film Processing**—Included here are procedures for developing and drying negatives and for indexing and editing film rolls, plus a description of the type of photographic paper (weight, finish, and contrast) to be used.

- **Quality of Negatives and Prints**—Negatives and prints should be free from stains, scratches, and blemishes that detract from the intended use.

- **Materials to be Delivered**—Two sets of contact prints and one set of index sheets are usually supplied. A copy of the original flight log may also be specified. Additional items such as enlargements, mosaics, maps, or plan -and profile sheets should be listed in detail. One set of contact prints should be delivered to the project manager within 5 days of the date of the photography, unless otherwise spc . ied. The SM should arrange for additional sets of prints to be delivered at the same time if needed.

14.6.2.2 Photogrammetric Mapping

The scale of the mapping photography should be suitable for the preparation of a topographic map by photogrammetric methods at a scale and contour interval requested by the project, usually a 1" = 50' scale and 2-foot contour intervals. Larger a: · or areas with great differences in elevation may require a different scale.

Map accuracy shall meet or exceed the following minimum standards:

- For horizontal accuracy, 90 percent of all defined points should be within 1/ 40 inch of their true position, and 100 percent of all defined points should be within 1/ 20 inch of their true position.

- For vertical accuracy, 90 percent of all contours shall be within one-half of a contour interval, and 100 percent of all contours shall be within one contour interval. Ninety percent of all spot elevations should be accurate to within one-fourth of the contour interval, and all spot elevations should be within one-half of the contour interval.

- Mapping should show all planimetric features including, but not limited to, buildings, walks, roads, fences, ditches, trees, utility poles, tanks, drums, lagoons, pits, ponds, and other such features visible on the photograph, as well as contours and spot elevations on roads, dikes, and ditch inverts. Assemblages of containers (e.g., drums, laboratory bottles) may be indicated by a symbol rather than by depicting individual containers. The height and estimated number of such containers should be depicted within the symbol.

- All horizontal and vertical control points should be shown on the final map along with a tabulation of coordinates and elevations. The description, origin, and elevations of the bench marks used for the mapping control should be shown on the map.

- The horizontal coordinate system should be referenced to a local recoverable baseline at the site. The state plane coordinate system should be used when it is readily available near the site.

- Photographic control points must be kept outside the hazardous areas where possible.

- The map should show the basis of bearing, north arrow, date of photography, names of streets and highways, project number, project name, and a bar scale.

14.6.3 Remote Sensing

The standards for remote sensing imagery will be determined on a project specific and instrument-specific basis. Remote sensing data are used in environmental surveys and risk assessments. Methods include, but are not limited to, the following:

- Satellite photography (LANDSAT, Skylab)
- Radar (side-looking airborne radar, plan positive indicator)
- Thermal imagery (infrared detectors, line scanning, infrared photography)
- Multiband spectral imagery
- Low-altitude helicopter photography (stereograms)
- Continuous strip photography

The National Cartographic Information Center (NCIC) provides information about and access to cartographic data generated by federal, state, and local governmental bodies and by private sources. NCIC does not hold these data; it functions as a link between the user and the desired material. Requests for information may be submitted to the following agency:

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507 National Center
Reston, Virginia 22092

Records of aerial photographic coverage of the United States and outlying areas and of space imagery are maintained at the EROS Data Center in Sioux Falls, South Dakota. The Earth Resources Observation Systems (EROS) program gathers and uses remotely sensed data, collected by satellite and aircraft, of natural features and those made by humans on the earth's surface. Reference files, consisting of microfilms of available data primarily from LANDSAT I and II, formerly known as Earth Resources Technology Satellite (ERTS), may be viewed at 20 locations across the United States. Purchases of such data may be made from the following:

EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198

14.6.4 Hydrographic Surveys

Hydrographic surveys deal with the measurement and definition of the configuration of the bottom and adjacent land areas of oceans, lakes, rivers, harbors, and other bodies of water.

The size of the body of water will dictate the type of survey required to perform the necessary mapping. Surveys should conform to the requirements set forth in the *Hydrographic Survey Manual* by the U.S. Department of Commerce.

14.7 REGION-SPECIFIC VARIANCES

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

14.8 INFORMATION SOURCES

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Pafford, William F. *Handbook of Survey Notekeeping*.

Umbach, Melvin J. *Hydrographic Survey Manual*. 4th ed. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration.

ESTABLISHMENT OF HORIZONTAL DATA ON 400 AREA AERIAL PHOTO CONTROL POINTS

Two permanent control monuments were chosen within the 400 Area grid system. These existing control monuments, 400-1 and 400-2, have plant coordinate system values assigned. Washington State Coordinate System of 1983, South Zone (WCS83S) values were assigned by Global Positioning System (GPS) method holding National Geodetic Survey (NGS) station McKINLEY by a single-loop traverse.

WCS83S closure: dN= -0.004m dE= 0.000m Σd= 15,058m 1:1,538,462

Photo control points were set in position as required by the photogrammetrist and surveyed by single sideshot (angle and distance) using control monuments 400-1 and 400-2 by plant coordinate values.

WCS83S values were assigned to the photo control points by a two-point coordinate transformation. The 400 Area plant ground level coordinates and WCS83S values were used for 400-1 and 400-2 permanent monuments to transform 400 Area plant ground level coordinate values to WCS83S values.

For ground level coordinate system used in mapping, grid ticks, see attached formula.

400 AREA

K= 1.000199262 was used as the scale factor on the 400 Area aerial mapping project when scaling state plane coordinate system. This factor best fit the field level measurements.

100 AREAS

K= 1.000104866 was used as the scale factor for the same reason as the 400 Area.

*Note: To arrive at the ground level coordinate system, you must first translate and then scale.

From LAMBERT to Ground Level

$$N_G = (N_L - 83{,}000) \times K$$

$$E_G = (E_L - 545{,}000) \times K$$

KAISER ENGINEERS HANFORD

SURVEY DATA REPORT

Request No. — 9 0 2 — 1 1 1

Project/W.O. No. ER0775

Title 400 AREA AERIAL MAPPING

File No. 1 2 2 7 — 0 0 6

KEH Job No. ER0775

Prepared By Vern Coyne

Date 6/18/90

Reviewer Michael W. Polster

DESCRIPTION OF WORK

Horizontal & vertical data of the aerial photo control points.
Horizontal and Vertical control are in Meter's.

ACCEPTABILITY (Within Plan Tolerance)

Yes —
No —
NA X
TBD by Requestor —

DISTRIBUTION

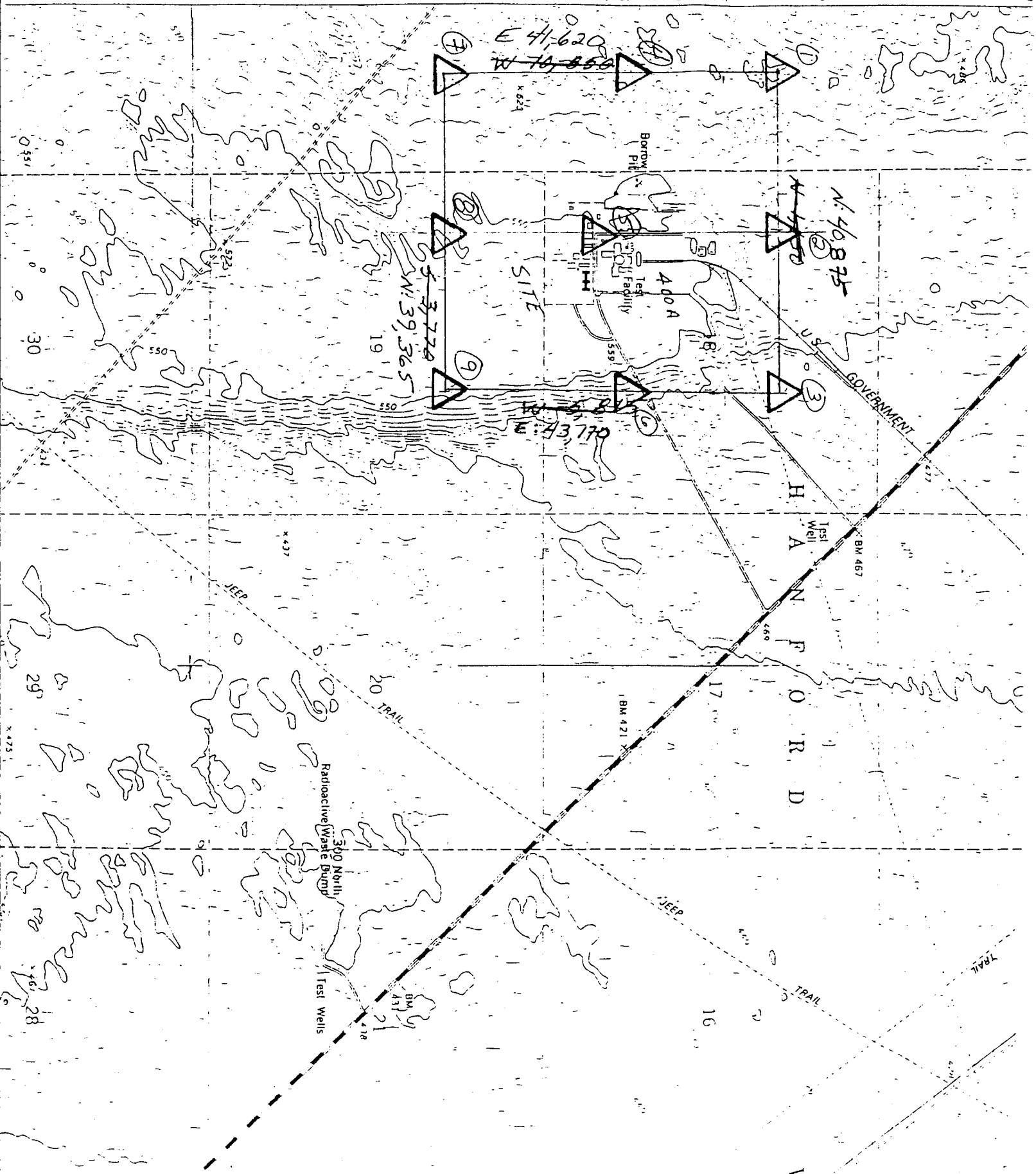
Survey File 1 OR.
Field Project File 0
G. Evans 1

SURVEY RESULTS AND COMMENTS

AERIAL PHOTO CONTROL POINTS	COORDINATES WCS83S	COORDINATES GROUND LEVEL COORDINATES METERS	ELEVATIONS NGVD 1929 METERS
1	N:123,361.469 E:586,618.348	N:40,869.610 E:41,626.641	153.723
2	N:123,363.541 E:587,385.530	N:40,871.683 E:42,393.976	157.533
3	N:123,365.612 E:588,152.712	N:40,873.755 E:43,161.311	143.723
4	N:123,123.583 E:586,615.297	40,131.577 E:41,623.589	156.735
5	N:123,031.741 E:587,375.257	N:40,039.718 E:42,383.701	165.705
6	N:123,115.952 E:588,154.736	N:40,123.946 E:43,163.336	167.305
7	N:122,362.150 E:586,622.397	N:39,369.992 E:41,630.691	156.021
8	N:122,364.222 E:587,389.579	N:39,372.065 E:42,398.026	166.367
9	N:122,366.293 E:588,156.761	N:39,374.137 E:43,165.361	172.645

1 DAY MAP CHECK
3 DAYS VER
3 DAYS HORIZ
1 DAY PANAL

ATTACHMENT #3



Attachment F: 100 Areas Fly-over Specifications Package

KAISER ENGINEERS HANFORD	SURVEY DATA REPORT	Request No. — —
Project/W.O. No.	Title: 100 AREAS AERIAL MAPPING	File No. 6 0 0 A — 0 3 3
KEH Job No. ER 2704	Prepared By: KLINE R WELSCH	Date: 4/3/92
		Reviewer: V. Coyne

DESCRIPTION OF WORK	ACCEPTABILITY (Within Plan Tolerance)	DISTRIBUTION	
100 Areas fly-over specifications	Yes ☐	Survey File	OR
	No ☐	Field Project File	
	NA ☒	R. Fox	1
	TBD by Requestor ☐		

SURVEY RESULTS AND COMMENTS

ATTACHMENT #1: Mapping specifications for the 100 Areas aerial mapping projects.

ATTACHMENT #2: Method of establishing horizontal data on aerial photo control points.

ATTACHMENT #3: Listing of aerial photo points for the 100 Areas mapping. Sketch showing target configuration.

ATTACHMENT #4: Maps indicating verification by random sampling. Check profiles were done on several sheets throughout project.

AERIAL MAPPING ESTIMATE

1. SCALE: Maps shall be drawn to a scale of 1:2000 with a contour interval of .5 meters. Horizontal and vertical will be in meters.

2. AREA TO BE MAPPED: 100 areas. See attachment A1 thru A5.

3. MAP FORMAT:

   a. Printed on Hanford standard-sized sheets (28"x40").

   b. Minimum margin of 1 inch around the borders.

   c. Provide Kaiser Kaiser Engineers Hanford (KEH) title block across the bottom right hand corner (within border) of the map.

   d. North shall be oriented up on the maps (parallel with the short dimension on the map sheets).

   e. Where necessary, map sheets shall be produced as a series with match lines to adjacent sheets. For map series, an index sheet will be provided to show the relative location of each map sheet. Graphic scale, contour interval, vertical and horizontal datum shall be included.

   f. Washington State Coordinate Grid Lines (NAD 83) with Plant Grid Ticks shall be shown on all maps. Grid ticks shall also be shown for the 100K and 100N local grid systems.

   g. Two sets of maps will be provided on double matte mylar.

   h. Maps will be signed and stamped by a licensed Land Surveyor or Engineer as to the accuracy of the maps.

   i. Data will be supplied to KEH in AutoCAD or compatible format such that maps can be generated or modified using AutoCAD software. See Attachment B.

4. PHOTOGRAPHY: Three sets of contact photographs and all negatives shall be delivered to KEH.

5. PREMARK REQUIREMENTS MUST BE SUBMITTED FOR THE FOLLOWING:

   a. Size of targets.
   b. Spacing for horizontal and vertical targets.
   c. Configuration of targets.

KEH Survey will provide ground control needed, and would like to minimize the number of targets required to do the job. This should be kept in mind when planning the overall job.

6. ACCURACY: Maps shall meet minimum standards as prescribed in the following two documents.

   a. Section 14, Compendium of Superfund Field Operations Methods, U.S. EPA, 12/87.
   b. The National Map Accuracy Standards.

   A statement shall placed on the map indicating compliance with these standards.

7. SCHEDULE: Maps are needed by August 31, 1990.

ATTACHMENT #1

~~ATTACHMENT "B"~~

SUBJECT: DATA FILES

In order to process data produced by mapping contractors, Kaiser Engineers Hanford Company (KEH) must receive the data in one of the two following formats:

1. "Autocad" Release 10.0 drawing files.
2. Drawing interchange files (DXF).

The data files shall be delivered on 20 Mb Bernoulli removable cartridges or on 360 kb, 1.2 Mb, 5.25" floppy disks, depending on file size.

The data files shall be able to be processed by an IBM-AT compatible personal computer using the MS-DOS Version 3.2.

All coordinate data shall be referenced to the single origin of the coordinate system, not to a local origin for each map sheet or file. The object is to be able to "window" any given area within the entire drawing using "real world" coordinates. Any questions at all about this, please call Alan Lewis, (509) 373-2615.

ATTACHMENT #1

~~ATTACHMENT C~~

SECTION 14

LAND SURVEYING, AERIAL PHOTOGRAPHY, AND MAPPING

14.1 SCOPE AND PURPOSE

This section provides information for use in the planning and implementation of land surveying, aerial photography, and mapping for hazardous waste sites.

14.2 DEFINITIONS

Azimuth
: A horizontal direction expressed as an angular distance between the direction of a fixed point and the direction of the depth.

Bearing
: The direction of one point with respect to another on the compass.

Bench Mark
: A mark on a permanent object indicating elevation and serving as a reference in topographic surveys.

Second (")
: The 60th part of a minute of angular measurement.

Site Manager (SM)
: The individual responsible for the successful completion of a work assignment within budget and schedule. This person is also referred to as the Site Project Manager or the Project Manager and is typically a contractor's employee (see Subsection 1.1).

Third-Order Plane Survey
: The lowest level of accuracy used in topographic mapping, usually limited to small-scale projects.

Transit
: A theodolite with the telescope mounted so that it can be transited; a surveyor's instrument.

Traverse
: A series of connected lines of known length related to one another by known angles.

14.3 APPLICABILITY

This section focuses on the methods of obtaining maps through field surveys, property surveys, surveys of monitoring wells, aerial photography, and photogrammetric mapping. In performing these methods, other survey requirements may need to be fulfilled (e.g., monument construction, boundary surveys, and time / method / accuracy / cost considerations of using an electronic distance meter instrument). Other surveying and mapping methods include plane table and alidade mapping, transit-stadia mapping, three-wire leveling, and trigonometric leveling. While these methods may have applications on a specific site, the methods discussed below apply to all mapping activities conducted for the U.S. EPA at hazardous waste sites.

14.4 RESPONSIBILITIES

It is the responsibility of the survey and mapping task leader to ensure that the proper techniques are followed throughout the project.

14.5 RECORDS

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed / wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Graphite pencils or water proof ballpoint pens should be used. Erasing is not acceptable; use a single strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Palford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work.

Aerial photography film annotation should include, at a minimum, the date of exposure, flight number, and exposure number. Additional information would include radar and barometric altitude, time, latitude, longitude, heading, pitch, roll, and drift angles.

Photogrammetric mapping should be in ink on mylar or scribed; maps should be 22 inches by 34 inches or as directed by the survey and mapping task leader.

14.6 PROCEDURES

14.6.1 Surveying—General

Survey requirements may necessitate survey accuracies of the third order; however, the second order may be required on some occasions and lower accuracies on other occasions. For the majority of sites, all surveys shall be third-order plane surveys as defined in the standards and specifications in Exhibit 14-1.

Third-order plane surveys and horizontal angular measurements should be made with a 20-second or better transit. Angles should be doubled, with the mean of the doubled angle within 10 seconds of the first angle. Distance measurements should be made with a calibrated tape corrected for temperature and tension or with a calibrated electronic distance meter instrument (EDMI). When using EDMI, the manufacturer's parts per million (ppm) error continues to be applied, as well as corrections for curvature and refraction.

14.6.1.1 Third-Order Vertical Survey

Land surveys are to be completed by a surveyor who is licensed and registered in the state where the survey is conducted. When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent bench mark. If possible, level circuits should close on a bench mark whose elevation is known (other than the starting bench mark). If the circuit closes on the original bench mark, the last point in the circuit must be used as a turning point. The following criteria should be met in conducting the survey:

Exhibit 14-1
STANDARDS FOR THIRD-ORDER PLANE SURVEYS

Principal Use:
Small engineering projects and small-scale topographics mapping.

Traverse	
Number of bearing courses between azimuth checks	30 to 30 [30]*
Astronomical bearings: standard error of results	8".0 [6".0]*
Azimuth closure at azimuth checkpoint not to exceed (use the smaller value)	30" $\sqrt{N}$ or 8".0 per station [20" $\sqrt{N}$]*
Standard error of the mean for length measurements	1 in 30,000 [1 in 20,000]*
Position closure per loop in feet after azimuth adjustment	1:5,000 checkpoint or 3.34 $\sqrt{M}$, whichever is smaller
Leveling	
Levels of error of closure per loop in feet	0.05 $\sqrt{M}$

*Figures in brackets are commonly used in preparing specifications for bid.

N = then number of stations for carrying bearing
M = the distance in miles

- Instruments should be pegged regularly.
- Rod levels should be used.
- Foresight and backsight distances should be reasonably balanced.
- No side shot should be used as a turning point in any level loop.
- Elevation readings should be recorded to 0.01 foot and estimated to 0.005 foot using a calibrated rod.

Temporary monuments should be set and referenced for future recovery. All monuments should be described in the field notes and should consist of a permanent mark scribed on facilities such as sidewalks, paved roads, or curbs. Sufficient description should be provided to facilitate their recovery.

14.6.1.2 Property Surveys

All property surveys should be performed in accordance with good land surveying practices and should conform to all pertinent federal and state laws and regulations governing land surveying in the area where the work is being accomplished. The surveyor shall be licensed and registered in the state where the survey is conducted.

Upon completion of the project, all original field note books, computations, and pertinent reference materials should be delivered to the SM for retention in the site file. The surveyor may keep photostatic copies of the material.

All field note reductions should be checked and marked in such a way that a visual inspection of the field notes will confirm that checks have been made. All office entries in field notebooks should be made in colored pencil.

The office worker who reduces or checks field notes should initial each page worked on in the color used on that page.

14.6.1.3 Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step one—Bearing closures will be computed and adjusted if within limits.
- Step two—Coordinate closures will be computed using adjusted bearings and unadjusted field distances.
- Step three—Coordinate positions will be adjusted if the traverse closes within the specified limits. The method of adjusting shall be determined by the surveyor.
- Step four—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.

- Step five—The direction and length of the unadjusted error of closure, the ratio of error over traverse length, and the method of adjustment should be printed with the final adjusted coordinates.

14.6.1.4 Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for that circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustment.

14.6.1.5 Monitoring Well Surveys

Monitoring well locations are surveyed only after the installation of the tamperproof locking cap well casing cover, which is set in concrete. The horizontal plane survey accuracy is ±1 foot (unless greater accuracy is desired) and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. Three elevations are measured, including the following:

- Top of the inner well casing (on the lip)
- Top of the outer protective casing (on the lip, not the cap)
- Finished concrete pad adjacent to the outer well casing

The point at which the elevation was measured should be scribed so that water level measurements may be taken at the same location. **Note:** The SM should ensure that the surveying party is given the keys to the locking cap before starting the survey.

14.6.2 Aerial Photography

Aerial photography for nonphotogrammetic use can be obtained from the following agencies:

- Environmental Monitoring System Laboratory (EMSL), Las Vegas, Nevada
- Environmental Photographic Interpretation Center (EPIC), Warrenton, Virginia
- National Cartographic Information Center, Reston, Virginia
- Soil Conservation Service, U.S. Department of Agriculture; Eastern or Western Laboratory, Asheville, North Carolina, or Salt Lake City, Utah, respectively

- Forest Service, U.S. Department of Agriculture, Washington, D.C. (for the eastern United States and Alaska), or the appropriate regional forester in Forest Service Regions 1-6 (Montana, Colorado, New Mexico, Utah, San Francisco, and Portland)

State and local transportation departments, zoning commissions, and planning divisions or local universities may also have useful aerial photographs. The EPA Enviropod, which consists of two 70-mm cameras mounted in a pod that can be attached to a light plane, is available through EPA regional offices. Aerial photographs may be obtained rapidly using the Enviropod and EPA photographic laboratories for developing the film. The photographs are not suitable for photogrammetric use. Photogrammetric aerial photography is usually contracted.

14.6.2.1 Contracting Aerial Photography

The following provisions should be included in the contract:

- **Business Arrangements**—These include such items as the cost of the aerial survey, posting of a performance bond, assumption of risks and damages, provision for periodic inspection of work, reflights, cancellation privileges, schedule for delivery and payments, and ownership and storage of negatives.

- **Area to be Photographed**—This includes location, size, and boundaries. These are ordinarily indicated on flight maps (1:24,000 scale) supplied by the purchaser.

- **Type of Photographic Film and Filter**—This includes such items as ASA exposure rating (ASA 100 is usually specified). The dimensional stability of the film base may also be specified.

- **Negative Scale**—The maximum scale deviation normally allowed is ±5 percent.

- **The Aerial Camera**—A National Bureau of Standards calibration report meeting U.S. Geological Survey standards for photogrammetric mapping is required. Other camera specifications include size of negative format, method of flattening film during exposure, type of shutter, focal length (usually 6 inches), distortion characteristics of the lens, and resolving power.

- **Position of Flight Lines**—Lines are to be parallel, oriented in the correct compass direction, and within a stated distance from positions drawn on flight maps.

- **Overlap**—This is usually set at 55 to 65 percent (the average is 60 percent) along the line of flight and 15 to 45 percent (the average is 30 percent) between adjacent lines. At the ends of each flight line, two photo centers should fall outside the boundary of the tract.

- **Print Alignment**—Crab or drift is not to affect more than 10 percent of the print width for any three consecutive photographs.

- **Tilt**—This should not exceed 2 or 3 degrees for a single exposure, or average more than 1 degree for the entire project.

- **Time of Photography**—The season of the year and the time of day (or minimum sun angle) are usually specified. The aerial photography should be conducted in the spring or fall when deciduous vegetation is bare and the ground is essentially free of snow cover. Ideal flight times are between 10:00 a.m. and 2:00 p.m. local standard time, or when the sun is at a minimum of 30 degrees above the horizon. Cloud or fog cover should not exceed 10 percent.

- Base Maps—If base maps or radial line plots are required, responsibility for ground control (field surveying) should be established.

- Film Processing—Included here are procedures for developing and drying negatives and for indexing and editing film rolls, plus a description of the type of photographic paper (weight, finish, and contrast) to be used.

- Quality of Negatives and Prints—Negatives and prints should be free from stains, scratches, and blemishes that detract from the intended use.

- Materials to be Delivered—Two sets of contact prints and one set of index sheets are usually supplied. A copy of the original flight log may also be specified. Additional items such as enlargements, mosaics, maps, or plan -and profile sheets should be listed in detail. One set of contact prints should be delivered to the project manager within 5 days of the date of the photography, unless otherwise spc. ied. The SM should arrange for additional sets of prints to be delivered at the same time if needed.

14.6.2.2 Photogrammetric Mapping

The scale of the mapping photography should be suitable for the preparation of a topographic map by photogrammetric methods at a scale and contour interval requested by the project, usually a 1" = 50' scale and 2-foot contour intervals. Larger a: · or areas with great differences in elevation may require a different scale.

Map accuracy shall meet or exceed the following minimum standards:

- For horizontal accuracy, 90 percent of all defined points should be within 1/ 40 inch of their true position, and 100 percent of all defined points should be within 1/ 20 inch of their true position.

- For vertical accuracy, 90 percent of all contours shall be within one-half of a contour interval, and 100 percent of all contours shall be within one contour interval. Ninety percent of all spot elevations should be accurate to within one-fourth of the contour interval, and all spot elevations should be within one-half of the contour interval.

- Mapping should show all planimetric features including, but not limited to, buildings, walks, roads, fences, ditches, trees, utility poles, tanks, drums, lagoons, pits, ponds, and other such features visible on the photograph, as well as contours and spot elevations on roads, dikes, and ditch inverts. Assemblages of containers (e.g., drums, laboratory bottles) may be indicated by a symbol rather than by depicting individual containers. The height and estimated number of such containers should be depicted within the symbol.

- All horizontal and vertical control points should be shown on the final map along with a tabulation of coordinates and elevations. The description, origin, and elevations of the bench marks used for the mapping control should be shown on the map.

- The horizontal coordinate system should be referenced to a local recoverable baseline at the site. The state plane coordinate system should be used when it is readily available near the site.

- Photographic control points must be kept outside the hazardous areas where possible.

- The map should show the basis of bearing, north arrow, date of photography, names of streets and highways, project number, project name, and a bar scale.

14.6.3 Remote Sensing

The standards for remote sensing imagery will be determined on a project specific and instrument-specific basis. Remote sensing data are used in environmental surveys and risk assessments. Methods include, but are not limited to, the following:

- Satellite photography (LANDSAT, Skylab)
- Radar (side-looking airborne radar, plan positive indicator)
- Thermal Imagery (Infrared detectors, line scanning, infrared photography)
- Multiband spectral imagery
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U.S. Geological Survey
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The size of the body of water will dictate the type of survey required to perform the necessary mapping. Surveys should conform to the requirements set forth in the *Hydrographic Survey Manual* by the U.S. Department of Commerce.

14.7 REGION-SPECIFIC VARIANCES

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

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Pafford, William F. *Handbook of Survey Notekeeping*.

Umbach, Melvin J. *Hydrographic Survey Manual*. 4th ed. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration.

ESTABLISHMENT OF HORIZONTAL DATA ON 100 AREAS
AERIAL PHOTO CONTROL POINTS

A horizontal control network was established by setting permanent control monuments in the vicinity of all the 100 areas. A conventional horizontal traverse of 19,533m in length, Traverse #1, was performed beginning at National Geodetic Survey (NGS) control station HAVEN through a portion of the control network ending at NGS control station BLEAKLEY. A second traverse of 16,685m in length, Traverse #2, was performed beginning at monument D-2. D-2 is a point in the first traverse through the remaining portion of the control network ending at BLEAKLEY. A traverse adjustment was performed on both traverses applying the Compass Rule Adjustment method and the Washington State Coordinate System of 1983, South Zone (WCS83S) was assigned. NGS control stations HAVEN, F-322, BLEAKLEY and GABLE were held as fixed for the traverse adjustment on WCS83S.

Traverse #1:

WCS83S closure: dN= -0.085m dE= 0.106m Σd= 19,533m 1:144,045

Traverse #2:

WCS83S closure: dN= -0.106m dE= 0.124m Σd= 16,685m 1:102,383

The photo control points were set in position as required by the photogrammetrist by using topographic features. The photo control points were surveyed from these traverses by single sideshot (angle and distance) with WCS83S assigned.

400 AREA

K= 1.000199262 was used as the scale factor on the 400 Area aerial mapping project when scaling state plane coordinate system. This factor best fit the field level measurements.

100 AREAS

K= 1.000104866 was used as the scale factor for the same reason as the 400 Area.

*Note: To arrive at the ground level coordinate system, you must first translate and then scale.

From LAMBERT to Ground Level

$$N_G = (N_L - 83{,}000) \times K$$

$$E_G = (E_L - 545{,}000) \times K$$

ATTACHMENT #3 235

KAISER ENGINEERS HANFORD

SURVEY DATA REPORT

Request No. —901—063

Project/W.O. No.	Title	File No.
ER0633	100 AREAS AREAS AERIAL MAPPING	600A—033

KEH Job No.	Prepared By	Date	Reviewer	
ER0633	Vern Coyne	6/16/90	G F Bryant	1 3

DESCRIPTION OF WORK

Horizontal & vertical data of the aerial photo control points

Horizontal & Vertical control are in Meter's.

ACCEPTABILITY (Within Plan Tolerance)

- Yes ☐
- No ☐
- NA ☒
- TBD by Requestor ☐

DISTRIBUTION

Survey File	OR
Field Project File	Ø
~~George Evans~~	1

SURVEY RESULTS AND COMMENTS

AERIAL PHOTO CONTROL POINTS	COORDINATES WCS83S	COORDINATES GROUND LEVEL COORDINATES METERS	AERIAL PHOTO CONTROL POINTS	COORDINATES WCS83S	COORDINATES GROUND LEVEL COORDINATES METERS
1	N:143,137.819 E:563,737.223	N: 60,144.124 E: 18,739.188	13	N:148,078.195 E:572,508.581	N: 65,085.019 E: 27,511.466
2	N:144,432.523 E:563,707.851	N: 61,438.964 E: 18,709.813	14	N:148,717.982 E:572,243.986	N: 65,724.873 E: 27,246.843
3	N:145,522.201 E:563,730.104	N: 62,528.756 E: 18,732.068	15	N:149,106.875 E:571,598.806	N: 66,113.807 E: 26,601.595
4	N:143,564.898 E:565,488.242	N: 60,571.248 E: 20,490.391	16		
5	N:145,353.648 E:565,488.904	N: 62,360.185 E: 20,491.053	17	N:149,683.130 E:574,458.668	N: 66,690.122 E: 29,461.757
6	N:143,195.449 E:566,391.676	N: 60,201.760 E: 21,393.920	18	N:150,337.927 E:573,022.686	N: 67,344.988 E: 28,025.624
7	N:144,732.456 E:566,117.158	N: 61,738.928 E: 21,119.373	19	N:150,808.620 E:572,019.877	N: 67,815.730 E: 27,022.710
8	N:144,381.354 E:567,266.271	N: 61,387.790 E: 22,268.606	20	N:149,845.425 E:574,911.579	N: 66,852.434 E: 29,914.716
9	N:145,955.465 E:567,216.578	N: 62,962.066 E: 22,218.908	21	N:151,334.033 E:574,333.574	N: 68,341.198 E: 29,336.650
10	N:145,144.404 E:568,357.981	N: 62,150.920 E: 23,360.431	22	N:152,031.457 E:573,131.116	N: 69,038.696 E: 28,134.066
11	N:146,648.592 E:570,694.172	N: 63,655.266 E: 25,696.867	23	N:150,748.971 E:575,940.421	N: 67,756.075 E: 30,943.665
12	N:147,332.165 E:569,644.584	N: 64,338.910 E: 24,647.168	24	N:151,750.101 E:575,267.477	N: 68,757.310 E: 30,270.651

KAISER ENGINEERS
HANFORD

FIELD SKETCH

Attachment To Or Description:
Attachment to survey data report dated 6/16/90

Sheet 2 of 3

AERIAL PHOTO CONTROL POINTS	COORDINATES WCS83S	COORDINATES GROUND LEVEL COORDINATES METERS	AERIAL PHOTO CONTROL POINTS	COORDINATES WCS83S	COORDINATES GROUND LEVEL COORDINATES METERS
25	N:152,513.447 E:574,073.562	N: 69,520.736 E: 29,076.610	41	N:150,940.452 E:579,842.385	N: 67,947.577 E: 34,846.039
26	N:151,528.168 E:576,991.044	N: 68,535.354 E: 31,994.398	42	N:145,394.330 E:580,121.020	N: 62,400.873 E: 35,124.703
27	N:152,097.671 E:577,228.228	N: 69,104.917 E: 32,231.607	43	N:146,430.269 E:580,640.518	N: 63,436.921 E: 35,644.256
28	N:153,344.066 E:575,535.887	N: 70,351.442 E: 30,539.089	44	N:147,967.048 E:581,127.707	N: 64,973.861 E: 36,131.496
29	N:154,138.046 E:574,432.469	N: 71,145.506 E: 29,435.555	45	N:146,452.992 E:581,278.346	N: 63,459.646 E: 36,282.151
30	N:152,635.650 E:578,197.924	N: 69,642.952 E: 33,201.405	46	N:147,075.993 E:581,951.038	N: 64,082.713 E: 36,954.913
31	N:153,577.822 E:577,328.832	N: 70,585.223 E: 32,332.222	47	N:147,404.350 E:582,274.596	N: 64,411.104 E: 37,278.505
32	N:154,324.315 E:576,101.295	N: 71,331.794 E: 31,104.556	48	N:146,555.685 E:581,924.237	N: 63,562.350 E: 36,928.109
33	N:154,545.384 E:574,927.373	N: 71,552.086 E: 29,930.511	K-1	N:146,614.984 E:568,272.354	N: 63,621.654 E: 23,274.795
34	N:148,549.114 E:576,721.221	N: 65,555.988 E: 31,724.547	K-2	N:145,853.370 E:568,663.461	N: 62,859.960 E: 23,665.943
35	N:149,369.338 E:577,454.664	N: 66,376.298 E: 32,458.067	K-3	N:146,380.644 E:569,641.329	N: 63,387.289 E: 24,643.913
36	N:150,917.586 E:578,222.200	N: 67,924.708 E: 33,225.684	K-4	N:147,095.971 E:569,275.608	N: 64,102.691 E: 24,278.154
37	N:151,524.926 E:579,393.043	N: 68,532.112 E: 34,396.649	JOE	N:148,999.863 E:571,478.414	N: 66,006.783 E: 26,481.191
38	N:147,187.172 E:578,428.433	N: 64,193.903 E: 33,431.939	16-A	N:149,050.694 E:570,781.829	N: 66,057.619 E: 25,784.533
39	N:147,942.937 E:579,008.438	N: 64,949.747 E: 34,012.004	BM		
40	N:149,586.492 E:579,499.790	N: 66,593.475 E: 34,503.408	ECC-A	N:145,316.671 E:563,776.921	N: 62,323.204 E: 18,778.890

KAISER ENGINEERS
HANFORD

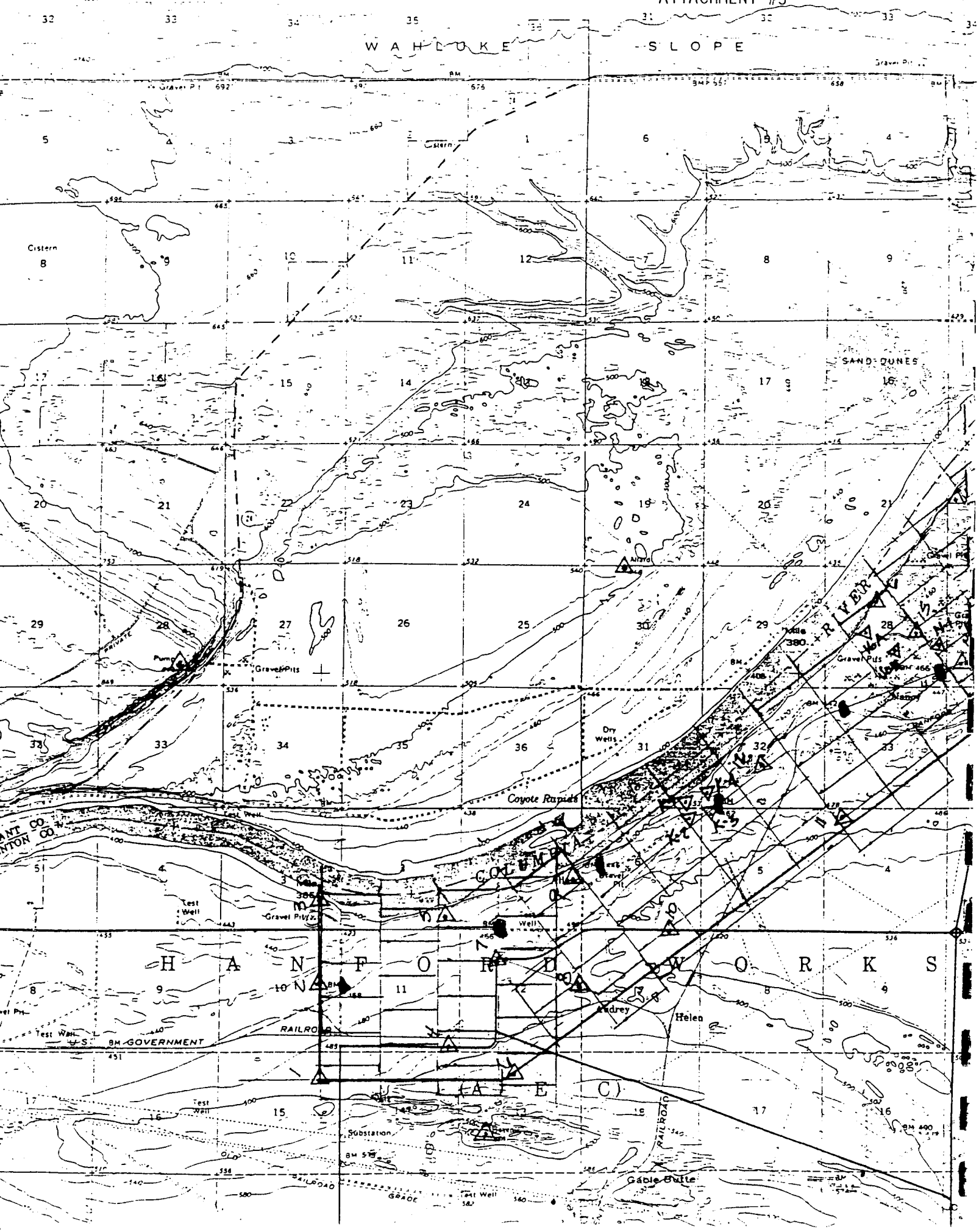
FIELD SKETCH

Attachment To Or Description:
Attachment to survey data report dated 6/16/90

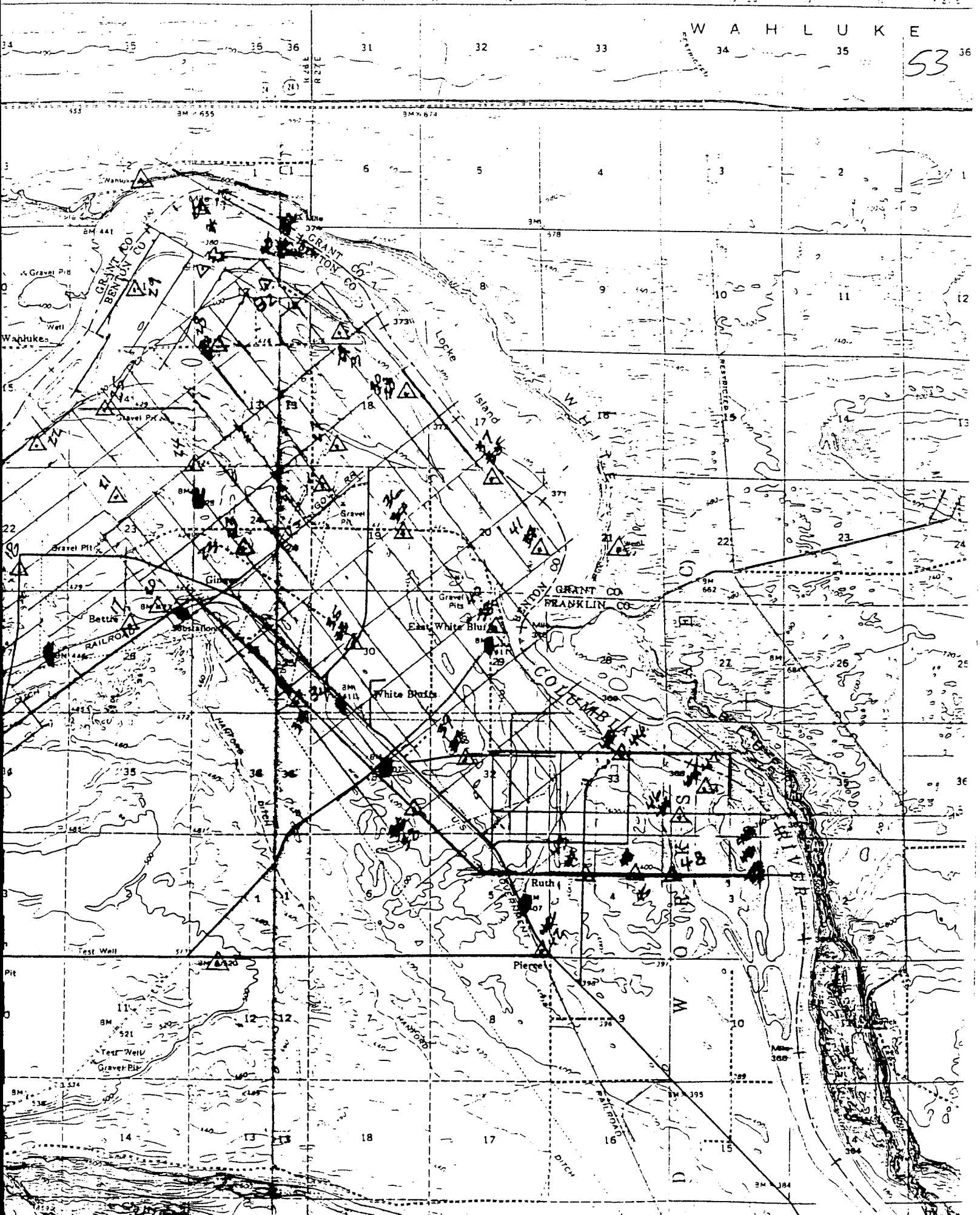
Sheet 3 of 3

AERIAL PHOTO CONTROL POINTS	ELEVATIONS NGVD 1929 METERS	AERIAL PHOTO CONTROL POINTS	ELEVATIONS NGVD 1929 METERS	AERIAL PHOTO CONTROL POINTS	ELEVATIONS NGVD 1929 METERS
1	149.538	22	141.382	43	123.594
2	137.102	23	128.696	44	119.613
3	121.180	24	129.568	45	123.155
4	148.112	25	130.820	46	118.174
5	133.878	26	127.035	47	112.974
6	160.383	27	124.240	48	122.761
7	146.344	28	123.411	K-1	125.813
8	151.425	29	118.723	K-2	152.568
9	132.597	30	126.648	K-3	149.422
10	156.268	31	124.285	K-4	135.706
11	149.840	32	118.266	JOE	141.089
12	138.422	33	118.951	16-A	137.864
13	140.501	34	125.441	BM	142.007
14	140.486	35	125.874	ECC-A	131.448
15	141.053	36	127.029		
16		37	119.055		
17	130.668	38	123.167		
18	143.942	39	125.547		
19	144.555	40	118.421		
20	128.412	41	118.833		
21	139.260	42	124.688		

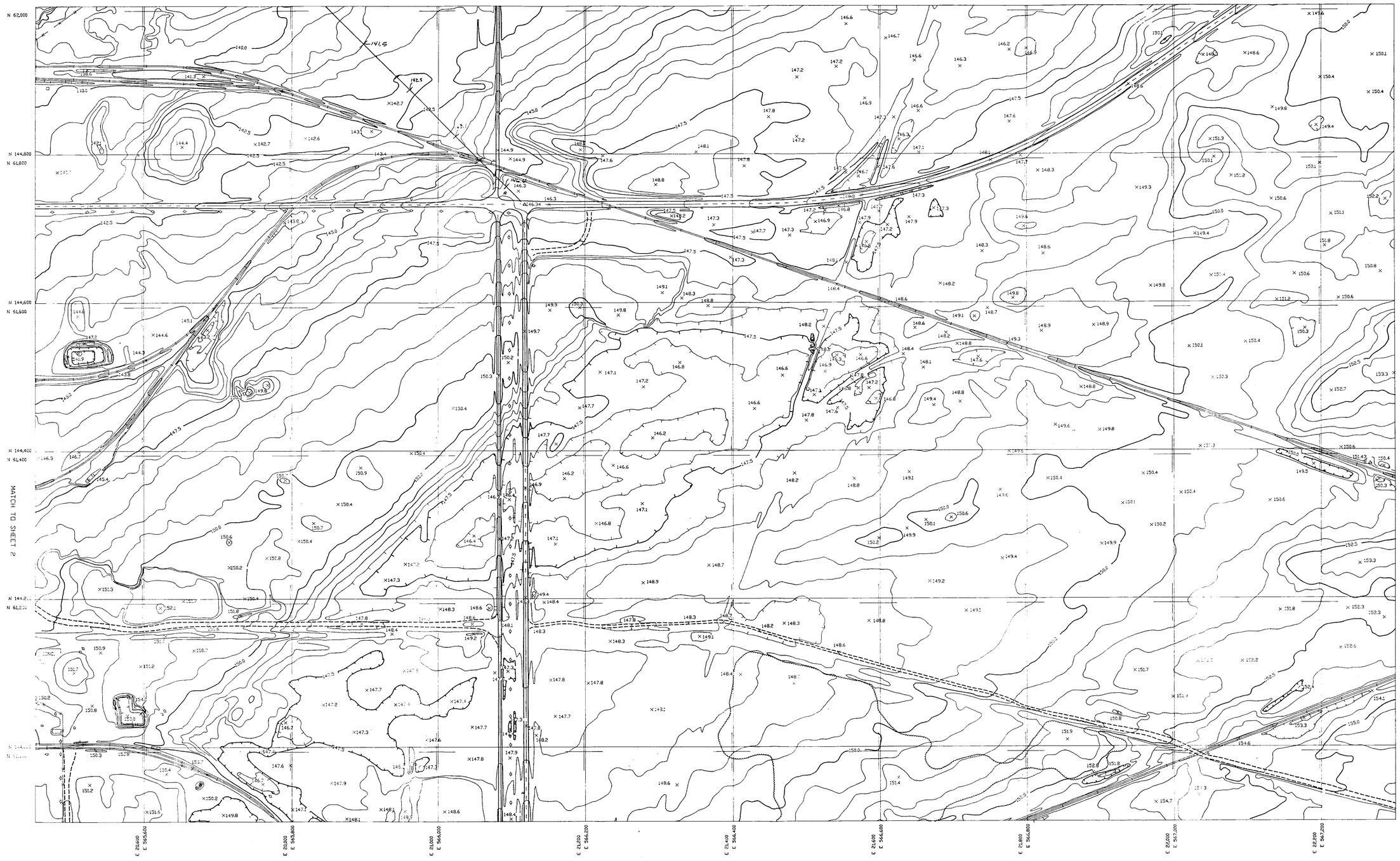
ATTACHMENT #3



ATTACHMENT #3



MATCH TO SHEET 6



MATCH TO SHEET 2

MATCH TO SHEET 8

MATCH TO SHEET 4

State of California
Photogrammetric Surveyor
William E. Brown
WILLIAM E. BROWN, NO. 133

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE — 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE
DRAWING TRACEABILITY LIST	

NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD FOR IMPL/PHC FOR DATE
REVISIONS						

CAD FILE 91103305.DWG. CAD CODE

		DATE
DRAWN		
CHECKED	KEH SURVEY	
SAFETY	N/A	
ENVIR	N/A	
QC	N/A	
LEAD ENG APVD		

APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL | EDT

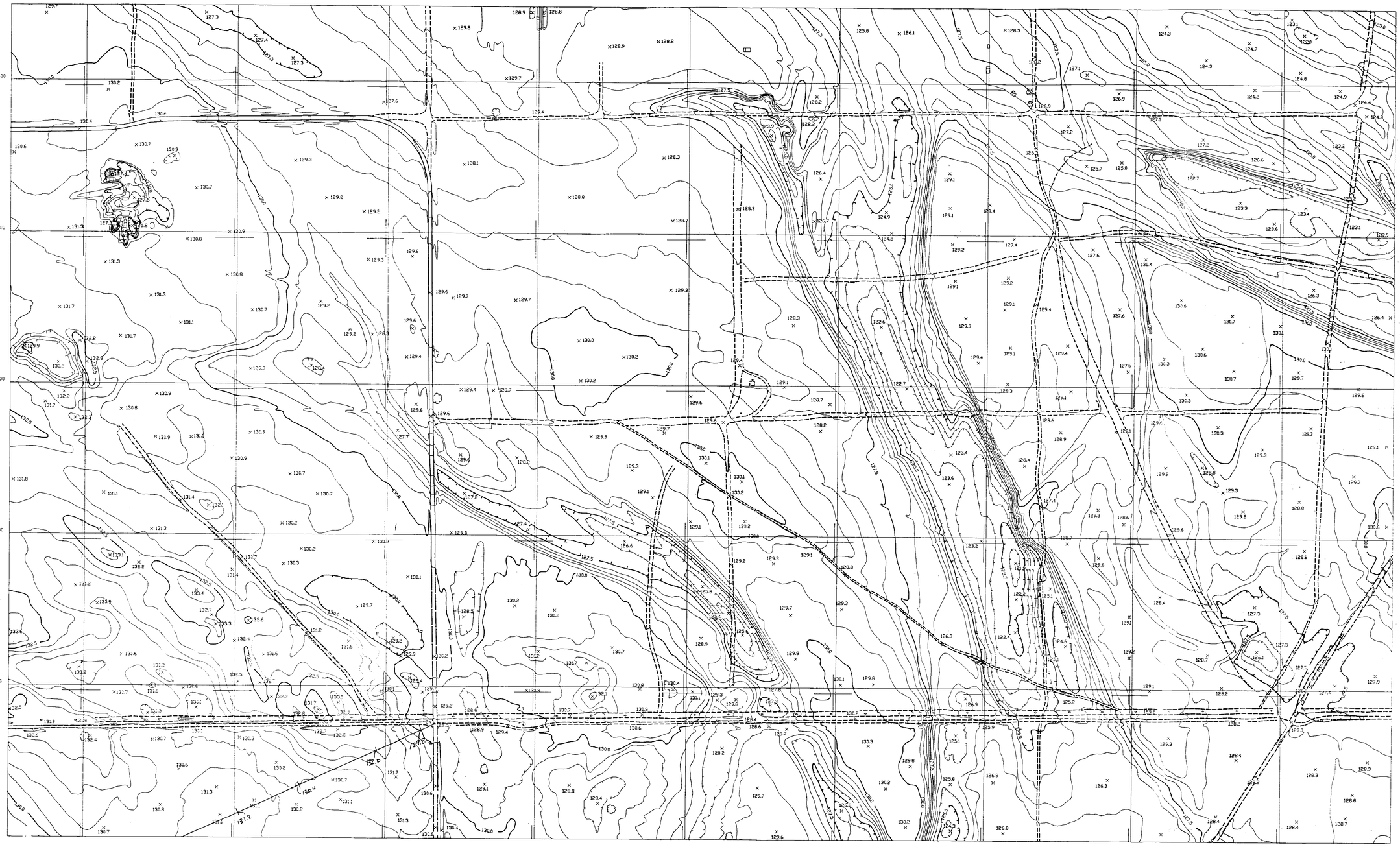
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

PROJECT				
SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0
SCALE 1:2000	JOB NO. ER-0633	SHEET 5 of 55		

KEHCAD

MATCH TO SHEET 34



MATCH TO SHEET 32

State of California
Photogrammetric Surveyor
William E. Brown
WILLIAM E. BROWN, NO. [illegible]

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE
DRAWING TRACEABILITY LIST	

NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE
REVISIONS					

CAD FILE 91103333.DWG. CAD CODE

DRAWN	DATE
CHECKED	KEH SURVEY
SAFETY	N/A
ENVIR	N/A
QC	N/A
LEAD ENG APVD	
BY	APPROVED FOR IMPLEMENTATION
FOR	DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

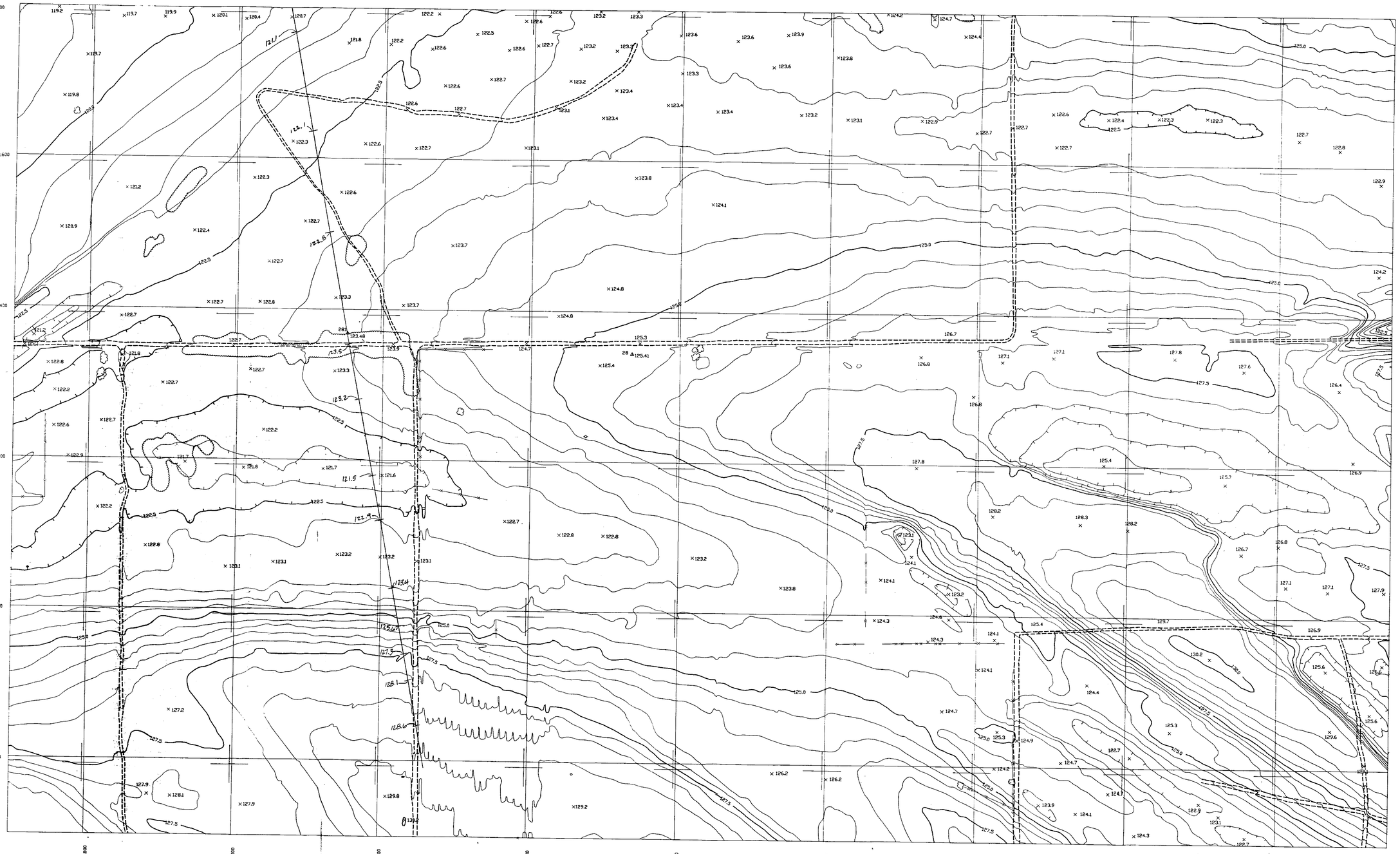
100 AREAS TOPOGRAPHIC MAPPING

PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0
SCALE 1:2000		JOB NO. ER-0633	SHEET 33 OF 55	

KEHCAD

MATCH TO SHEET 35



MATCH TO SHEET 28

MATCH TO SHEET 42

MATCH TO SHEET 33

State of California
Photogrammetric Surveyor
William E. Brown
WILLIAM E. BROWN, NO. 103

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE — 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPL/IWC FOR DATE
REVISIONS					
CAD FILE 91103334 DWG.		CAD CODE			

		DATE
DRAWN		
CHECKED	KEH SURVEY	
SAFETY	N/A	
ENVIR	N/A	
QE	N/A	
LEAD ENG APVD		
APPROVED FOR IMPLEMENTATION		
BY		
FOR		DATE

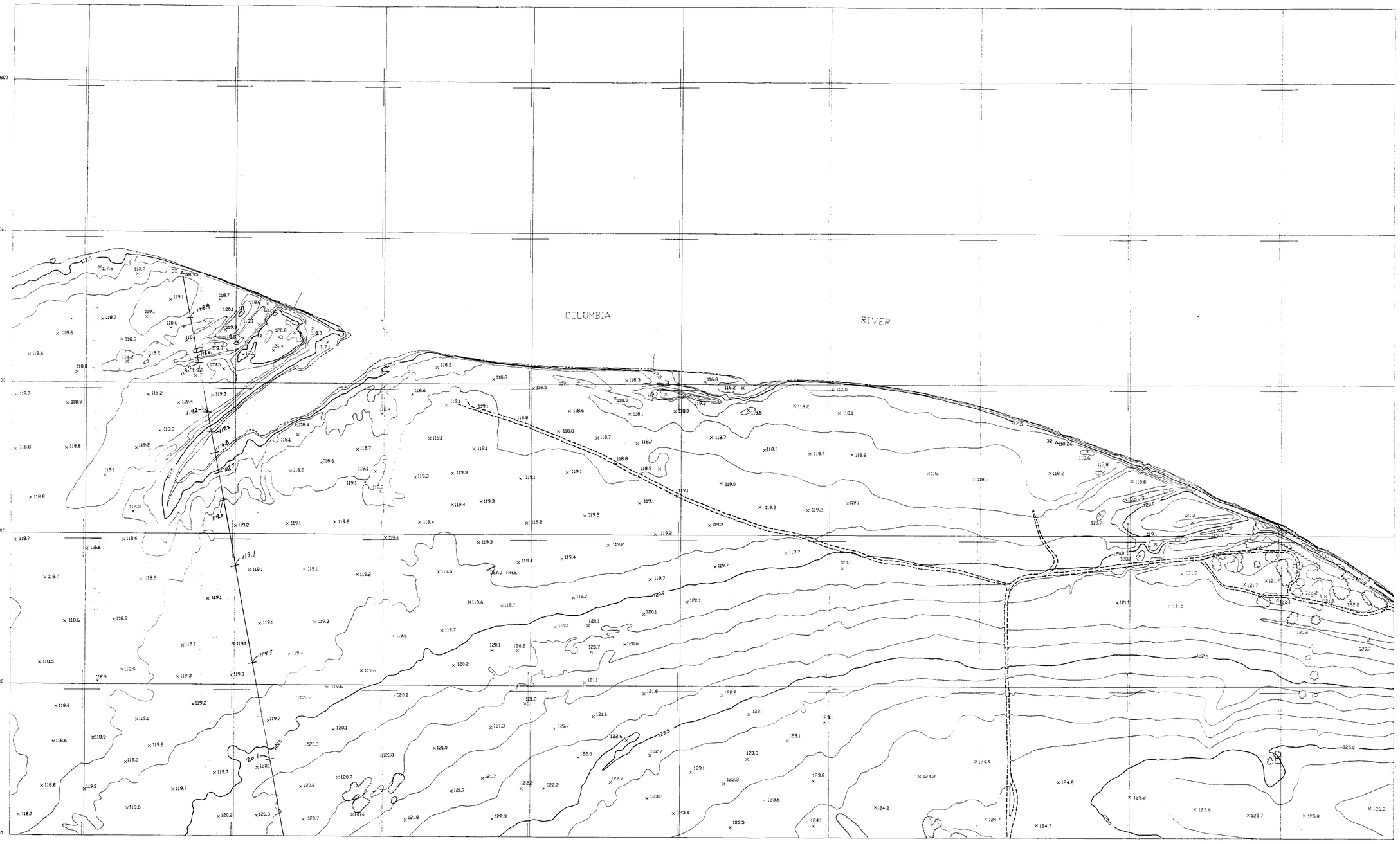
IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

PROJECT				
SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0
SCALE 1:2000		JOB NO. ER-0633	SHEET 34 OF 55	

KEHCAD



State of California
Photogrammetric Surveyor
William E. Brown
WILLIAM E. BROWN, NO. 103

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE — 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	

MF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD FOR IMP. INC FOR DATE
REVISIONS						

CAD FILE 91103335.DWG CAD CODE

DRAWN	DATE	
CHECKED	KEH SURVEY	
SAFETY	N/A	
ENVIR	N/A	
QC	N/A	
LEAD ENG APVD		

APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

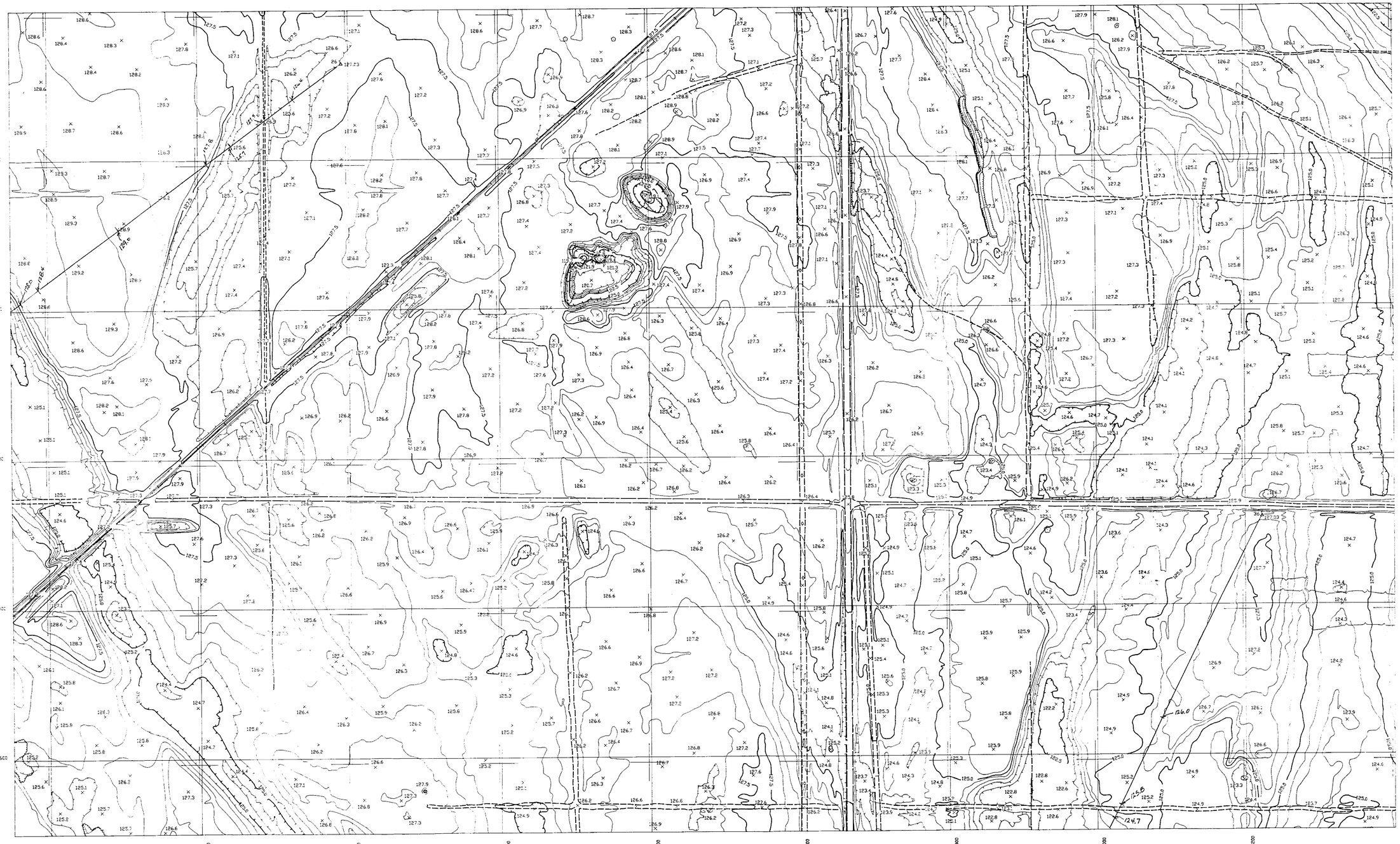
PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0

SCALE 1:2000 JOB NO. ER-0633 SHEET 35 of 55

KEHCAD

MATCH TO SHEET 41



MATCH TO SHEET 39

State of California
Photogrammetric Surveyor
William E. Brown
WILLIAM E. BROWN No. [illegible]

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

MF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD FOR IMPL/DATE FOR DATE
REVISIONS						

CAD FILE 91103340. DWG. CAD CODE

		DATE
DRAWN		
CHECKED	KEH SURVEY	
SAFETY	N/A	
ENVIR	N/A	
QC	N/A	
LEAD ENG APVD		

APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

PROJECT					
SIZE	BLDG NO.	INDEX NO.	DWG NO.		REV NO.
F	N/A	N/A	H-1-52166		0
SCALE 1:2000			JOB NO. ER-0633	SHEET 40 of 55	

KEHCAD

SHEET INDEX

7	8
5	6
3	4
1	2

200 METERS

0 CENTIMETERS

NOTES

MAP CONTROL SURVEYS BY KAISER ENGINEERS, HANFORD.

COMPILED BY PHOTOGRAMMETRIC METHODS FROM 1:8100 SCALE AERIAL PHOTOS DATED 10-30-89.

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS AND SECTION 14 COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA 12-87.

DAVID S. SWANSON — STATE OF WASHINGTON — REGISTERED — PROFESSIONAL LAND SURVEYOR

NUMBER	TITLE
DRAWING TRACEABILITY LIST	

NUMBER	TITLE
DRAWING LIST	
REFERENCES	
NEXT USED ON	

MICROFILMED

BY-DATE	BY-DATE	REV BY DATE	DESCRIPTION	REV
APPROVAL	KEH APPROVAL	REVISIONS		
COMMENT REVIEW				

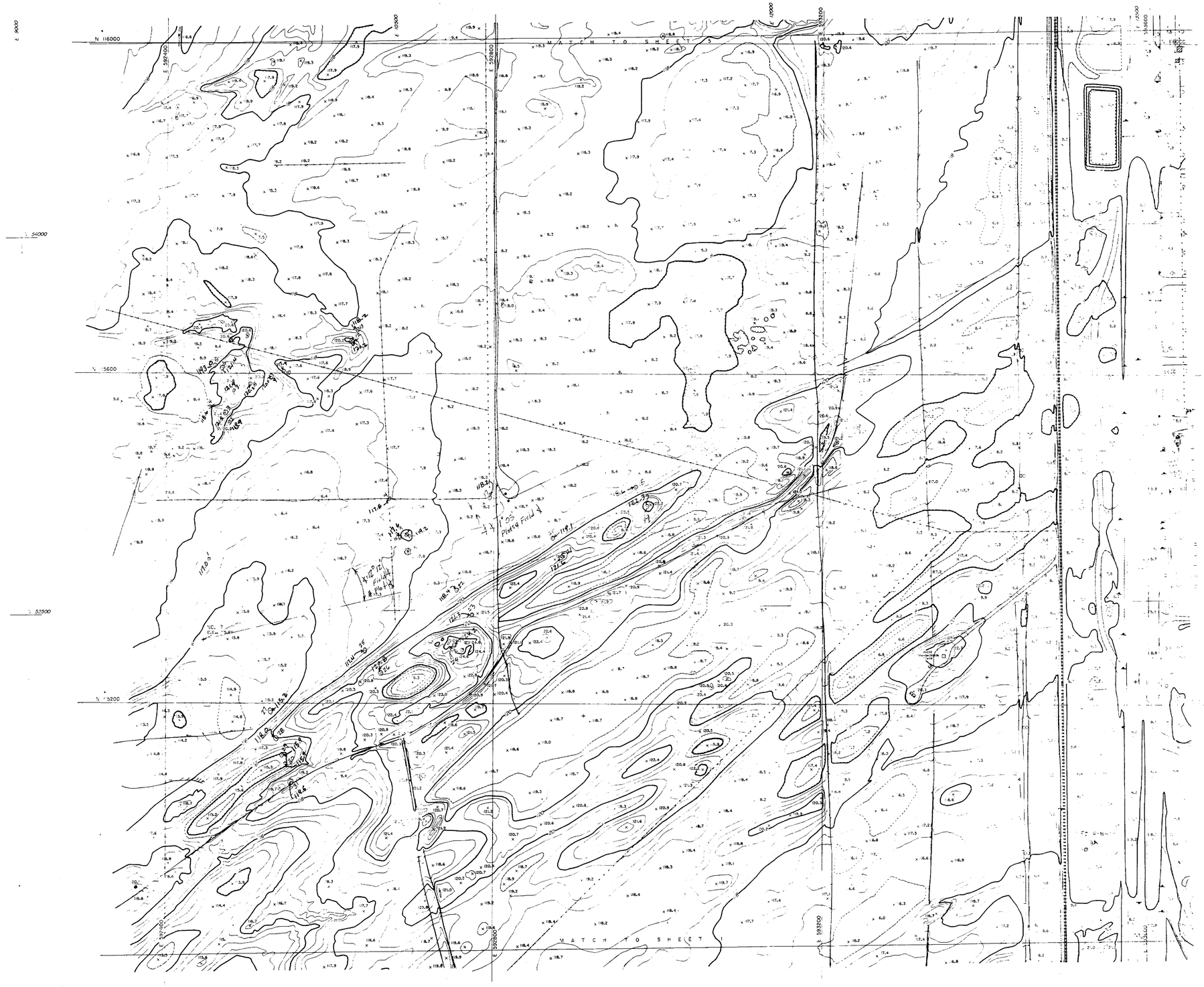
APPROVAL BY	DATE
PROJ. ENGR	
QA	
APPROVED BY	
SAFETY	
APPROVED BY	
CHECKED BY	
DRAWN BY	
DES SHED BY	

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

300 AREA CONTOUR CHECK

PROJECT TITLE		
PROJ.	AO	JOB
SCALE	BLDG	INDEX

DRAWING NUMBER	SHEET	OF	REV
	8	8	



SHEET INDEX

7	8
5	6
3	4
1	2

METERS

CENTIMETERS

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

300 AREA CONTOUR CHECK

NOTES

MAP CONTROL SURVEYS BY KAISER ENGINEERS, HANFORD.

COMPILED BY PHOTOGRAMMETRIC METHODS FROM 1:8100 SCALE AERIAL PHOTOS DATED 10-30-89.

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS AND SECTION 14 COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA 12-87.

DAVID S. SWANSON
STATE OF WASHINGTON
REGISTERED
PROFESSIONAL LAND SURVEYOR

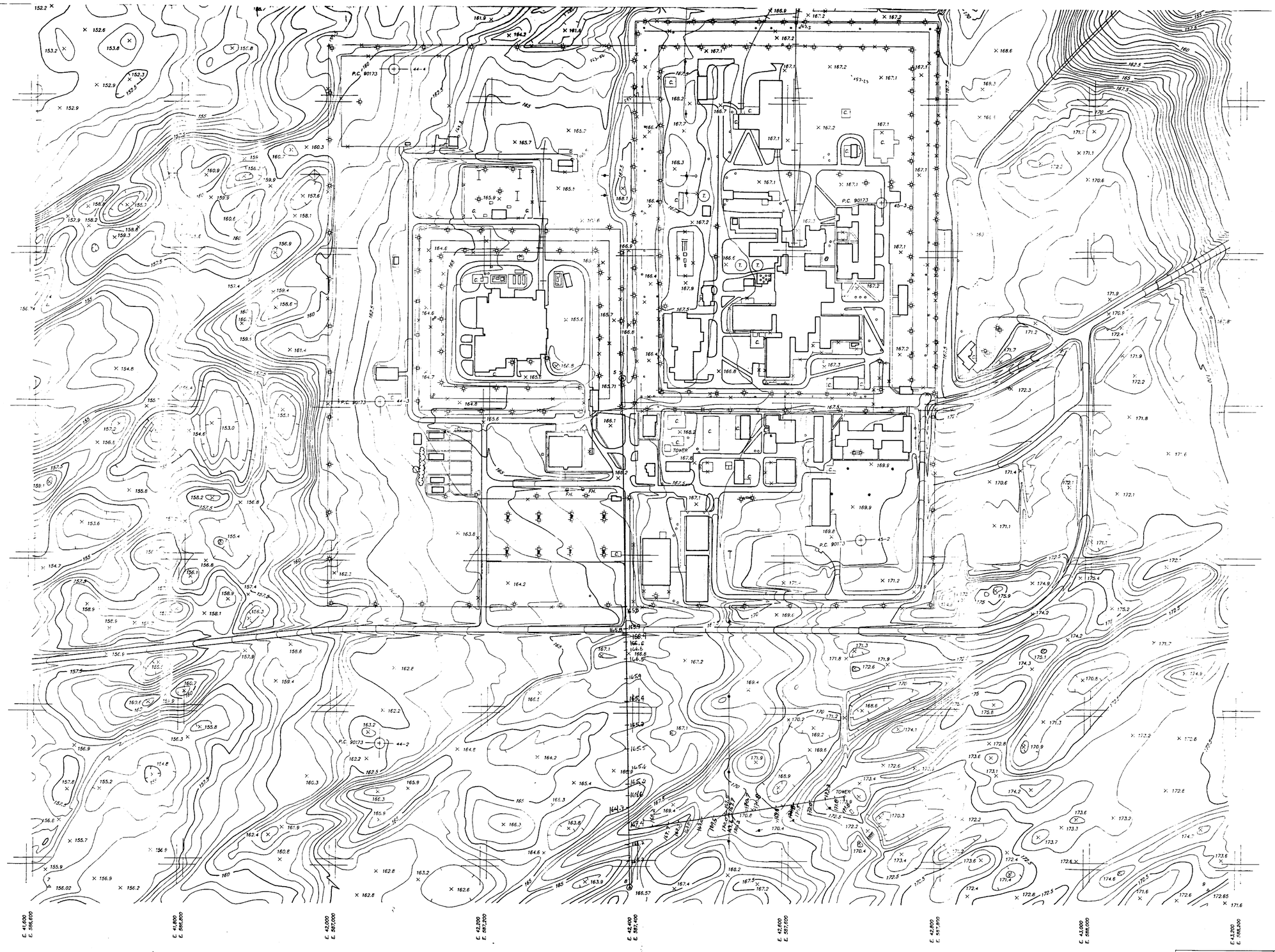
NUMBER	TITLE
	DRAWING TRACEABILITY LIST

NUMBER	TITLE
	DRAWING LIST
	REFERENCES
NEXT USED ON	

MICROFILMED	BY-DATE	BY-DATE	REV. BY DATE	DESCRIPTION
	APPROVAL	KEH APPROVAL		
	COMMENT REVIEW			

REVISIONS

SHEET 3 OF 8



NUMBER	TITLE
DRAWING TRACEABILITY LIST	

NUMBER	TITLE
NEXT USED ON	REFERENCES

MF	REV NO.	DESCRIPTION	REV BY / DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE
REVISIONS					

CAD FILE | CAD CODE

	DRAWN	DATE
	CHECKED	
	SAFETY	
	ENVIR	
	QC	
	LEAD ENG APVD	

APPROVED FOR IMPLEMENTATION:
BY
FOR DATE

IMPACT LEVEL | EDT

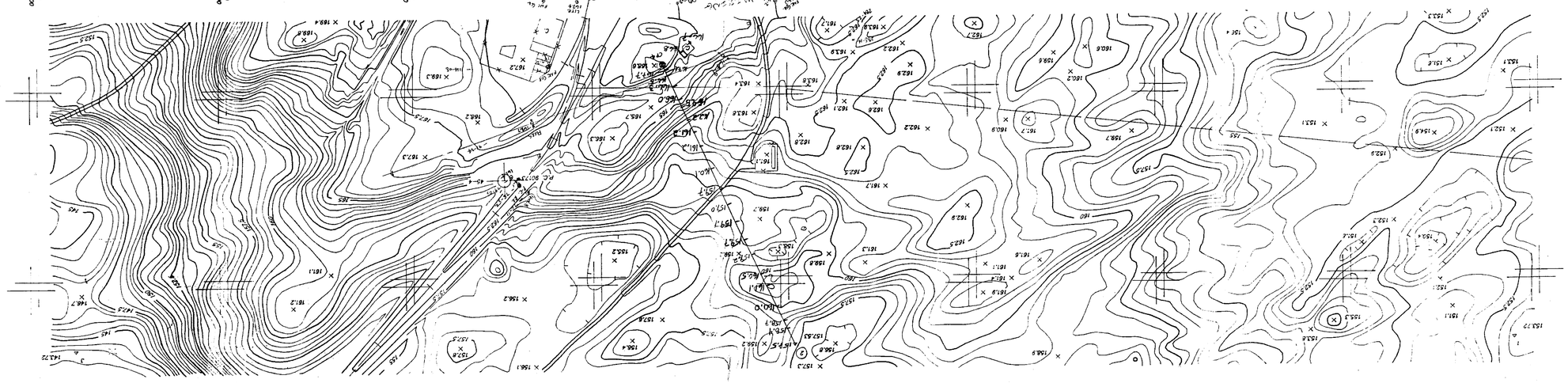
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F				

SCALE | JOB NO. | SHEET | OF

KEHCAD



NUMBER	TITLE

DRAWING TRACEABILITY LIST

NUMBER	TITLE

REFERENCES

NEXT USED ON

MF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD FOR BDN/JNC FOR DATE

REVISIONS

CAD FILE | CAD CODE

APPROVED FOR INTERPRETATION

BY | DATE | FOR

DRAWN | DATE
CHECKED
SAFETY
DRAWN
QC
LEAD EHO APVD

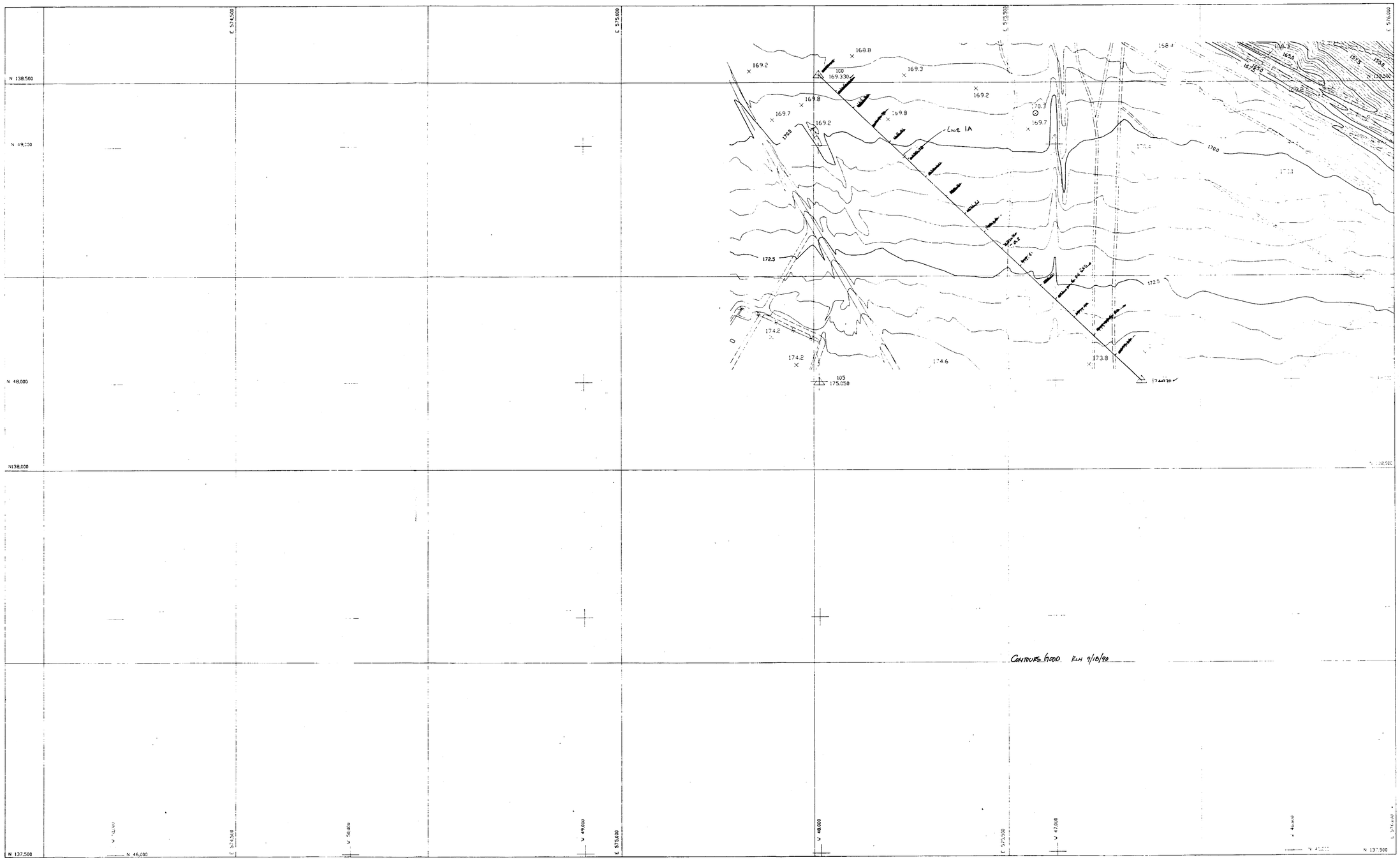
PROJECT | BLDG NO. | INDEX NO. | DWG NO. | REV NO.

SCALE | JOB NO. | SHEET | OF

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

BAPCT LEVEL | EDT

KEHCAD



SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NOTE:

GRID LINES REPRESENT NAD1983 METRIC COORDINATES

GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Date of Photography: May 3, 1990

THIS MAP HAS BEEN PREPARED TO MEET A.S.P. NATIONAL MAP ACCURACY STANDARDS. HOWEVER, IN AREAS OF DENSE VEGETATION, CONTOURS AND PLANIMETRIC DETAIL MAY NOT MEET THESE STANDARDS. SUCH AREAS SHOULD BE FIELD CHECKED BEFORE FINAL DESIGN.

DEGROSS AERIAL MAPPING
17520 BOTHELL WAY N.E.
BOTHELL, WASH. 98011
Phone (206) 487-2225

JOB# 90-487
SHEET 1 / 6

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV. NO.	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPLNG FOR DATE
REVISIONS					
CAD FILE		CAD CODE			

DRAWN DEGROSS MAPPING DATE MAY 3 1990
CHECKED
SAFETY NA
ENGR NA
X NA
LEAD ENG APVD
APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

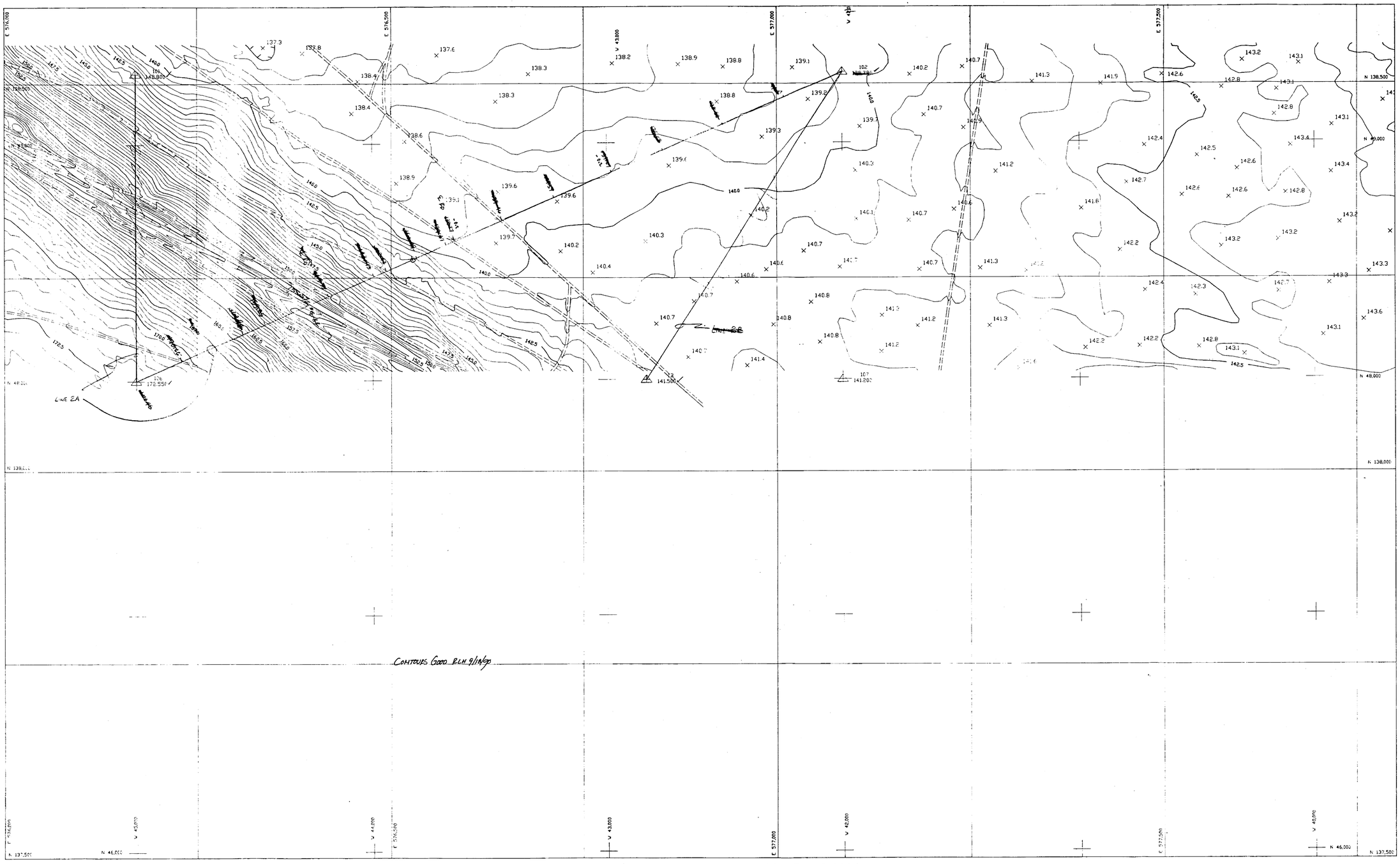
200 E MAPPING EXTENSION

PROJECT ECRA TOPOGRAPHIC MAPPING

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	NA	NA	H-2-82096	0

SCALE 1 : 2,000 JOB NO. ER 0275 SHEET 1 OF 6

KEHCAD



SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NOTE:
GRID LINES REPRESENT NAD1983 METRIC COORDINATES
GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Date of Photography: May 3, 1990

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DEGROSS AERIAL MAPPING
17520 BOTHELL WAY N.E.
BOTHELL, WASH. 98011
Phone (206) 487-2121

JOB# 90-487
SHEET 2 / 6

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY / DATE	KEH APPROVALS	APVD FOR IMPL/PVC FOR DATE
REVISIONS					
CAD FILE		CAD CODE			

DRAWN: DEGROSS MAPPING DATE: MAY 3 1990
CHECKED:
SAFETY: NA
ENVIR: NA
QL: NA
LEAD ENG APVD:
APPROVED FOR IMPLEMENTATION
BY:
FOR: DATE:

IMPACT LEVEL: EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

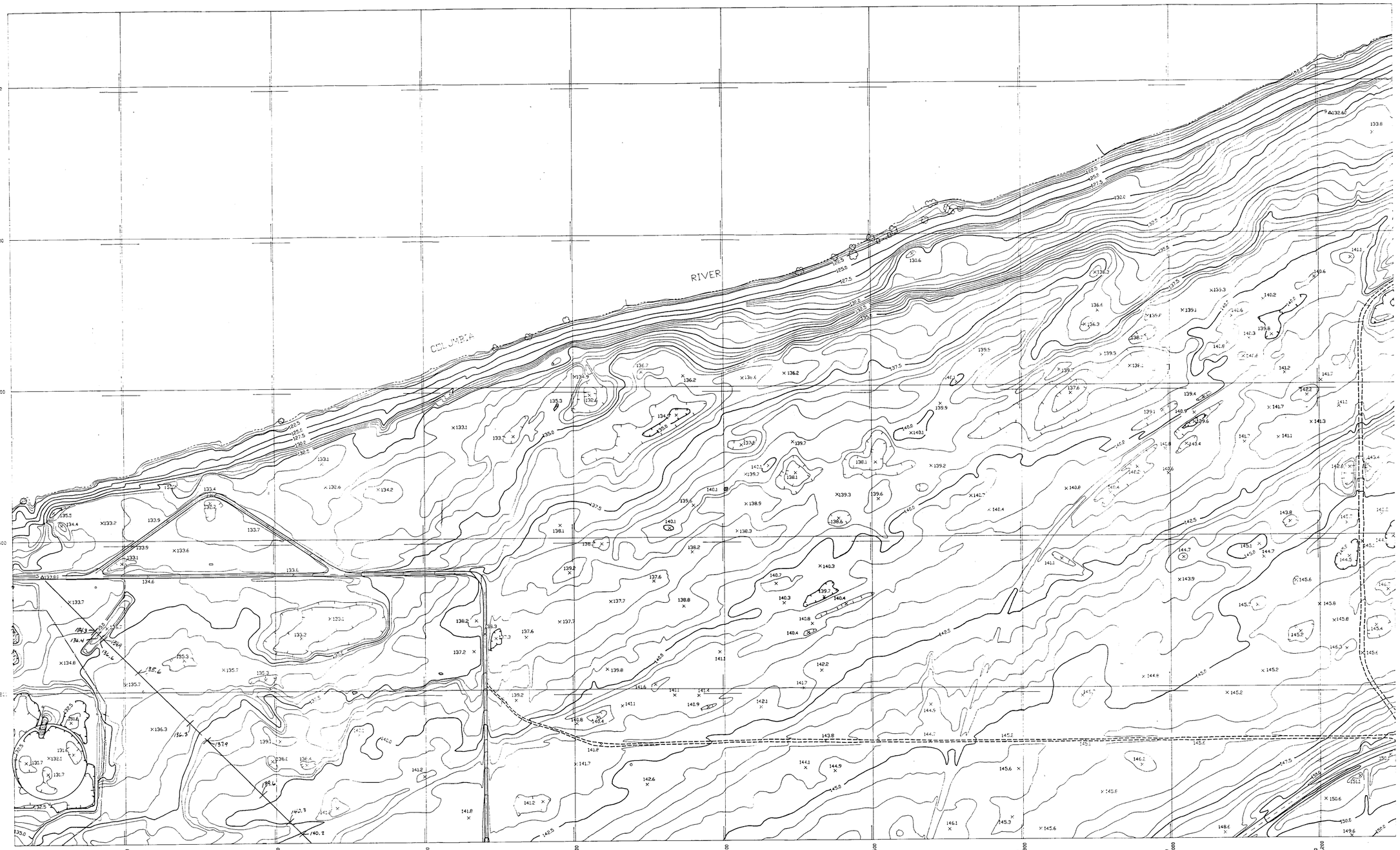
ZOOE MAPPING EXTENSION

PROJECT: RCRA TOPOGRAPHIC MAPPING

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	NA	NA	H-2H22-82096	0

SCALE 1 : 2,000 JOB NO. EE-0775 SHEET 2 of 6

KEHCAD



MATCH TO SHEET 5

State of California
Photogrammetric Surveyor
William J. Dunn
LICENSE NO. 1310

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE — 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE

DRAWING TRACEABILITY LIST

NUMBER	TITLE

REFERENCES

NEXT USED ON:

MF	REV. NO.	DESCRIPTION	REV BY / DATE	KEH APPROVALS	APVD FOR INFO/INC FOR DATE

REVISIONS

CAD FILE 91103306.DWG. CAD CODE

		DATE
DRAWN:		
CHECKED	KEH SURVEY	
SAFETY	N/A	
ENVIR	N/A	
QC	N/A	
LEAD ENG APVD		

APPROVED FOR IMPLEMENTATION

BY

FOR DATE

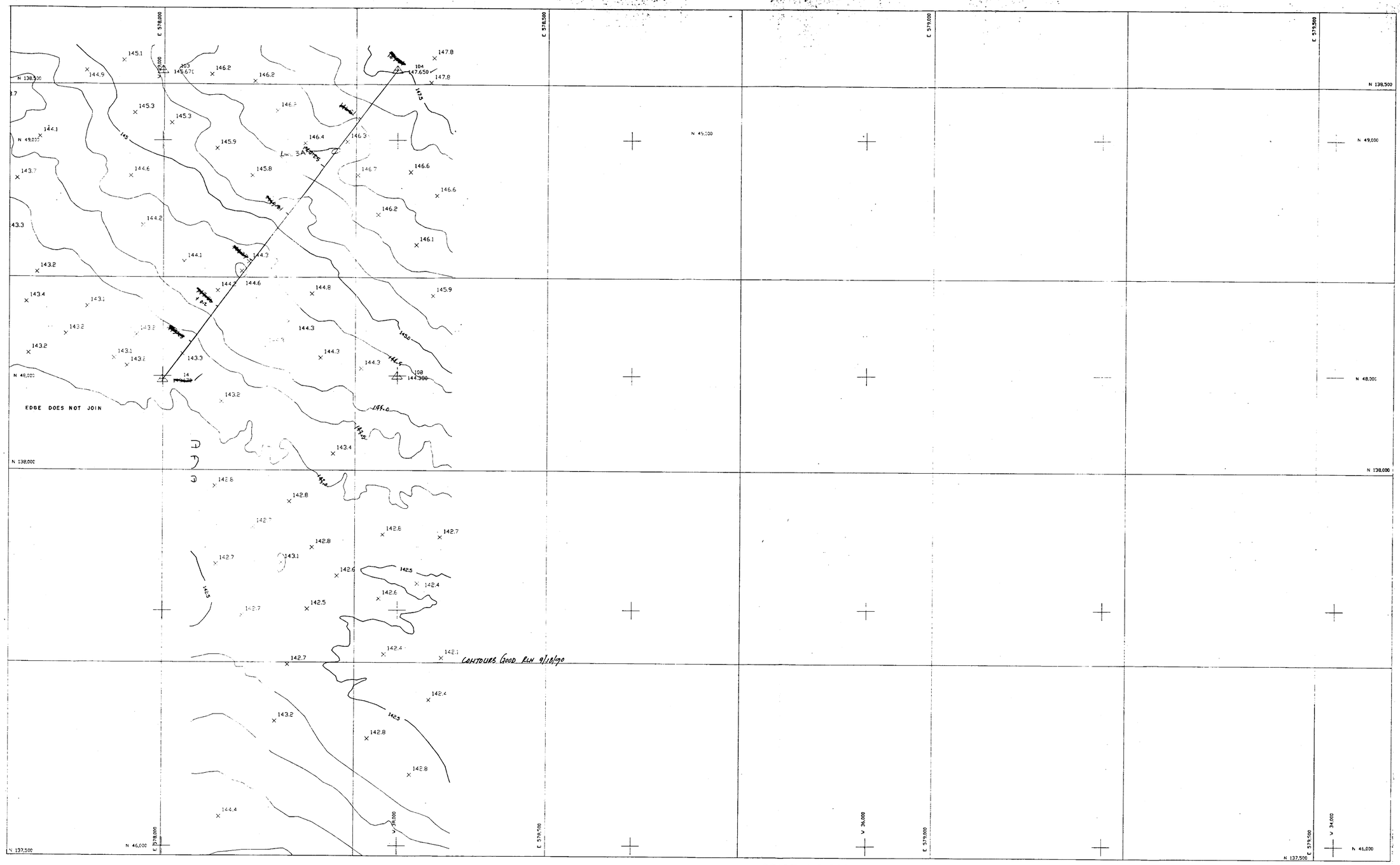
IMPACT LEVEL: EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

PROJECT				
SIZE F	BLDG NO. N/A	INDEX NO. N/A	DWG NO. H-1-52166	REV NO. 0
SCALE 1 : 2000			JOB NO. ER-0633	SHEET 6 OF 55

KEHCAD



SCALE 1:2,000

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NOTE:

GRID LINES REPRESENT NAD1983 METRIC COORDINATES

GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Date of Photography: May 3, 1990

GERRIE E. DE GROSS — STATE OF WASHINGTON — 18889 — REGISTERED PROFESSIONAL LAND SURVEYOR

THIS MAP HAS BEEN PREPARED TO MEET A NATIONAL MAP ACCURACY STANDARDS. HOWEVER, IN AREAS OF DENSE VEGETATION, CONTOURS AND PLANIMETRIC DETAIL MAY NOT MEET THESE STANDARDS. SUCH AREAS SHOULD BE FIELD CHECKED BEFORE FINAL DESIGN.

DEGROSS AERIAL MAPPING
17520 BOTHELL WAY N.E.
BOTHELL, WASH. 98011
Phone (206) 487-2522

JOB# 90-487
SHEET 3 / 6

NUMBER	TITLE
DRAWING TRACEABILITY LIST	

NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MF	REV NO	DESCRIPTION	REV BY	DATE	EH APPROVALS	APVD FOR IMPL/INC FOR DATE
REVISIONS						
CAD FILE		CAD CODE				

DRAWN	DEGROSS MAPPING — DATE MAY 3 1990
CHECKED	
SAFETY	NA
ENVIR	NA
QC	NA
LEAD ENG APVD	
APPROVED FOR IMPLEMENTATION BY	
FOR	DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

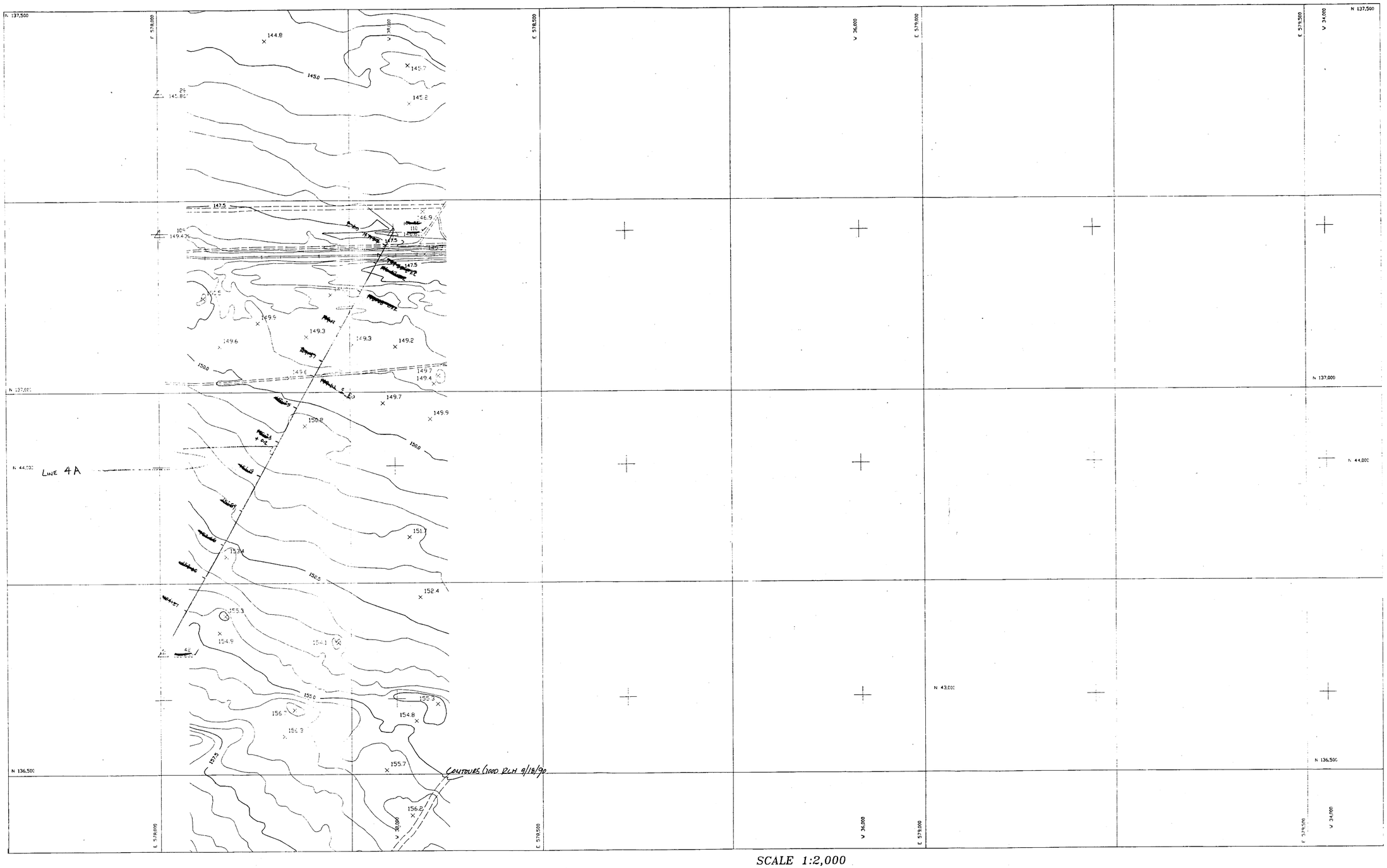
200 E MAPPING EXTENSION

PROJECT: RCRA TOPOGRAPHIC MAPPING

SIZE	BLDG NO	INDEX NO	DWG NO	REV NO
F	N/A	N/A	H-2-82095	0

SCALE 1 : 2,000 | JOB NO. ER-0775 | SHEET 3 of 6

KEHCAD



SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NOTE:

GRID LINES REPRESENT NAD1983 METRIC COORDINATES

GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Date of Photography: May 3, 1990

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DEGROSS AERIAL MAPPING
17502 BITTNELL WAY N.E.
BITTNELL, WASH 98011
Phone (206) 487-2325

JOB# 90-487
SHEET 6

NUMBER	TITLE

DRAWING TRACEABILITY LIST

NUMBER	TITLE

REFERENCES

NEXT USED ON

MF	REV NO	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPLMNT FOR DATE

REVISIONS

CAD FILE | CAD CODE

DRAWN DEGROSS MAPPING DATE MAY 3 1990
CHECKED
SAFETY NA
ENVIR NA
QC NA
LEAD ENG APVS
APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

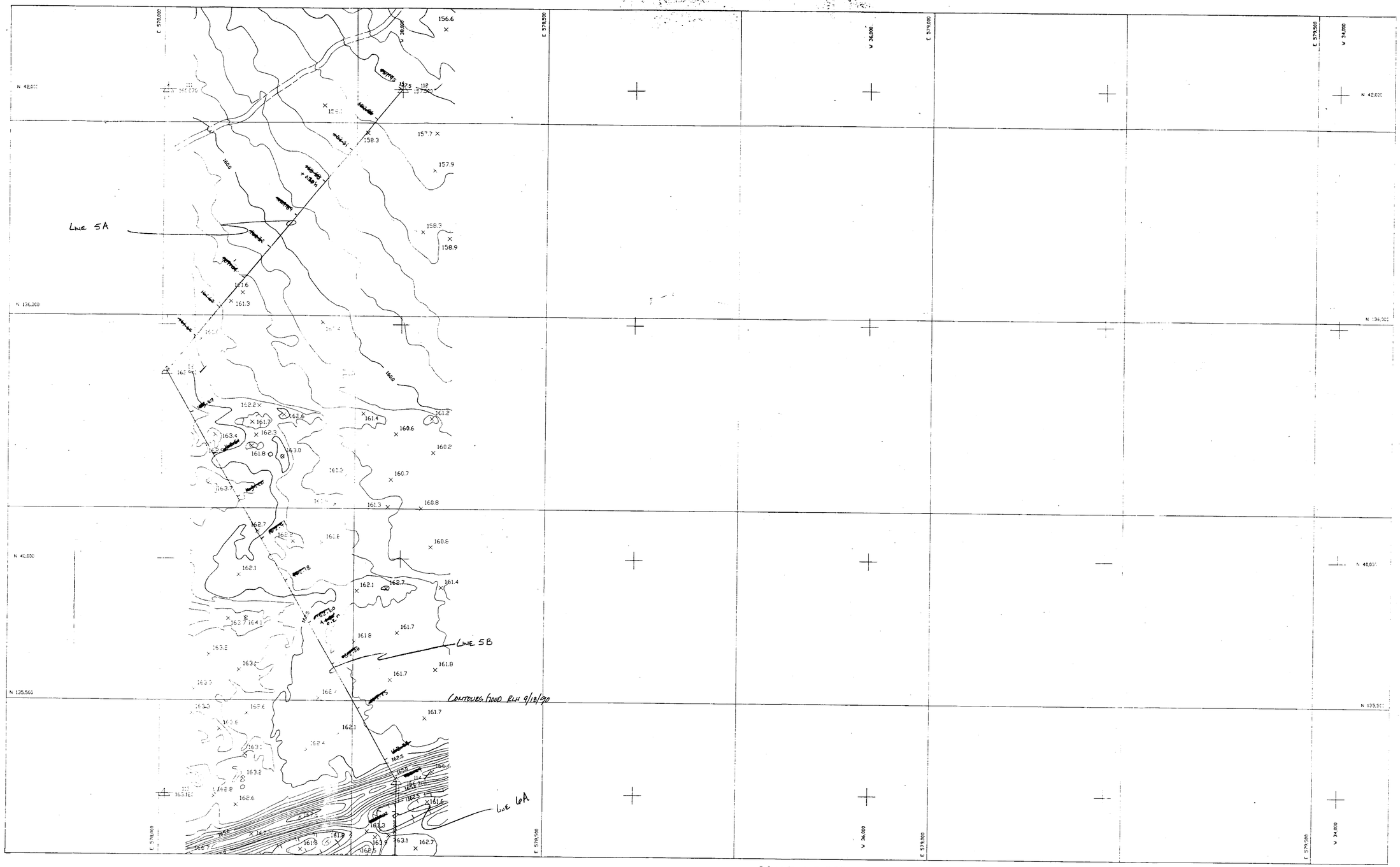
200E MAPPING EXTENSION

PROJECT RCRA TOPOGRAPHIC MAPPING

SIZE	BLDG NO	INDEX NO	DWG NO	REV NO
F	NA	NA	H-2-82096	0

SCALE 1 : 2,000 | JOB NO ER-0775 | SHEET 4 OF 6

KEHCAD



NOTE:
GRID LINES REPRESENT NAD1983 METRIC COORDINATES
GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Date of Photography: May 3, 1990

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DEGROSS AERIAL MAPPING
17500 BOTHELL WAY N.E.
BOTHELL, WASH 98011
Phone (206) 487-2521

JOB# 90-487
SHEET 5 / 6

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD
REVISIONS						
CAD FILE		CAD CODE				

DRAWN DEGROSS MAPPING DATE MAY 3 1990
CHECKED
SAFETY NA
ENVIR NA
QE NA
LEAD ENG APVD
APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

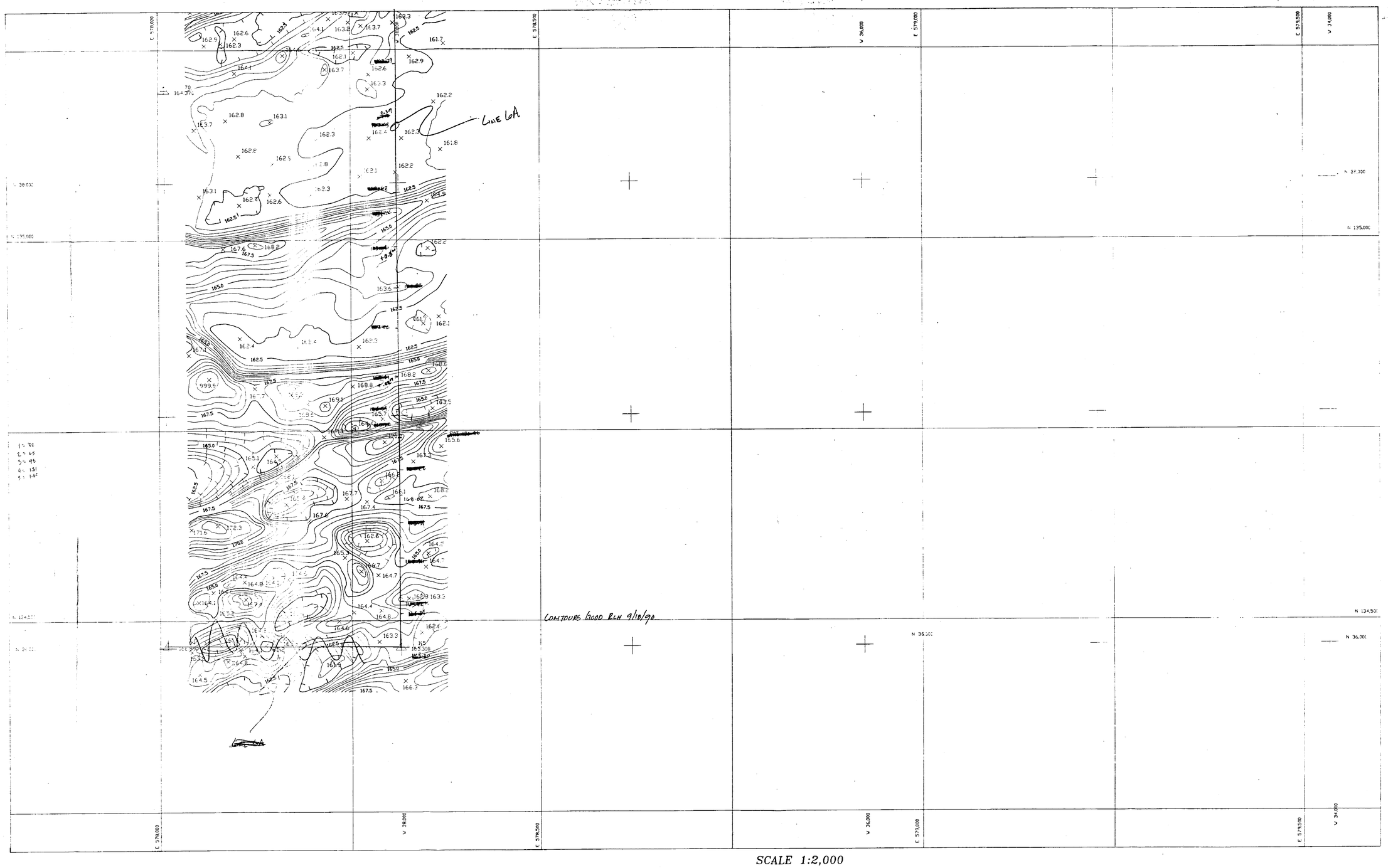
ZOOE MAPPING EXTENSION

PROJECT ECRA TOPOGRAPHIC MAPPING

SCALE	INDEX NO	DWG NO	REV NO
NA	NA	H-2-82096	0

SCALE 1 : 2,000 JOB NO EE-0775 SHEET 5 of 6

KEHCAD



SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NOTE:

GRID LINES REPRESENT NAD1983 METRIC COORDINATES

GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Photogrammetry May 3, 1990

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DEGROSS AERIAL MAPPING
17520 BOTHELL WAY N.E.
BOTHELL, WASH. 98011
Phone (206) 487-2525

JOB# 90-487

SHEET 6 / 6

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE
REVISIONS					
CAD FILE		CAD CODE			

DRAWN DEGROSS MAPPING DATE MAY 3 1990
CHECKED
SAFETY NA
ENVIR NA
QC NA
LEAD ENG APVD
APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

200E MAPPING EXTENSION

PROJECT RCRA TOPOGRAPHIC MAPPING

SIZE	BLDG NO	INDEX NO	DWG NO	REV NO
F	NA	NA	H-2-82096	

SCALE 1 : 2,000 JOB NO ER-0775 SHEET 6 OF 6

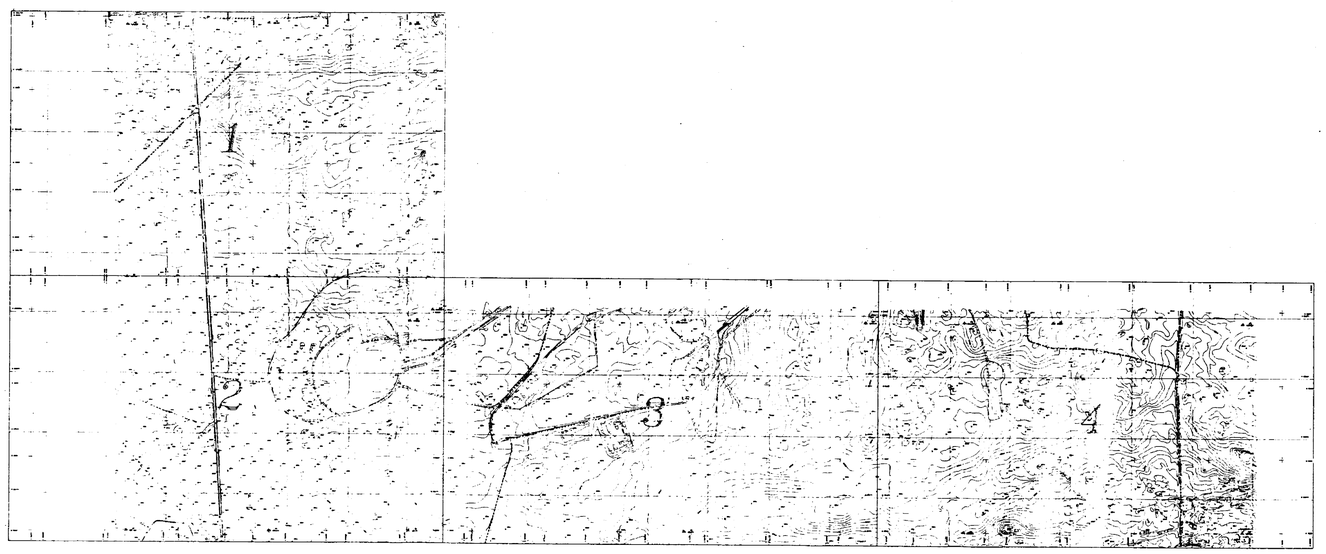
KEHCAD

KAISER HANFORD COMPANY

200 WEST AREA

MAPPING SCALE 1:2000

CONTOUR 0.5 METER



SCALE 1:10,000

DEGROSS AERIAL MAPPING

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

DRAWN: DEGROSS MAPPING
CHECKED: RLH
SAFETY: N/A
ENGR: N/A
QC: N/A
CAD ENG APPD: AKL

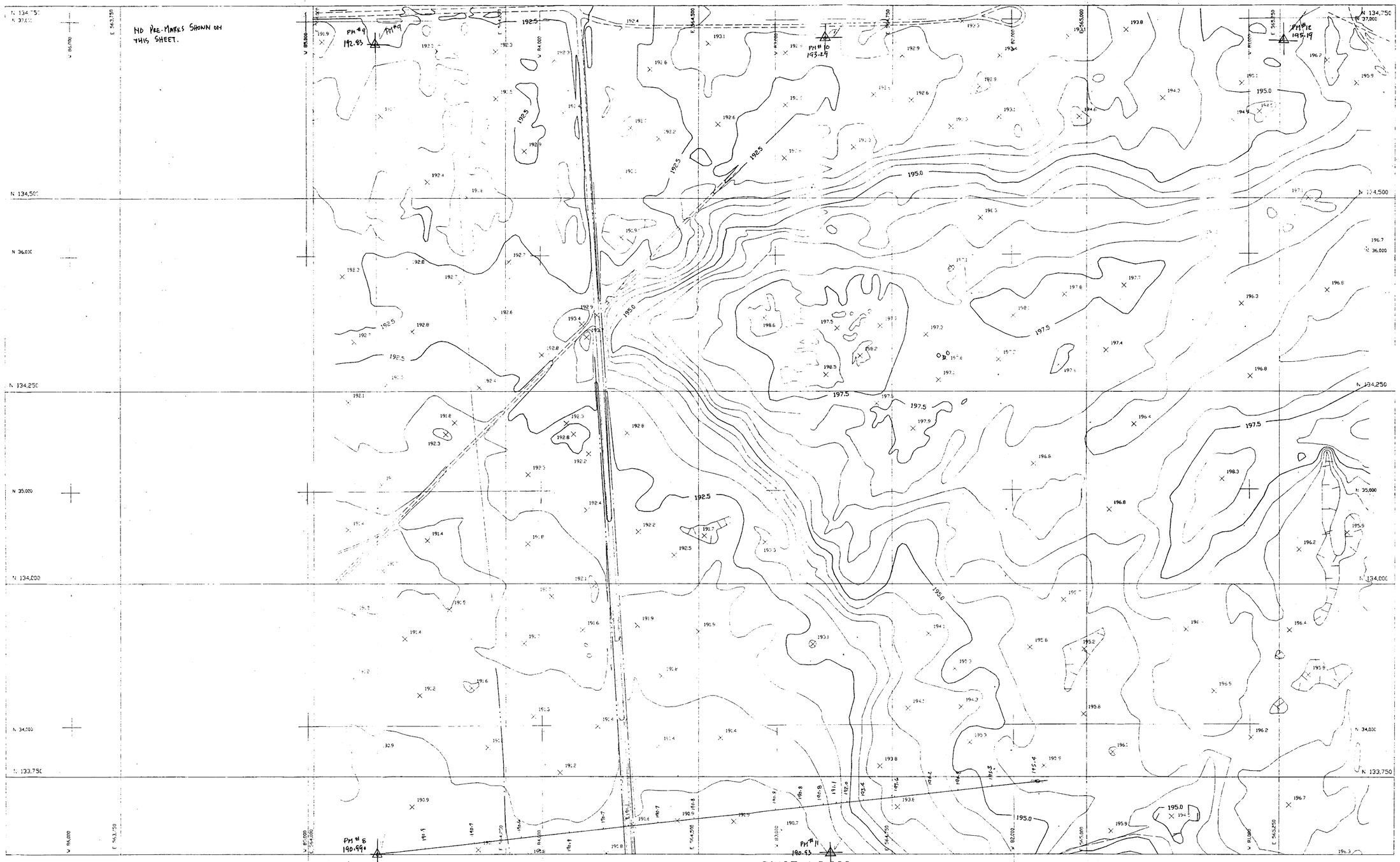
200W MAPPING EXTENSION
(SOUTH & WEST)

RCRA TOPOGRAPHIC MAPPING

6006 0103 H-2-82616 0

SCALE: 1:10,000 DWG NO: E-1396 SHEET 1 OF 1

KEHCAD



SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NOTES:
GRID LINES REPRESENT NAD1983 METRIC COORDINATES
GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NAD 1929 VERTICAL
SCALE 1:2,000
CONTOURS
Date of Photography: SEP 22, 1990

THIS MAP HAS BEEN PREPARED TO MEET A.S.P. NATIONAL MAP ACCURACY STANDARDS. HOWEVER, IN AREAS OF DENSE VEGETATION, CONTOURS AND PLANIMETRIC DETAIL MAY NOT MEET THESE STANDARDS. SUCH AREAS SHOULD BE FIELD CHECKED BEFORE FINAL DESIGN.

DEGROSS AERIAL MAPPING
17520 BOTHELL WAY NE
BOTHELL, WASH 98011

JOB# 90-493
SHEET 1 of 4

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

NO.	DESCRIPTION	REV. BY / DATE	KEH APPROVALS	APVD FOR IMPL. FOR DATE
REVISIONS				
CAD FILE		CAD CODE		

DRAWN DEGROSS MAPPING	DATE SEP 22 1990
CHECKED	RLH
SAFETY	N/A
ENVIR	N/A
GE	N/A
LEAD ENG ATT	AKL
BY	APPROVED FOR IMPLEMENTATION
FOR	DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

ZOOW MAPPING EXTENSION
(SOUTH & WEST)

RCRA TOPOGRAPHIC MAPPING

SIZE	BLDG NO	NO	DRAWING NO	REV NO
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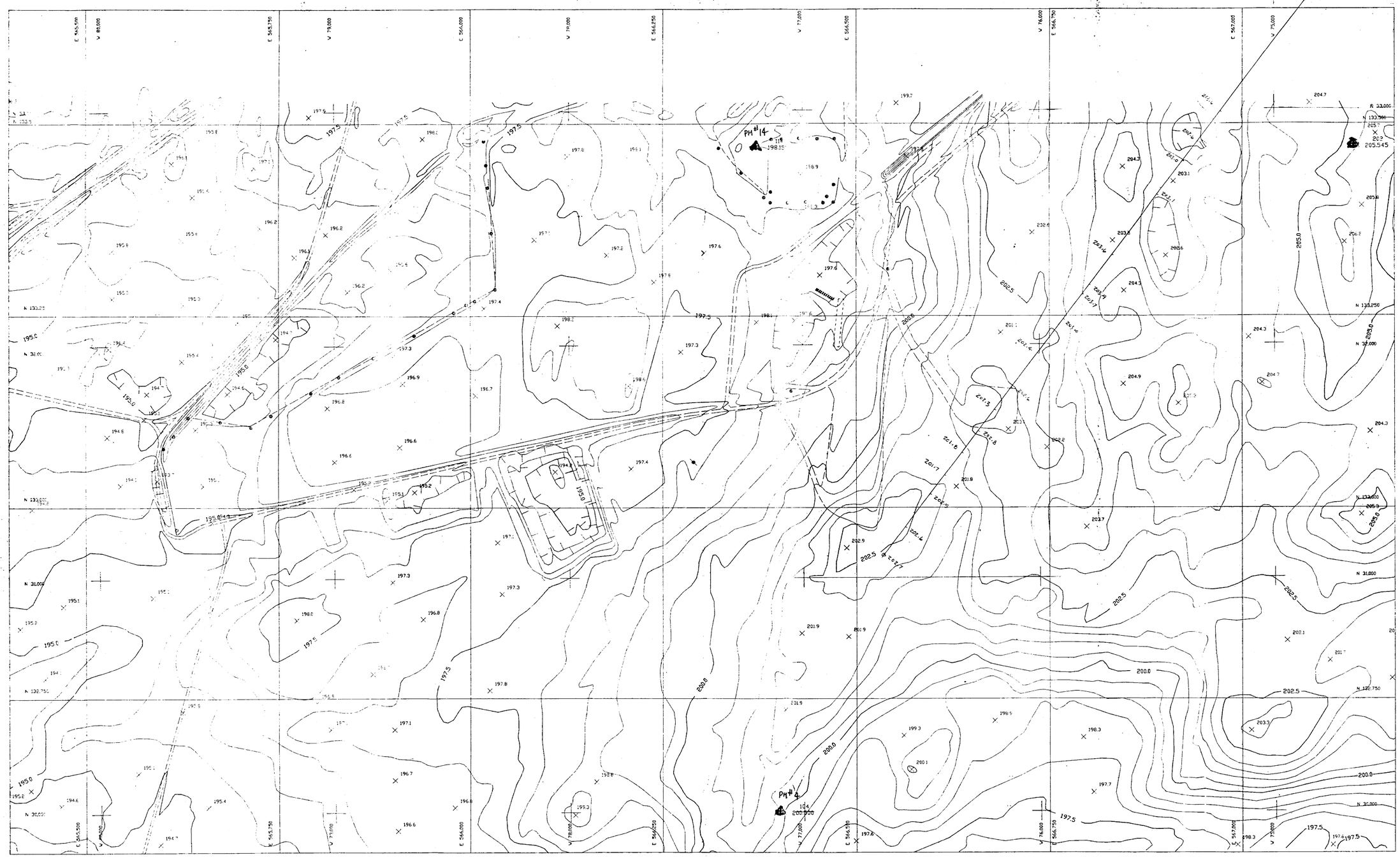
SCALE 1 : 2,000 | JOB NO E-1396 | SHEET 1 of 4

KEHCAD



SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NOTE:
GRID LINES REPRESENT NAD1983 METRIC COORDINATES
GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Date of Photography: SEP 1990

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DEGROSS AERIAL MAPPING
T-17520 BOTHELL WAY N.E.
BOTHELL, WASH. 98011
PHONE (206) 487-2521

JOB# 90-493
SHEET 3 / 4

NUMBER	TITLE	NUMBER	TITLE	REV NO	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPLEMENTATION FOR DATE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES	REVISIONS				
				CAD FILE	CAD CODE			

DRAWN: DEGROSS MAPPING DATE: SEP 22 1990
CHECKED: RLH
SAFETY: N/A
ENVIR: N/A
QL: N/A
LEAD ENG AND: AKL

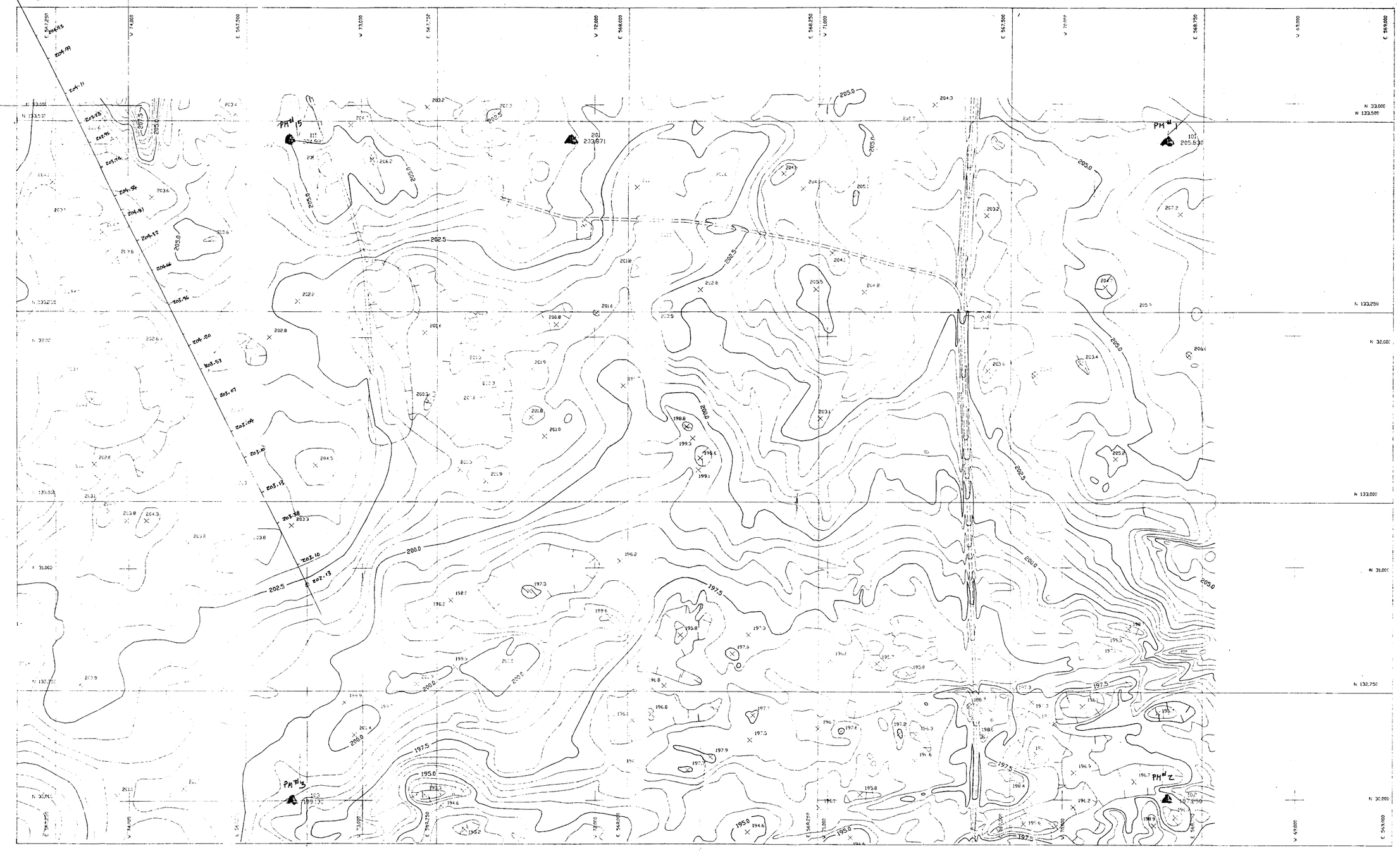
IMPACT LEVEL | SECT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

200 W MAPPING EXTENSION
(SOUTH & WEST)

PROJECT: RCRA TOPOGRAPHIC MAPPING
SIZE: F | BLDG NO: 6606 | 0103 | WO NO: H-2-82617 | REV NO: 0
SCALE: 1 : 2,000 | JOB NO: E-1596 | SHEET 3 OF 4

KEHCAD



NOTE:
GRID LINES REPRESENT NAD1983 METRIC COORDINATES
GRID TICKS REPRESENT PLANT (FOOT) COORDINATES

NAD 1983 HORIZONTAL
NGVD 1929 VERTICAL
SCALE 1:2,000
.5 Meter CONTOURS
Date of Photography SEP 21 1990

THIS MAP HAS BEEN PREPARED TO MEET A.S.P. NATIONAL MAP ACCURACY STANDARDS. HOWEVER, IN AREAS OF DENSE VEGETATION, CONTOURS AND PLANIMETRIC DETAIL MAY NOT MEET THESE STANDARDS. SHOW AREAS TO BE FIELD CHECKED BEFORE PHASE

DEGROSS AERIAL MAPPING
17520 BOTHELL WAY N.E.
BOTHELL WASH 98011
Phone (206) 481-2...

JOB# 90-493
SHEET 2

SCALE 1:2,000

200 150 100 50 0 100 200 300 400 500

NUMBER	TITLE	REFERENCES
DRAWING TRACEFILE LIST		

NUMBER	TITLE
NETWORK	

REV. NO.	DESCRIPTION	REVISIONS	REVISED BY DATE	KEH APPROVALS	APVC. FOR MFG/PNC FOR DATE
CAT FILE	CAT CL				

FINISHED LEVEL EOT

DRAWN DEGROSS MAPPING
CHECKED KLH
SAFETY N/A
ENGR N/A
QC N/A
LEAD ENG APVL AVL

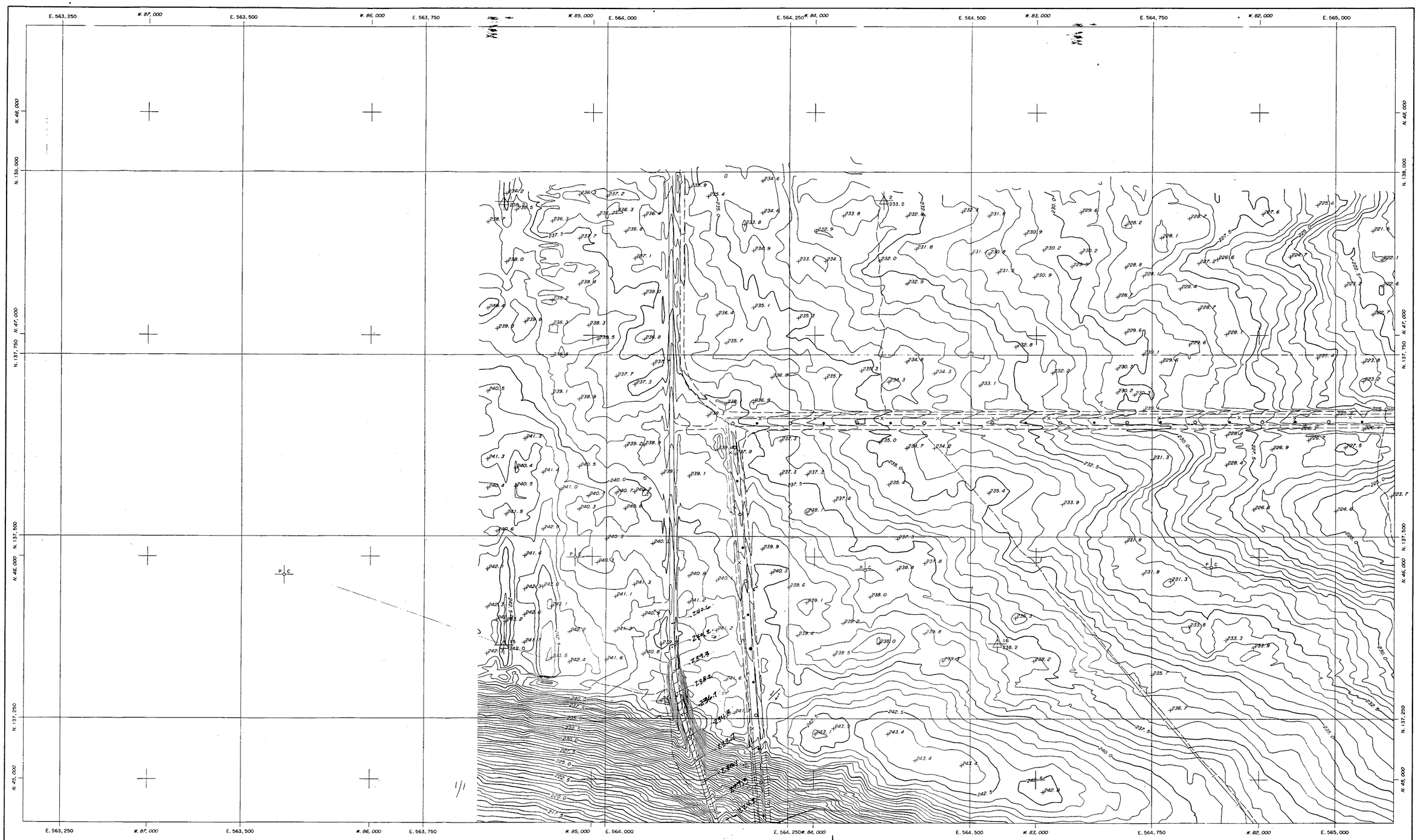
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

200W MAPPING EXTENSION
(SOUTH & WEST)

RCRA TOPOGRAPHIC MAPPING

APPROVED FOR IMPLEMENTATION
DATE
CODE 21000
BLDG NO. INDEX NO. H-2-82617
JOB NO. E-1596 SHEET 4 OF 4

KEHCAD



Prepared By:
MERRICK
Merrick & Company Telephone 303/751-4741
11000 E. Bethany Drive Aurora, Colorado 80041
Post Office Box 15338 Denver, Colorado 80202

0 20 40 80 120 160
SCALE = 1:2000

N

MICRO FFO	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
REVISION APPROVALS						REVISIONS	LAST REV.

COMMENT PRT ISSUE NO. DATE CHECK PRT ISSUE NO. TE

DRAWING STATUS

DRAWING APPROVALS	DATE
APPD FOR QUALITY ASSURANCE	
APPD	
APPD	
APPD	
RESPONSIBLE ENGINEER	
DRAFTING APPD	
CHECKED	
DRAWN	
CLASSIFICATION	BY

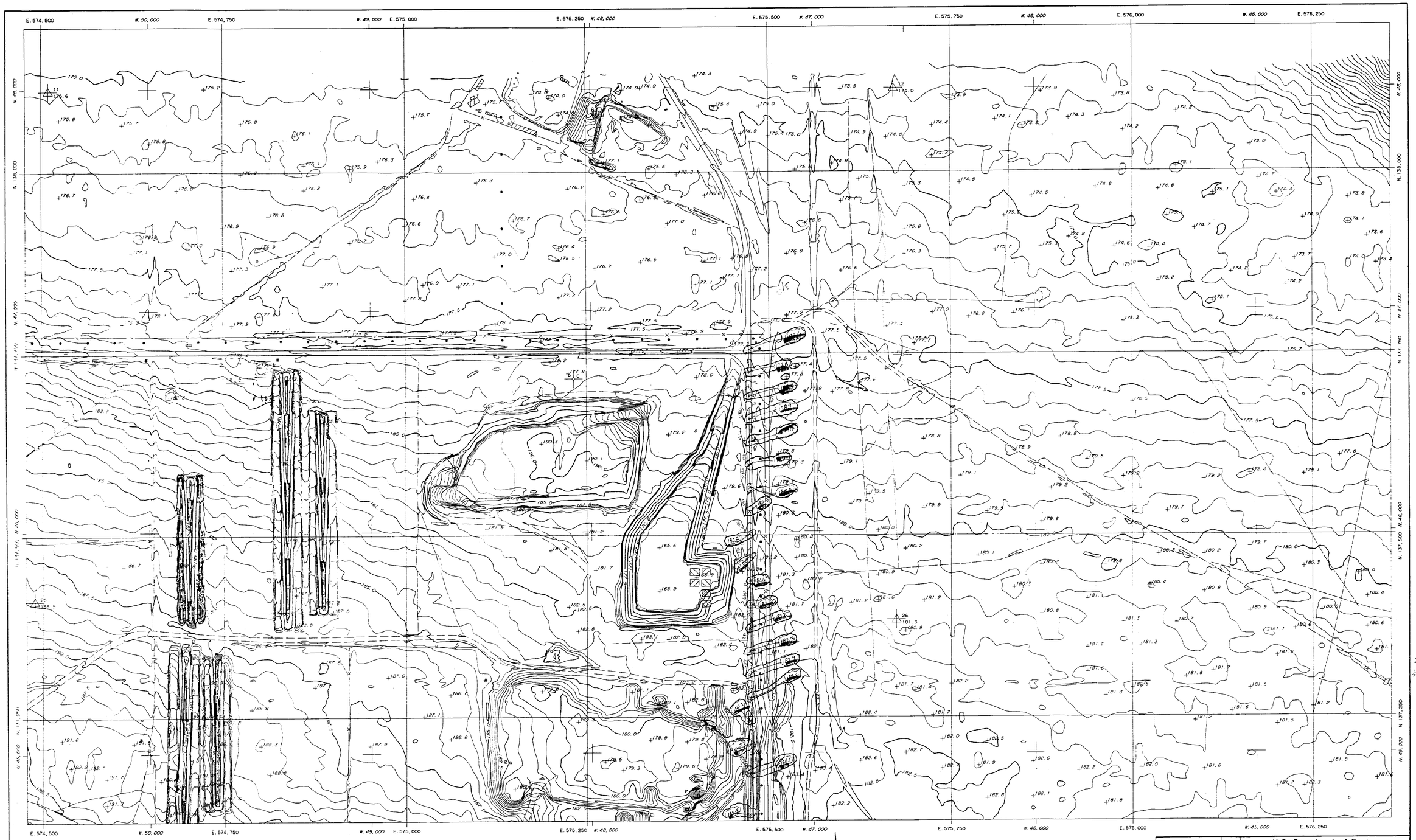
U.S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

200 E-W CONTOUR CHECK

SCALE | BLDG NO | INDEX NO.

DR | SHEET NO. 1 | SHEETS 37



INDICATES GOOD
INDICATES ?

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SCALE = 1:2000

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DRAWING APPROVALS	DATE
APPD FOR QUALITY ASSURANCE	
APPD	
APPD	
APPD	
RESPONSIBLE ENGINEER	
DRAFTING APPD	
CHECKED	
DRAWN	
CLASSIFICATION	BY

U.S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

200 E-W CONTOUR CHECK

MICRO FFD	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
REVISION APPROVALS							

REVISIONS

COMMENT PRT ISSUE NO. DATE CHECK PRT ISSUE NO. TE

DRAWING STATUS

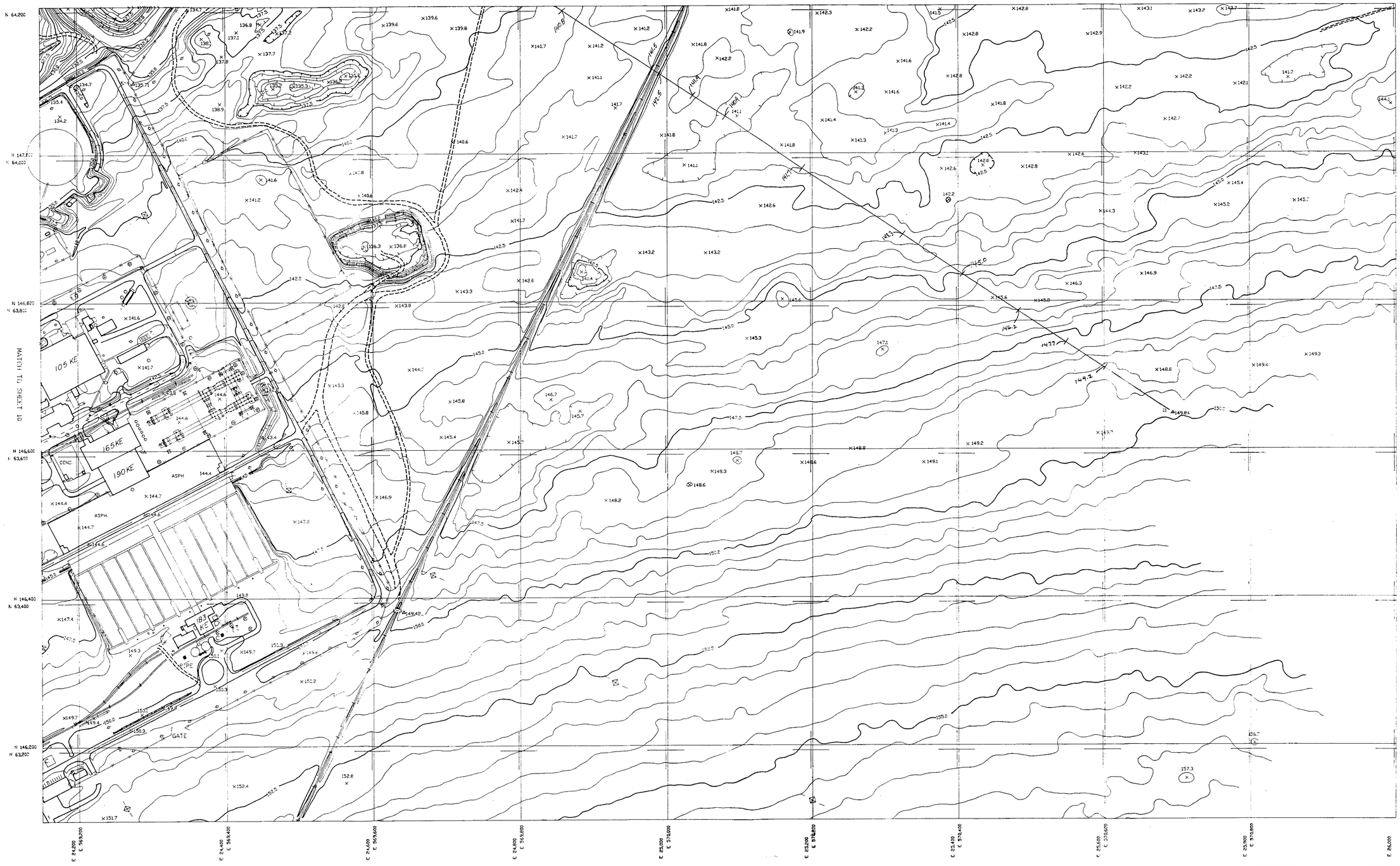
SCALE | BLDG NO | INDEX NO

DP | SHEET NO 7 | SHEETS 37

Prepared By:
MERRICK
Merrick & Company Telephone 303/751-0741
10200 E. Belleview Drive Aurora, Colorado 80041
Post Office Box 28035 Denver, Colorado 80202

20 scale
2.538
1/20 = 2.538 ft
21.5
35
25.0

MATCH TO SHEET 14



MATCH TO SHEET 10

MATCH TO SHEET 17

MATCH TO SHEET 12

State of California
Photogrammetric Surveyor
William F. Brown
WILLIAM F. BROWN NO. [illegible]

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE — 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE

DRAWING TRACEABILITY LIST

NUMBER	TITLE

REFERENCES

NEXT USED ON:

MF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD FOR IMPL/ENG FOR DATE

REVISIONS

CAD FILE 91103313.DWG. CAD CODE

		DATE
DRAWN		
CHECKED	KEH SURVEY	
SAFETY	N/A	
ENVIR	N/A	
QC	N/A	
LEAD ENG APVD		

APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

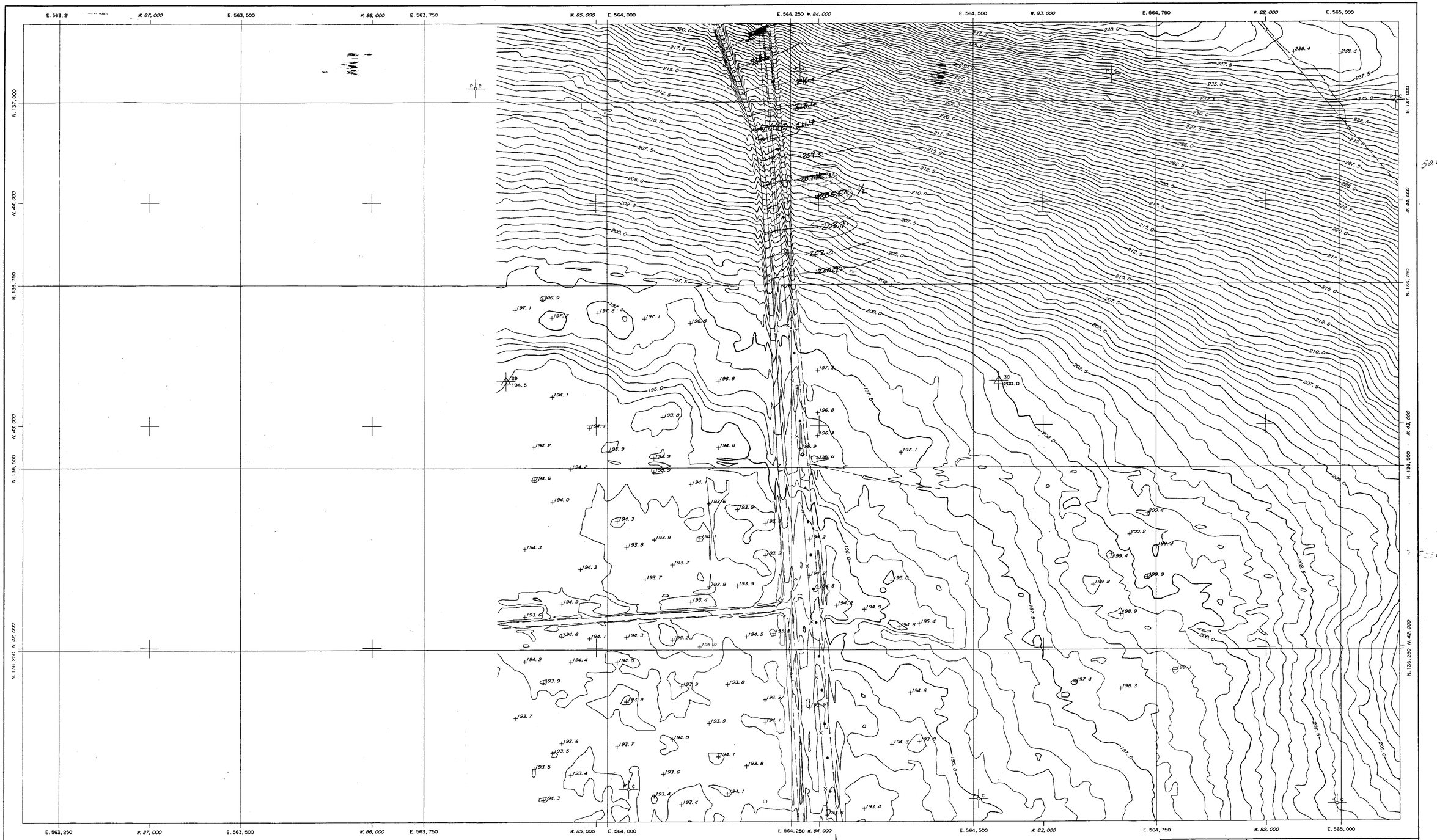
100 AREAS TOPOGRAPHIC MAPPING

PROJECT

SITE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
E	N/A	N/A	H-1-52166	0

SCALE 1 : 2000 JOB NO. ER-0633 SHEET 13 OF 55

KEHCAD



0 20 40 80 120 160

SCALE = 1:2000

N

DRAWING APPROVALS	DATE
APPD FOR QUALITY ASSURANCE	
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RESPONSIBLE ENGINEER	
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CLASSIFICATION	BY

U.S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

200 EW CONTOUR CHECK

SCALE	BLDG NO.	INDEX NO.

DR

SHEET NO. 9 SHEETS 37

MICRO FFD	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
	REVISION APPROVALS						

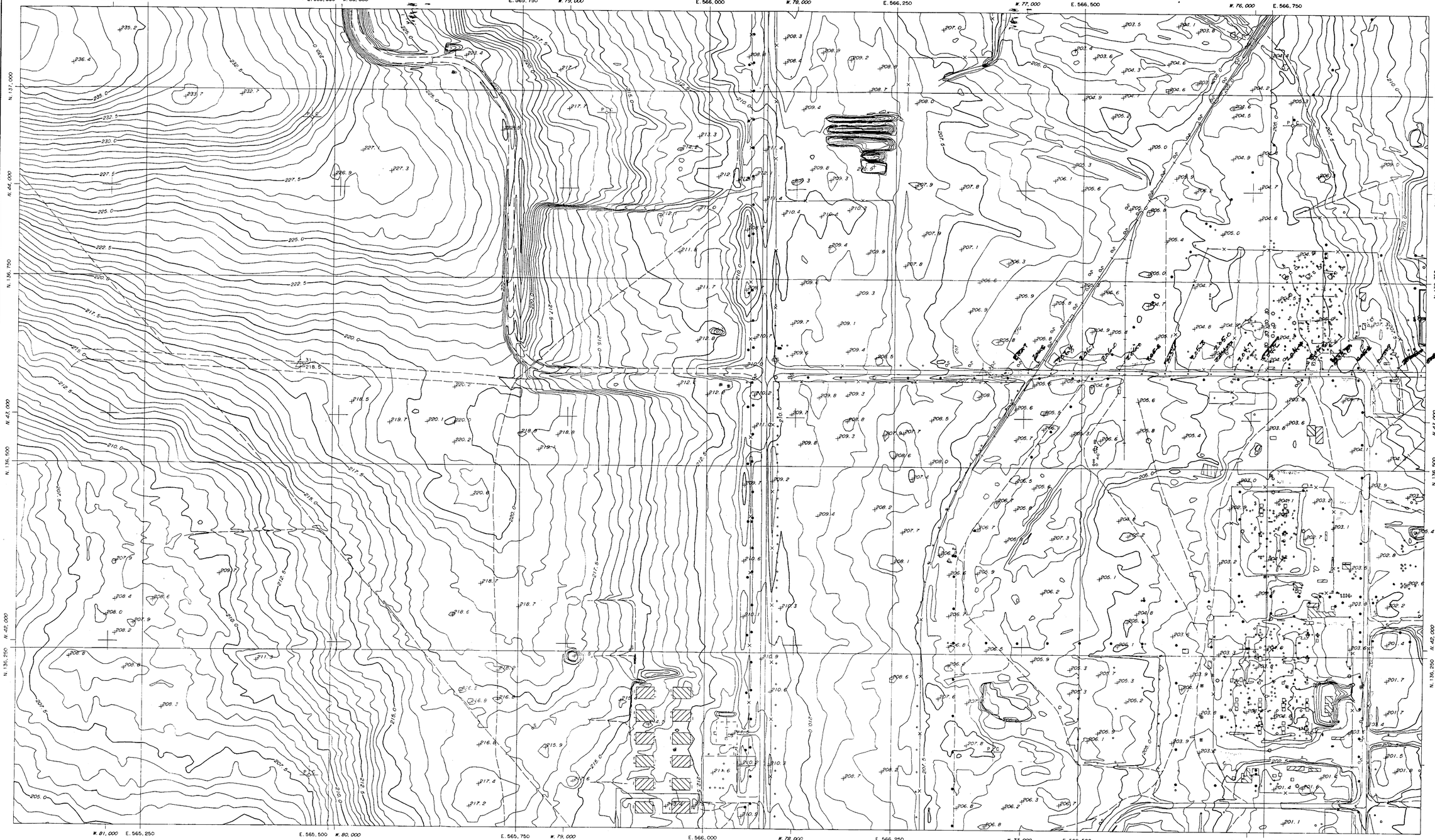
REVISIONS

LAST REV.

COMMENT PRT ISSUE NO. DATE CHECK PRT ISSUE NO. TE

DRAWING STATUS

Prepared By:
MERRICK
Merrick & Company Telephone 303/751-0741
11055 E. Bethany Drive Aurora, Colorado 80041
Post Office Box 22038 Denver, Colorado 80222



0 20 40 80 120 160
SCALE - 1:2000

N

Prepared By:
MERRICK
Merrick & Company Telephone 303/751-0741
110866 E. Bethany Drive Aurora, Colorado 80014
Post Office Box 22036 Denver, Colorado 80222

MICRO FED	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
REVISION APPROVALS							

REVISIONS

COMMENT PRT ISSUE NO.	DATE	CHECK PRT ISSUE NO.	TE

DRAWING STATUS

DRAWING APPROVALS	DATE
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RESPONSIBLE ENGINEER	
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CHECKED	
DRAWN	
CLASSIFICATION	BY

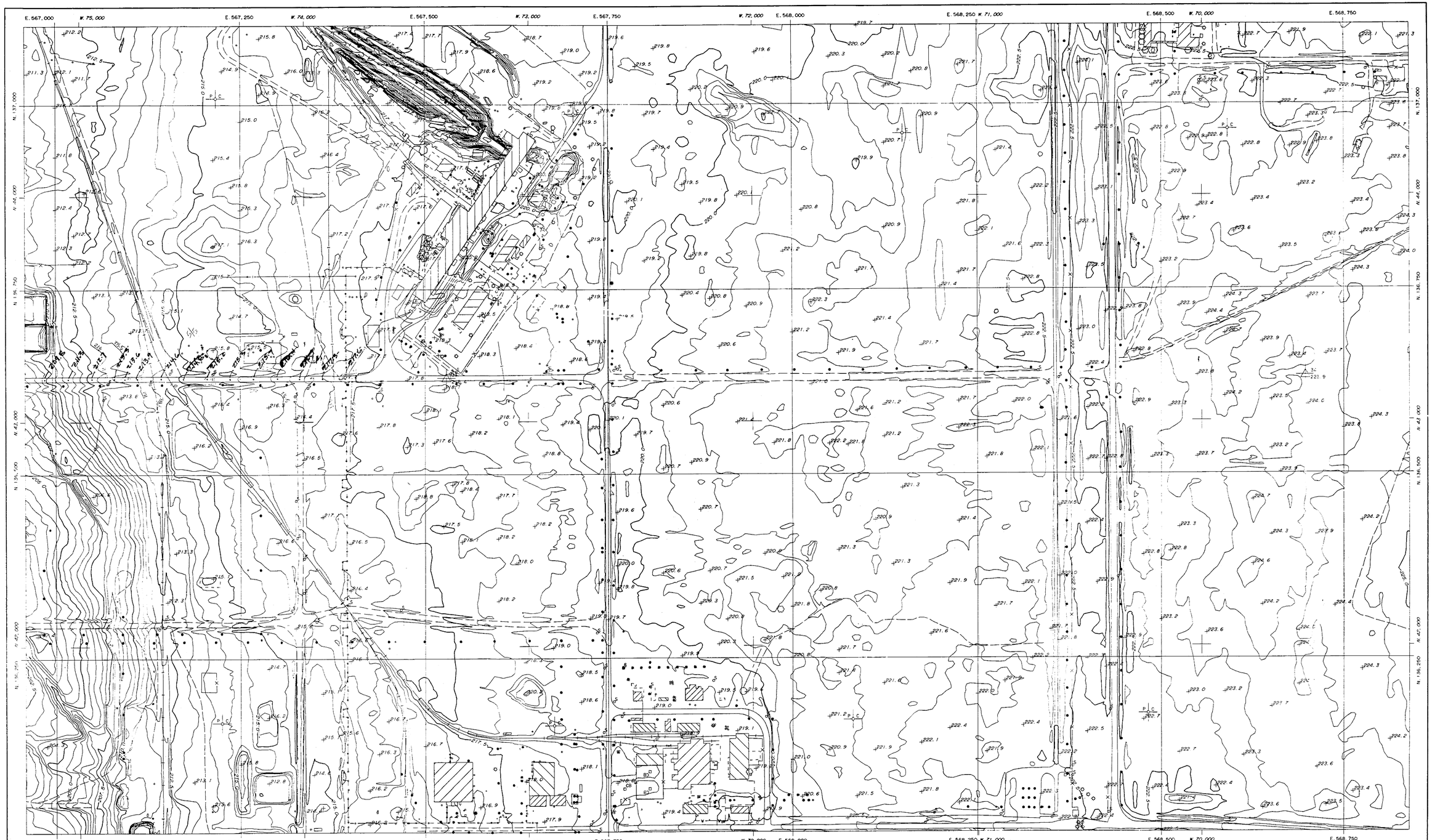
U.S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

200 E-W CONTOUR CHECK

SCALE	BLDG NO.	INDEX NO.
DR		

SHEET NO 10 SHEETS 37



0 20 40 80 120 160

SCALE 1:2000

DRAWING APPROVALS	DATE
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RESPONSIBLE ENGINEER	
DRAFTING APPD	
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DRAWN	
CLASSIFICATION	BY

U.S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

ZOO E-W CONTOUR CHECK

MICRO FED	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
REVISION APPROVALS						REVISIONS	LAST REV

COMMENT PRT ISSUE NO. DATE CHECK PRT ISSUE NO. TE

DRAWING STATUS

SCALE | BLDG NO | INDEX NO

DR | SHEET NO 11 | SHEETS 37

Prepared By:
MERRICK
Merrick & Company Telephone 303/751-0741
110850 E. Bethany Drive Aurora, Colorado 80041
Post Office Box 22036 Denver, Colorado 80022

0 20 40 80 120 160

SCALE = 1:2000

N

Prepared By:

MERRICK

Merrick & Company Telephone 303/751-0741
1100 E. Bellevue Street Aurora, Colorado 80014
Post Office Box 25036 Denver, Colorado 80202

DRAWING APPROVALS	DATE
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RESPONSIBLE ENGINEER	
DRAFTING APPD	
CHECKED	
DRAWN	
CLASSIFICATION	BY

U.S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

200 E-W CONTOUR CHECK

MICRO FFD	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
REVISION APPROVALS							

REVISIONS

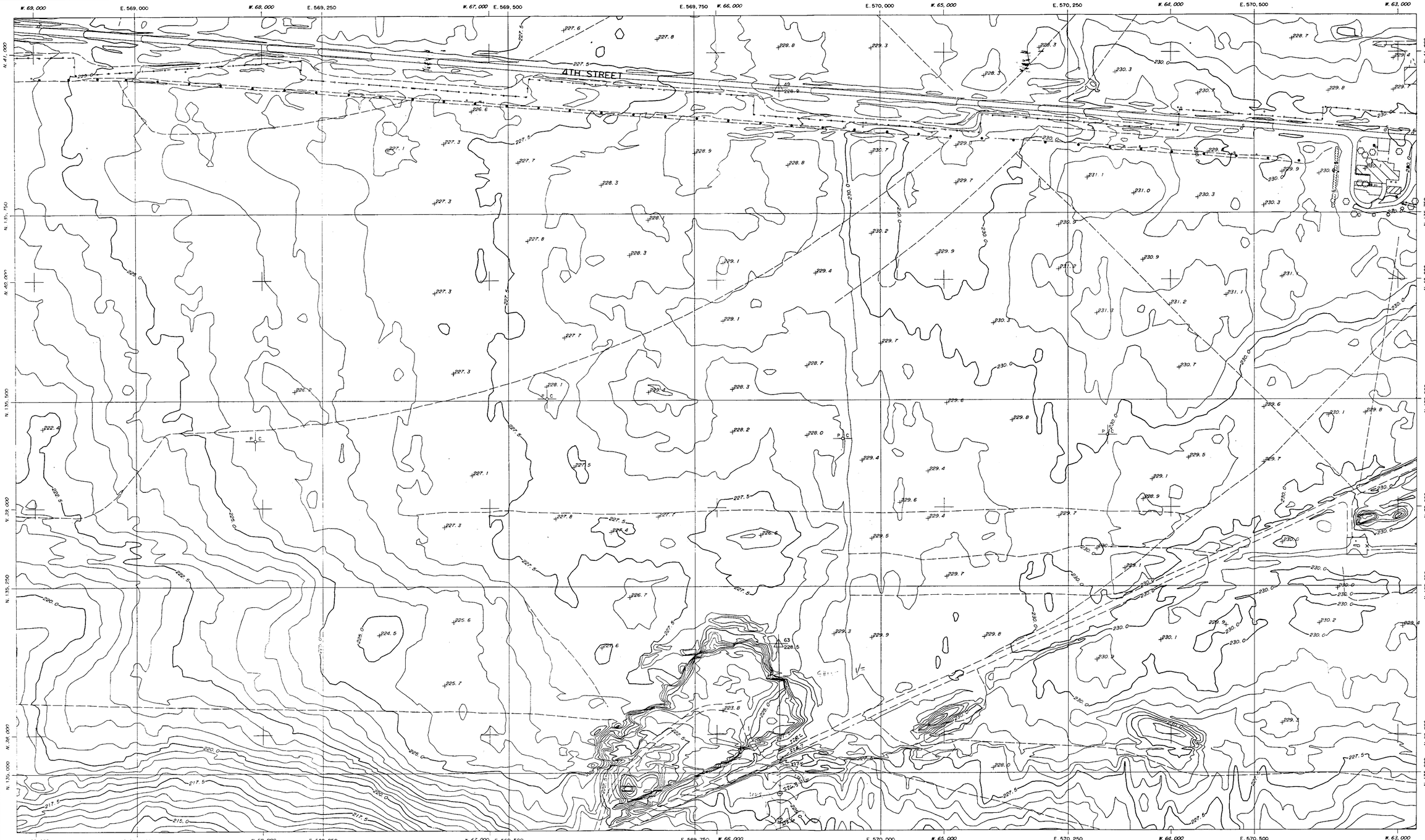
LAST REV.

COMMENT PRT ISSUE NO. DATE CHECK PRT ISSUE NO. TE

DRAWING STATUS

SCALE — BLDG NO INDEX NO.

SHEET NO 15 SHEETS 37



SCALE = 1:2000

DRAWING APPROVALS	DATE
APPD FOR QUALITY ASSURANCE	
APPD	
APPD	
APPD	
RESPONSIBLE ENGINEER	
DRAFTING APPD	
CHECKED	
DRAWN	
CLASSIFICATION	BY

U.S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

200 E-W COMTOUR CHECK

MICRO FFD	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
REVISION APPROVALS							

REVISIONS

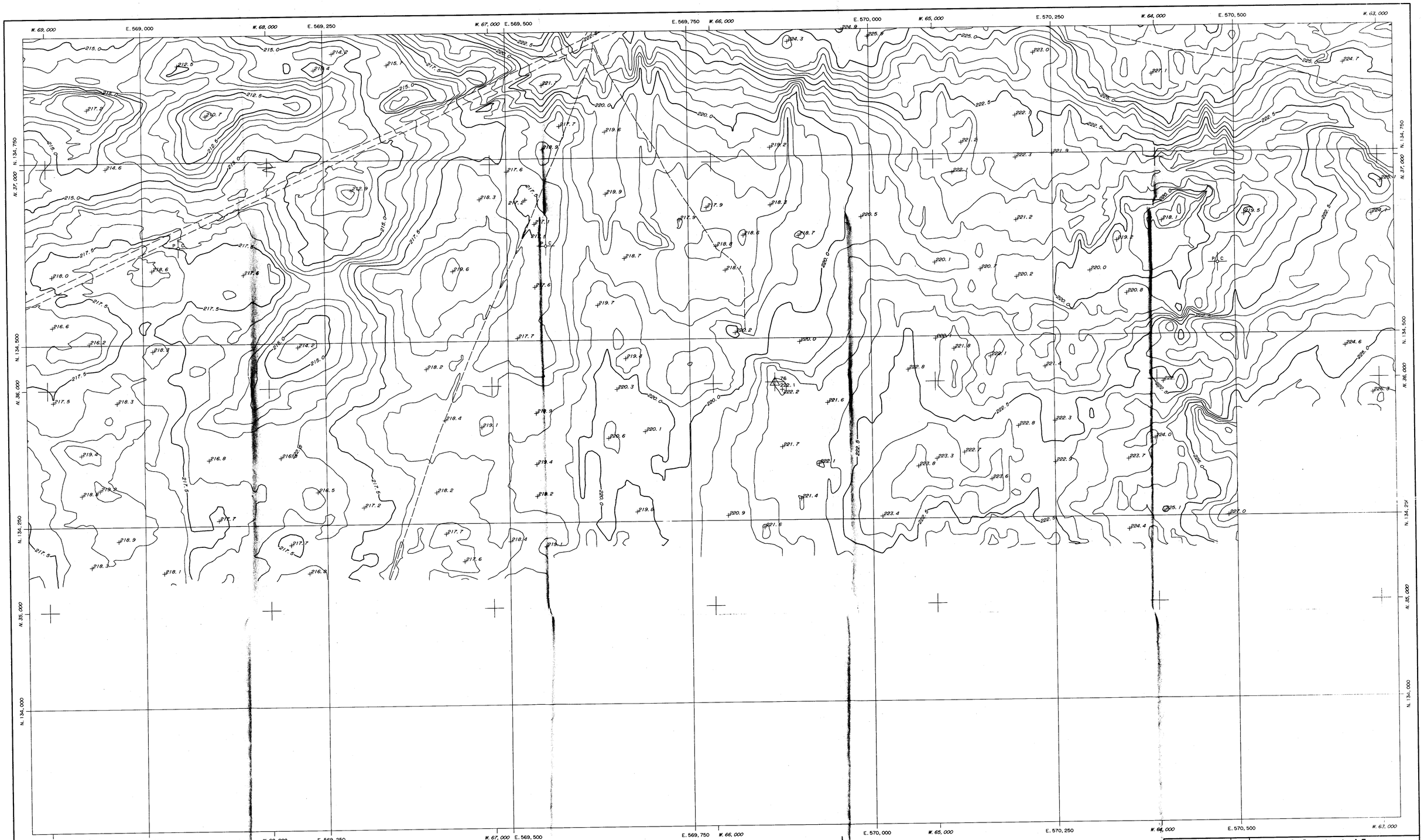
COMMENT PRT ISSUE NO.	DATE	CHECK PRT ISSUE NO.	TE

DRAWING STATUS

SCALE	BLDG NO	INDEX NO.

DR	SHEET NO	SHEETS
	20	37

Prepared By:
MERRICK
Merrick & Company Telephone 303/751-0741
11066 E. Bethany Drive Aurora, Colorado 80014
Post Office Box 22038 Denver, Colorado 80222



Nelson L. O'Connor
11-29-89

THIS MAP WAS PRODUCED THROUGH A DIGITIZED DATA BASE METHOD AND MEETS OR EXCEEDS MAPPING STANDARD ACCURACY.

SCALE = 1:2000

0 20 40 80 120 160 meters

1cm = 20 meters
PHOTO DATE: 6-26-89
CONTOUR INTERVAL: 0.5 meter

HORIZONTAL DATUM: NAD-83 LAMBERT PROJECTION

VERTICAL DATUM: NATIONAL GEODETIC SURVEY DATUM AS PROVIDED BY KAISER ENGINEERS - HANFORD.

Prepared By:
MERRICK
Merrick & Company Telephone 303/751-0741
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Post Office Box 22026 Denver, Colorado 80022

MICRO FILD	QUALITY ASSURANCE	RESPONSIBLE ENGINEER	DRAFTING	CHKD BY DATE	REV BY DATE	DESCRIPTION	REV. NO.
REVISION APPROVALS							LAST REV.

REVISIONS

COMMENT PRT ISSUE NO. DATE CHECK PRT ISSUE NO. TE

DRAWING STATUS

DRAWING APPROVALS	DATE
APPD FOR QUALITY ASSURANCE	
APPD	
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APPD	
RESPONSIBLE ENGINEER	
DRAFTING APPD	
CHECKED	
DRAWN	
CLASSIFICATION	BY

U.S. Department of Energy
Richland Operations Office

200 E-W Contour Check

SCALE	BLDG NO.	INDEX NO.

DR

SHEET NO. 28 SHEETS 37

MATCH TO SHEET 15

MATCH TO SHEET 11

MATCH TO SHEET 18

MATCH TO SHEET 13

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE
		REVISIONS			

CAD FILE 91103314.DWG. CAD CODE

DRAWN	DATE
CHECKED	KEH SURVEY
SAFETY	N/A
ENVIR	N/A
QE	N/A
LEAD ENG APVD	
APPROVED FOR IMPLEMENTATION BY	
FOR	DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

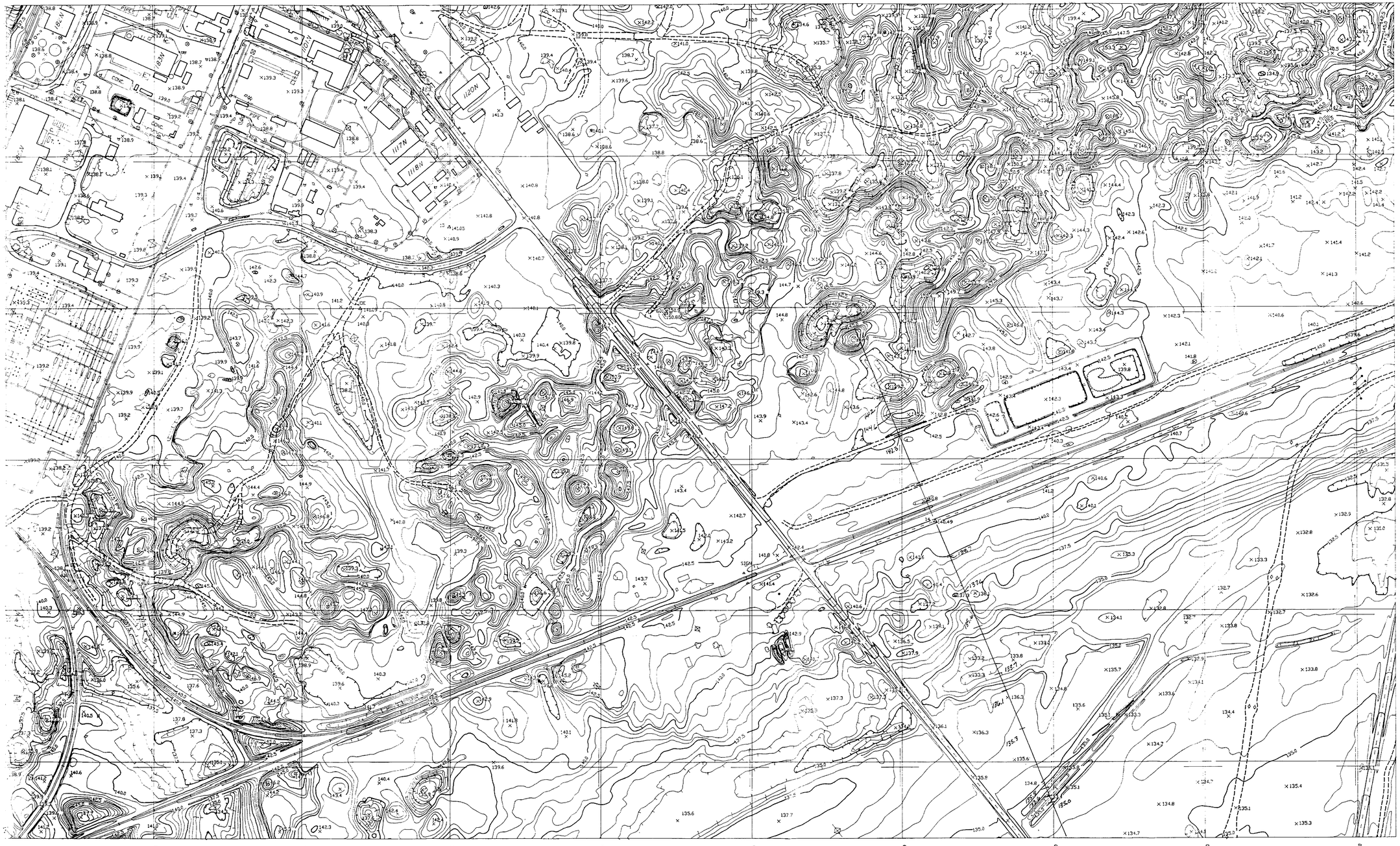
PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0

SCALE 1 : 2000 JOB NO. ER-0633 SHEET 14 OF 55

KEHCAD

MATCH TO SHEET 20



MATCH TO SHEET 15

MATCH TO SHEET 24

MATCH TO SHEET 18

State of California
Photogrammetric Surveyor
William E. Brown
WILLIAM E. BROWN NO. 18

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 50 0 50 100 SCALE METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE
REVISIONS					
CAD FILE 91103319.DWG.		CAD CODE			

DRAWN	DATE
CHECKED	KEH SURVEY
SAFETY	N/A
ENVIR	N/A
QE	N/A
LEAD ENG APVD	
APPROVED FOR IMPLEMENTATION	
BY	
FOR	DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

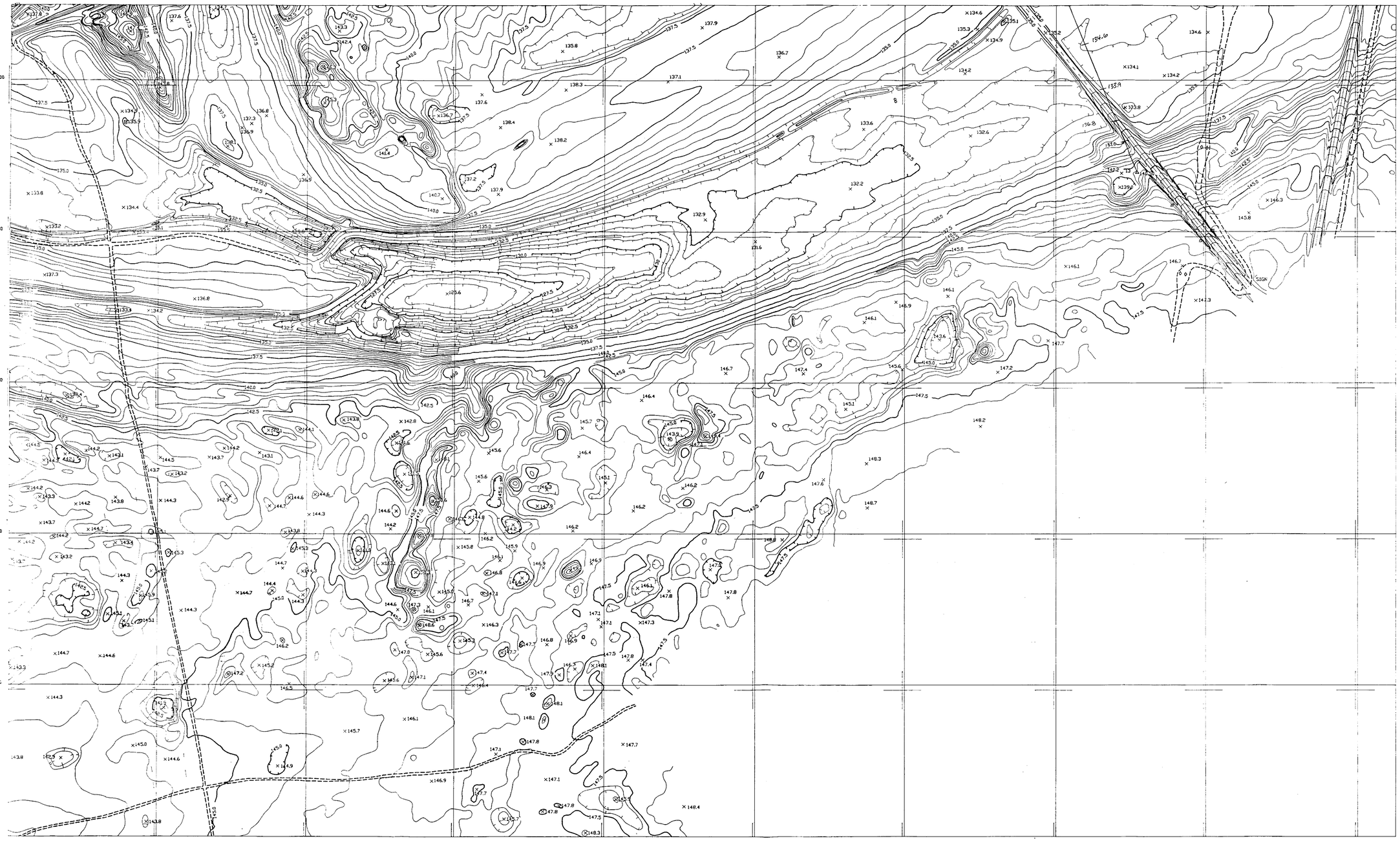
PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0

SCALE 1:2000 | JOB NO. ER-0633 | SHEET 19 OF 55

KEHCAD

MATCH TO SHEET 19



MATCH TO SHEET 14

MATCH TO SHEET 23

MATCH TO SHEET 17

State of California
Photogrammetric Surveyor
William E. Crown
NAME PROGRAM, NO. 103

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 — 50 0 50 100 SCALE METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE	NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE
REVISIONS						

CAD FILE 91103318. DWG. CAD CODE

DRAWN	DATE
CHECKED	KEH SURVEY
SAFETY	N/A
ENVIR	N/A
QC	N/A
LEAD ENG APVD	
APPROVED FOR IMPLEMENTATION	
BY	
FOR	DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

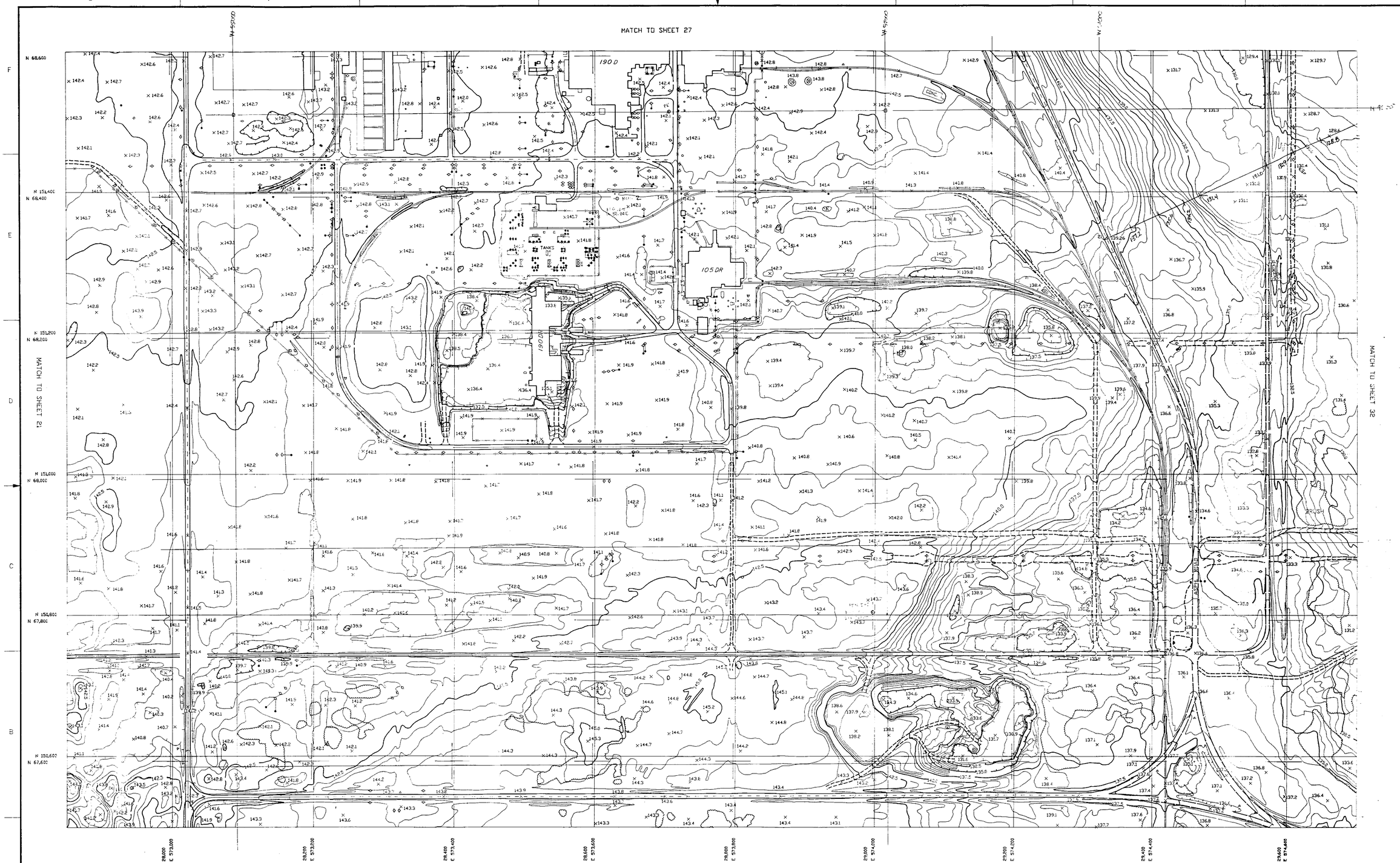
100 AREAS TOPOGRAPHIC MAPPING

PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0

SCALE 1 : 2000 | JOB NO. ER-0633 | SHEET 18 OF 55

KEHCAD



THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE
DRAWING TRACEABILITY LIST	

NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY / DATE	KEH APPROVALS	APVD FOR IMPL./INC FOR DATE
REVISIONS					

CAD FILE 91103326.DWG. CAD CODE

DRAWN	DATE
CHECKED	KEH SURVEY
SAFETY	N/A
ENVIR	N/A
QE	N/A
LEAD ENG APVD	

APPROVED FOR IMPLEMENTATION

BY

FOR DATE

IMPACT LEVEL EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

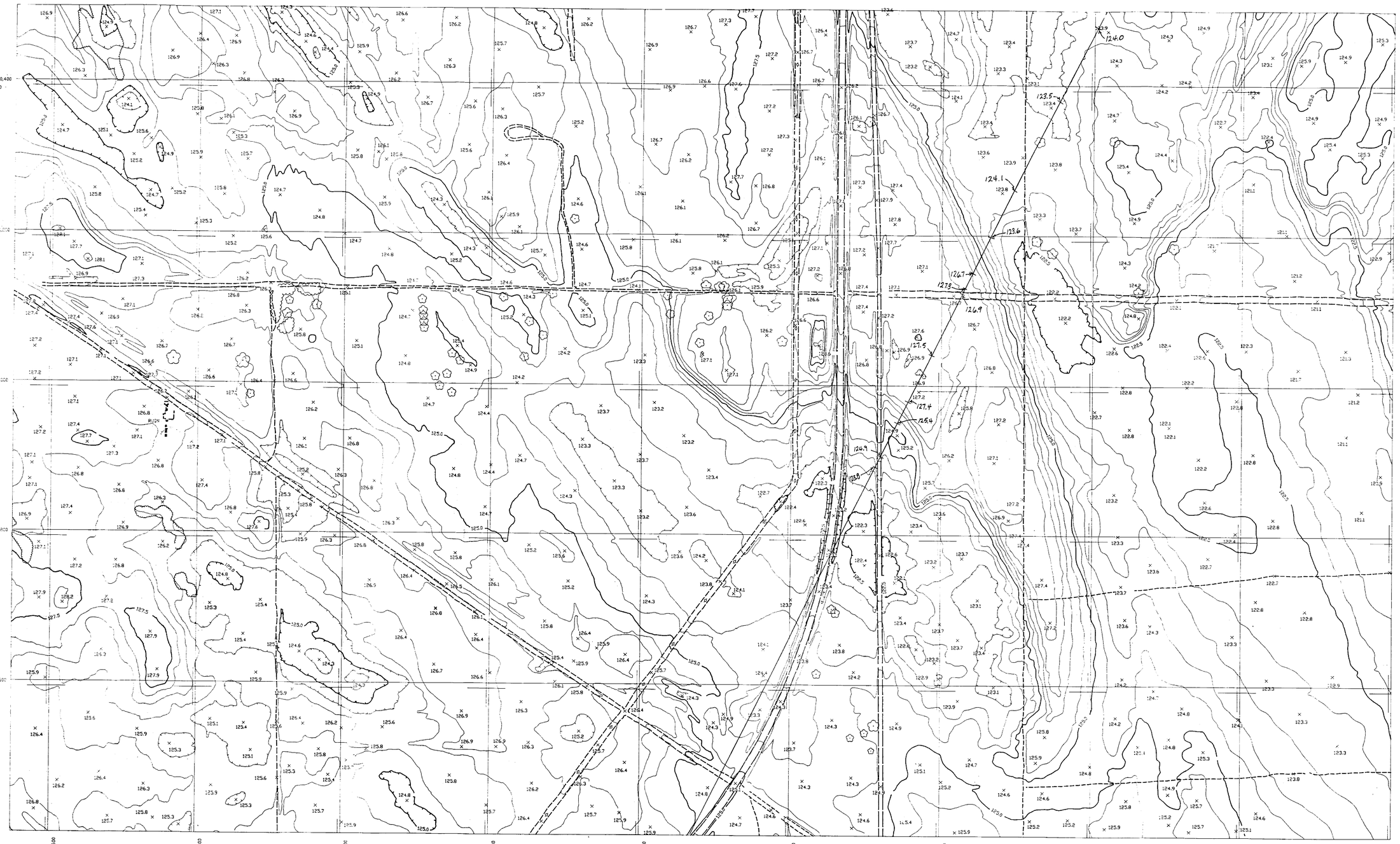
PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0

SCALE 1:2000 JOB NO. ER-0633 SHEET 26 OF 55

KEHCAD

MATCH TO SHEET 40



MATCH TO SHEET 31

MATCH TO SHEET 47

MATCH TO SHEET 38

State of Washington
Photogrammetric Surveyor
William E. Brown
WILLIAM E. BROWN NO. [illegible]

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE
DRAWING TRACEABILITY LIST	

NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MF	REV NO.	DESCRIPTION	REV BY DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE
REVISIONS					

CAD FILE 91103339.DWG. CAD CODE

DRAWN	DATE
CHECKED	KEH SURVEY
SAFETY	N/A
ENVIR	N/A
QE	N/A
LEAD ENG APVD	
APPROVED FOR IMPLEMENTATION	
BY	
FOR	DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

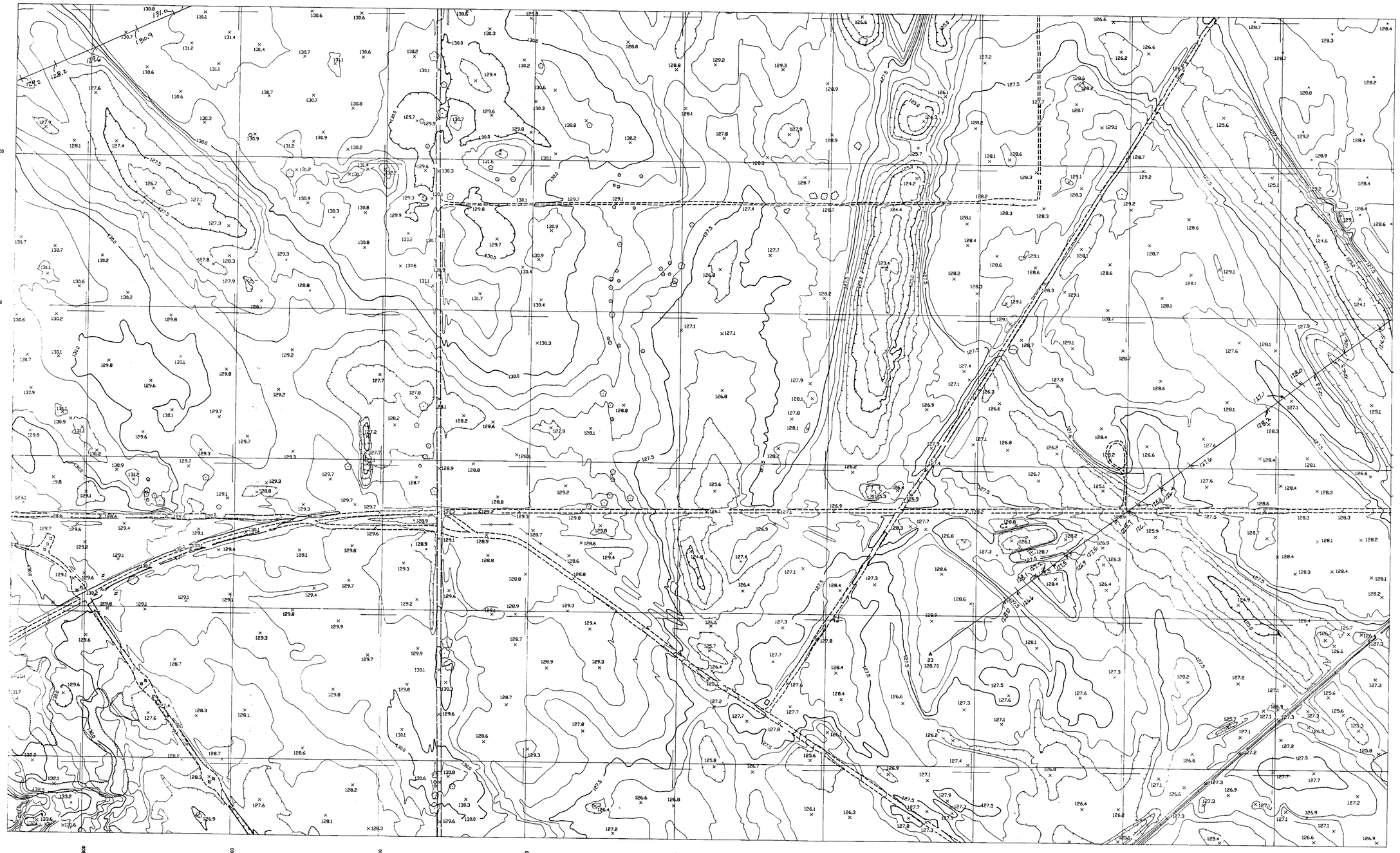
PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0

SCALE 1:2000 | JOB NO. ER-0633 | SHEET 39 OF 55

KEHCAD

MATCH TO SHEET 33



MATCH TO SHEET 31

State of California
Photogrammetric Surveyor
William E. Brown
WILLIAM E BROWN, NO 103

THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS. ALL STANDARDS PRESCRIBED BY SECTION 14, COMPENDIUM OF SUPERFUND FIELD OPERATIONS METHODS, U.S. EPA, 12/87, HAVE BEEN MET.

PHOTOGRAMMETRICALLY COMPILED BY GEONEX CARTWRIGHT, INC.

GRID LINES REPRESENT NAD-83 WASHINGTON STATE SOUTH ZONE COORDINATES.

GRID TICKS REPRESENT GROUND LEVEL COORDINATES.

VERTICAL DATUM NGVD 1929.

1:2000 SCALE — 50 0 50 100 METERS

CONTOUR INTERVAL EQUALS 0.5 METER

NUMBER	TITLE

DRAWING TRACEABILITY LIST

NUMBER	TITLE

REFERENCES

NEXT USED ON

NF	REV NO.	DESCRIPTION	REV BY	DATE	KEH APPROVALS	APVD FOR IMPL/INC FOR DATE

REVISIONS

CAD FILE 91103332.DWG. CAD CODE

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CHECKED	KEH SURVEY	
SAFETY	N/A	
ENVIR	N/A	
QE	N/A	
LEAD ENG APVD		

APPROVED FOR IMPLEMENTATION
BY
FOR DATE

IMPACT LEVEL | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
KAISER ENGINEERS HANFORD COMPANY

100 AREAS TOPOGRAPHIC MAPPING

PROJECT

SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	N/A	N/A	H-1-52166	0
SCALE 1:2000	JOB NO. ER-0633	SHEET 32 OF 55		

KEHCAD