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**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Final Report on the Waste Area
Grouping Perimeter Groundwater
Quality Monitoring Well Installation
Program at Oak Ridge National
Laboratory, Oak Ridge, Tennessee**

J. A. Greene

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

UCN-17560 (6 7-91)

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Environmental Restoration Division
ORNL Environmental Restoration Program

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Quality Monitoring Well Installation Program at Oak Ridge
National Laboratory, Oak Ridge, Tennessee**

J. A. Greene

Date Issued—June 1991

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Prepared for
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
under budget and reporting cod. EW 20

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Oak Ridge, Tennessee 37831-6285
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MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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EXECUTIVE SUMMARY

A groundwater quality monitoring well installation program was conducted at Oak Ridge National Laboratory (ORNL) to meet the requirements of environmental regulations, including the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A total of 173 wells were installed and developed at 11 different waste area groupings (WAGs) between June 1986 and November 1990. The program was conducted under the management of the ORNL Remedial Action Program through FY 1989 and under the ORNL Environmental Restoration Program through completion. It was accomplished through the joint effort of several ORNL divisions and subcontractors.

The wells were installed through a series of general plant projects. Drilling and hydrogeologic subcontracts were utilized for the performance of the work. A blanket well-drilling contract with A. L. Clark Drilling Services was used from November 1986 through April 1987 to provide well construction. A second drilling subcontract with Geotek Engineering, Inc., was used from April 1989 through November 1990. The hydrogeologic subcontractor ERC Environmental Energy Services Co., Inc. (ERCE), formerly MCI Consulting Engineers, Inc., and The EDGe Group, Inc., provided observation and documentation of well installation activities to ensure compliance with procedures, furnished technical advice, and performed hydraulic conductivity testing. ERCE produced a data package for each well and co-authored all of the final installation reports. Field industrial hygiene and health physics coverage was provided by ORNL personnel and their subcontractors.

The Engineering Division of Martin Marietta Energy Systems, Inc., developed the specifications for well construction based upon the criteria provided by ORNL hydrogeologists and requirements identified in the Environmental Protection Agency document, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document* (OSWER-9950-1, September 1986). Engineering Division also provided construction management and mapping/surveying services.

Well installation was basically completed in a WAG-by-WAG sequence. Data packages that document the installation of the wells for each WAG and include a data package for each well were compiled for each of the wells during construction and development. When well construction and development were complete, custody of the wells was transferred to the ORNL Environmental Monitoring and Compliance Department (EMCD) for initiation of sampling. The first-year semiannual sampling of all WAG perimeter wells is expected to be completed by the end of CY 1991.

1. INTRODUCTION

A groundwater quality monitoring well installation program was conducted at Oak Ridge National Laboratory (ORNL) to meet the requirements of environmental regulations, including the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A total of 173 wells were installed and developed at 11 different waste area groupings (WAGs) between June 1986 and November 1990. A location map of the wells is shown in Fig. 1 (see pocket on inside back cover).

2. METHOD OF ACCOMPLISHMENT

The program was accomplished through the support of several Martin Marietta Energy Systems, Inc., organizations under the management of the ORNL Remedial Action Program through FY 1989 and under the ORNL Environmental Restoration (ER) Program through completion in early FY 1991.

2.1 ENGINEERING DIVISION

The Engineering Division administered two blanket drilling subcontracts used to provide well installation and development and related support. The first contract with A. L. Clark Drilling Services extended from November 1986 through April 1987. A second drilling subcontract with Geotek Engineering, Inc., was awarded in April 1989 and continued until completion of the program in November 1990. The well construction was funded by a series of general plant projects (Table 1).

Table 1. General plant projects (GPPs) for groundwater quality monitoring well installation

<u>GPP</u>	<u>FY</u>	<u>Title</u>	<u>Amount (\$K)</u>
AT	85	Groundwater Monitoring Network, Phase I	250
KG	86	Regulatory Compliance Monitoring Wells, Phase I	850
KG	87	Regulatory Compliance Monitoring Wells, Phase II	1100
AT	88	Regulatory Compliance Monitoring Wells, Phase III	1000
GFO1	88	Groundwater Monitoring Network, Phase II	500
KG	89	Groundwater Monitoring Network, Phase III	735

The specifications for well construction were developed by the Engineering Division based upon criteria provided by ORNL hydrogeologists and requirements identified in the Environmental Protection Agency (EPA) document, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document* (OSWER-9950.1, September 1986). Engineering Division provided project management for all construction and development activities to ensure compliance with the construction specifications. In order to maintain productivity and resolve any problems, weekly construction meetings were held with representatives of the drilling subcontractor and the various support groups. Progress was discussed as well as the work schedule for the following week.

An excavation permit for each well location was obtained by Engineering Division personnel. A permitting process that was expanded and refined over the course of the drilling program eventually entailed review and approval of each proposed drilling location by several departments to ensure, as well as possible, that any hazards present were acknowledged and avoided before drilling could begin. One of the purposes of the excavation permit was to obtain a "contamination rating" for each well location. These ratings were assigned by the Radiation Protection Department to indicate a probability of encountering radioactive contamination and by the Industrial Hygiene Department to indicate the probability of encountering chemical contamination. The definitions of the categories are as follows:

- Category 1—low probability of encountering contamination,
- Category 2—moderate probability of encountering contamination, and
- Category 3—high probability of encountering contamination.

The ratings define the level of monitoring and protective measures to be exercised while working at a well site. For example, a well in an area where contamination has neither been detected nor is expected would likely be rated Category 1. Intermittent monitoring by the appropriate department (Radiation Protection or Industrial Hygiene) is required. Well sites in areas where very low-level contamination is known or suspected would likely be rated Category 2. This rating required that representatives from the appropriate department remain on site continuously during drilling activities. The use of protective clothing and the presence of respirators on site were also required. A Category 3 rating was assigned to sites with known or likely presence of contamination. The Category 3 rating involved special requirements, which are explained in Appendix A.

The Civil and Architectural Department of the Engineering Division and their subcontractors provided surveying and staking of wells before drilling, as-built surveying of the completed wells, and production of proposed and as-built well location maps.

2.2 HYDROGEOLOGIC SUPPORT

In-house hydrogeologic support was supplied by personnel from the Environmental Sciences Division and the Energy Division. They provided criteria for well siting and

construction specifications and advice on altering the well construction to fit unusual field conditions.

Hydrogeologic support in the field was supplied by a subcontract administered by the ER project manager. The subcontractors, ERC Environmental Energy Services Co., Inc., (ERCE), formerly MCI Consulting Engineers, Inc., and The EDGe Group, Inc., observed well installation activities to ensure compliance with procedures. They provided technical advice during drilling, performed hydraulic conductivity testing, and chronicled the details of well installation during the course of construction and development. They also operated instruments that measured specific conductance, pH, and turbidity of water samples. Additionally, they checked the work area with an organic vapor analyzer. The ERCE hydrogeologists also produced a data package for each well, submitted well construction data for inclusion in the ER electronic data base, and co-authored all of the final installation reports.

Well installation was basically completed in a WAG-by-WAG sequence. Data packages that document the installation of the wells for each WAG and include a data package for each well were compiled for each of the wells during construction and development. When well construction and development were complete, custody of the wells was transferred to the ORNL Environmental Monitoring and Compliance Department (EMCD) so that sampling could begin. Upon receiving the data packages for the wells, the EMCD personnel removed the locks kept on the wells during development and replaced them with EMCD locks. The wells and their installation dates are listed by WAG in Table 2.

2.3 HEALTH AND SAFETY SUPPORT

The health and safety of field personnel were protected through the use of procedures, training, and monitoring. After January 1988, all field personnel were required to successfully complete 40 h of hazardous worker training from a Martin Marietta-approved course. Drillers and hydrogeologists were required to have a complete physical, a whole body count, and bioassay monitoring before starting and upon terminating work at ORNL. Respirator training and fitting were conducted through the Industrial Hygiene department, and health physics coverage was provided by ORNL personnel or their subcontractors. The breathing zone near the well was checked by the hydrogeologist using a Foxboro Organic Vapor Analyzer. All field personnel were required to wear hard hats and safety glasses. Additional protective clothing was required depending upon site conditions.

Table 2. Groundwater Quality Monitoring Wells at ORNL

Total	Well No.	Area	Date Installed	Total	Well No.	Area	Date Installed
1	745	WAG 6	03-23-87	49	854	WAG 6	03-03-87
2	806	WAG 1	05-12-87	50	855	WAG 6	03-17-87
3	807	WAG 1	05-06-87	51	856	WAG 6	03-20-87
4	808	WAG 1	05-04-87	52	857	WAG 6	03-09-87
5	809	WAG 1	04-19-87	53	858	WAG 6	03-20-87
6	810	WAG 1	05-05-87	54	859	WAG 6	03-24-87
7	811	WAG 1	05-12-87	55	860	WAG 6	03-26-87
8	812	WAG 1	05-14-87	56	946	WAG 1	08-16-89
9	813	WAG 1	06-01-87	57	947	WAG 1	07-25-89
10	814	WAG 1	06-11-87	58	948	WAG 4	10-12-89
11	815	WAG 1	05-20-87	59	949	WAG 4	10-13-89
12	816	WAG 1	05-01-87	60	950	WAG 4	09-23-87
13	817	WAG 1	05-15-87	61	951	WAG 4	12-01-87
14	818	WAG 1	06-02-87	62	952	WAG 4	09-23-87
15	819	WAG 1	05-20-87	63	953	WAG 4	11-20-87
16	820	WAG 1	07-01-87	64	954	WAG 4	04-17-90
17	821	WAG 1	06-22-87	65	955	WAG 4	04-17-90
18	822	WAG 1	06-18-87	66	956	WAG 4	04-20-90
19	823	WAG 1	06-11-87	67	957	WAG 4	04-09-90
20	824	WAG 1	06-04-87	68	958	WAG 4	04-09-90
21	825	WAG 1	05-08-87	69	959	WAG 4	04-03-90
22	826	WAG 1	05-13-87	70	960	WAG 4	04-04-90
23	827	WAG 1	04-30-87	71	961	WAG 4	10-16-89
24	828	WAG 1	06-29-87	72	962	WAG 4	10-11-89
25	829	WAG 1	05-01-87	73	963	WAG 5	07-28-87
26	830	WAG 1	05-13-87	74	964	WAG 5	07-30-87
27	831	WAG 6	02-26-87	75	965	WAG 5	08-17-87
28	832	WAG 6	03-12-87	76	966	WAG 5	08-24-87
29	833	WAG 6	03-07-87	77	967	WAG 5	08-21-87
30	835	WAG 6	03-12-87	78	968	WAG 5	08-24-87
31	836	WAG 6	03-11-87	79	969	WAG 5	08-28-87
32	837	WAG 6	02-25-87	80	970	WAG 5	08-28-87
33	838	WAG 6	03-07-87	81	971	WAG 5	08-26-87
34	839	WAG 6	03-25-87	82	972	WAG 5	08-31-87
35	840	WAG 6	03-20-87	83	973	WAG 5	09-09-87
36	841	WAG 6	03-26-87	84	974	WAG 5	09-01-87
37	842	WAG 6	03-23-87	85	975	WAG 5	09-09-87
38	843	WAG 6	03-21-87	86	976	WAG 5	08-22-89
39	844	WAG 6	03-24-87	87	977	WAG 5	07-14-87
40	845	WAG 6	03-27-87	88	978	WAG 5	07-23-87
41	846	WAG 6	02-26-87	89	979	WAG 5	08-13-87
42	847	WAG 6	03-31-87	90	980	WAG 5	08-17-87
43	848	WAG 6	03-28-87	91	981	WAG 5	07-25-87
44	849	WAG 6	03-07-87	92	982	WAG 5	07-31-87
45	850	WAG 6	03-29-87	93	983	WAG 5	08-14-87
46	851	WAG 6	04-10-87	94	984	WAG 5	08-19-87
47	852	WAG 6	03-28-87	95	985	WAG 3	11-29-89
48	853	WAG 6	03-04-87				

(Table 2 continued)

Total	Well No.	Area	Date Installed	Total	Well No.	Area	Date Installed
96	986	WAG 3	11-20-89	136	1140	WAG 3	03-05-90
97	987	WAG 3	11-18-87	137	1141	WAG 3	02-14-90
98	988	WAG 3	11-09-87	138	1142	WAG 3	03-07-90
99	990	WAG 3	12-31-87	139	1143	WAG 3	03-06-90
100	991	WAG 3	11-12-87	140	1144	WAG 3	02-15-90
101	992	WAG 3	09-28-87	141	1145	WAG 3	01-15-90
102	993	WAG 3	12-09-87	142	1146	WAG 3	02-27-90
103	994	WAG 3	01-14-88	143	1147	WAG 3	01-29-90
104	995	WAG 3	12-05-89	144	1148	WAG 3	03-01-90
105	996	WAG 3	11-28-89	145	1149	WAG 3	03-01-90
106	997	WAG 3	11-27-89	146	1150	WAG 2	12-14-89
107	998	WAG 3	09-25-87	147	1151	WAG 2	12-12-89
108	1071	WAG 7	07-17-89	148	1152	WAG 2	12-13-89
109	1072	WAG 7	06-30-89	149	1153	WAG 2	12-20-89
110	1073	WAG 7	07-06-89	150	1154	WAG 2	12-06-89
111	1074	WAG 7	08-10-89	151	1155	WAG 2	12-12-89
112	1075	WAG 7	08-08-89	152	1156	WAG 2	01-02-90
113	1076	WAG 7	08-14-89	153	1185	WAG 2	12-19-89
114	1077	WAG 7	08-08-89	154	1186	WAG 2	12-21-89
115	1078	WAG 7	08-15-89	155	1187	WAG 2	01-05-90
116	1079	WAG 7	07-20-89	156	1188	WAG 2	05-01-90
118	1081	WAG 7	08-21-89	157	1189	WAG 2	05-10-90
119	1082	WAG 7	08-25-89	158	1190	WAG 2	05-14-90
120	1083	WAG 7	08-11-89	159	1191	WAG 2	05-23-90
121	1084	WAG 7	08-09-89	160	1192	WAG 2	01-18-90
122	1085	WAG 7	08-08-89	161	1193	WAG 2	02-12-90
123	1086	WAG 7	07-27-89	162	1194	WAG 2	02-06-90
124	1087	WAG 8	09-21-89	163	1195	WAG 2	11-21-89
125	1088	WAG 8	01-05-90	164	1196	WAG 17	11-28-89
126	1089	WAG 8	10-12-89	165	1197	WAG 17	11-20-89
127	1090	WAG 8	10-11-89	166	1198	WAG 17	11-15-89
128	1091	WAG 8	12-12-89	167	1199	WAG 17	11-13-89
129	1092	WAG 8	11-16-89	168	1200	WAG 17	12-07-89
130	1093	WAG 8	12-08-89	169	1201	WAG 17	12-11-89
131	1094	WAG 8	10-09-89	170	1202	WAG 17	01-04-90
132	1095	WAG 8	10-13-89	171	1203	WAG 17	05-25-90
133	1096	WAG 9	04-27-90	172	1247	WAG 3	05-21-90
134	1097	WAG 9	04-25-90	173	1248	WAG 3	
135	1139	WAG 3	01-22-90				

3. SEQUENCE OF INSTALLATION

3.1 WELL SITING AND PERMITTING

The first step in the well installation process was the selection of well locations. The in-house hydrogeologists used water level data obtained from a network of piezometers and existing wells to determine hydraulic gradients at the various WAGs. They estimated the interval to be screened to obtain these objectives: (1) to intersect the water table (in shallow wells) so that any contaminants lighter than water could be intercepted, (2) to make the screen deep enough so that the well would not go dry, and (3) to intersect water-bearing fractures (in bedrock wells). Other factors that affected well siting included presence of known or suspected contamination, local geologic conditions, proximity to WAG boundaries, and determination of depth at which significant groundwater flow occurs. Generally, well sites were staked with both single wells and pairs following the WAG boundaries. All locations were reviewed and accepted during field trips by U.S. Department of Energy (DOE), Tennessee Department of Environment and Conservation (TDEC), and EPA representatives, who offered recommendations and suggestions for the best well placement. The locations were assigned a unique four-digit number and were staked and located by coordinate. These locations were then plotted on plant utilities maps during the excavation permitting process for review by the personnel checking for hazards. Only when the excavation permit was approved could drilling begin.

Over 18,000 linear feet of roads and drilling pads were constructed or upgraded during the course of the project to provide access to the well locations selected. Review by the U.S. Army Corps of Engineers was required for roads that involved the installation of drainage pipes. Road and drilling pad construction was performed by the drilling subcontractor.

3.2 CLEANING AND MOBILIZATION OF EQUIPMENT

Before the drilling equipment was mobilized to ORNL, sandblasting of all downhole tools was required to remove any contaminants present. Upon arrival, the driller was stationed at a "staging area" where well construction materials, tools, and equipment were delivered and stored. The rig and tools underwent a cleaning procedure before the first use and after drilling at each well. The procedure consisted of washing with a hot-water, high-pressure sprayer and soap, then rinsing with the sprayer. The tools (not the rig) were then rinsed with isopropyl alcohol followed by deionized water. The tools were wrapped in clean plastic sheeting until they were ready for use at the drill site. Plastic sheeting was also spread over the drill site before the rig was set up to contain any hydraulic fluid leaks from the rig.

3.3 AUGERING AND SPLIT-SPOON SAMPLING

There were basically two well types installed as a part of this program: soil/bedrock interface or "shallow" wells and bedrock or "deep" wells. The first step of drilling either well type involves augering through the soil portion. Shallow wells were augered to refusal, at which point the well was installed in the borehole. Deep wells were augered to a predetermined depth, which was specified based on review of local conditions by a staff hydrogeologist. Continuous soil samples were collected during drilling of each well (with the exception of well pairs where typically samples were obtained for only one of the wells) by hydraulically pushing a split-spoon sampler tube ahead of the auger. Soil samples (as well as drill water samples) were collected by the on-site hydrogeologist according to the procedure in Appendix B. Samples were submitted to the ORNL Analytical Chemistry Division for chemical analysis. The analyses performed on the soil and water samples generally included an inductively coupled plasma (ICP) scan for metals and analyses for ^{40}K , ^{137}Cs , ^{60}Co , and gross beta. The percent-moisture content was also determined for the soil samples.

Containment of cuttings was required for all types of drilling at ORNL to prevent dispersal into the environment. During augering, containment was achieved through the use of a metal pan with a hole in the center that surrounds the boring. As cuttings were generated, they accumulated in a pile within the pan. The procedure followed for disposing of auger cuttings is included as Appendix C.

3.4 DRILLING IN ROCK

Deep wells were installed below the bedrock level and involved air rotary drilling through the rock portion. After augering to a specified depth, a "diverter" casing was installed and grouted in place to allow the use of a special containment system. Air rotary drilling is done by using tricone bits, which grind the rock while a high-velocity air stream (with a small amount of water added for dust control) blows the cuttings up through the annular space surrounding the drill steel (Fig. 2). A gasketed fitting over the top of the diverter casing routes the exiting air/water/cuttings mixture to a hose that leads to the containment tank. The cuttings and water drop out of the stream inside the tank, and the air is released through a stack containing demister elements and a high-efficiency particulate air (HEPA) filter (Fig. 3). The tank contents were handled according to the procedure in Appendix C.

After drilling 2 ft into bedrock, a steel surface casing was installed and grouted in place to prevent water from above bedrock from entering the interval to be sampled. Air rotary drilling continued after waiting 24 h for the grout to cure.

3.5 INSTALLING THE WELL

Although air-rotary drilled holes were generally clean and free of mud and cuttings after drilling, the augered holes required bailing with a 4-in.-diam steel bailer on a cable before the well could be installed.

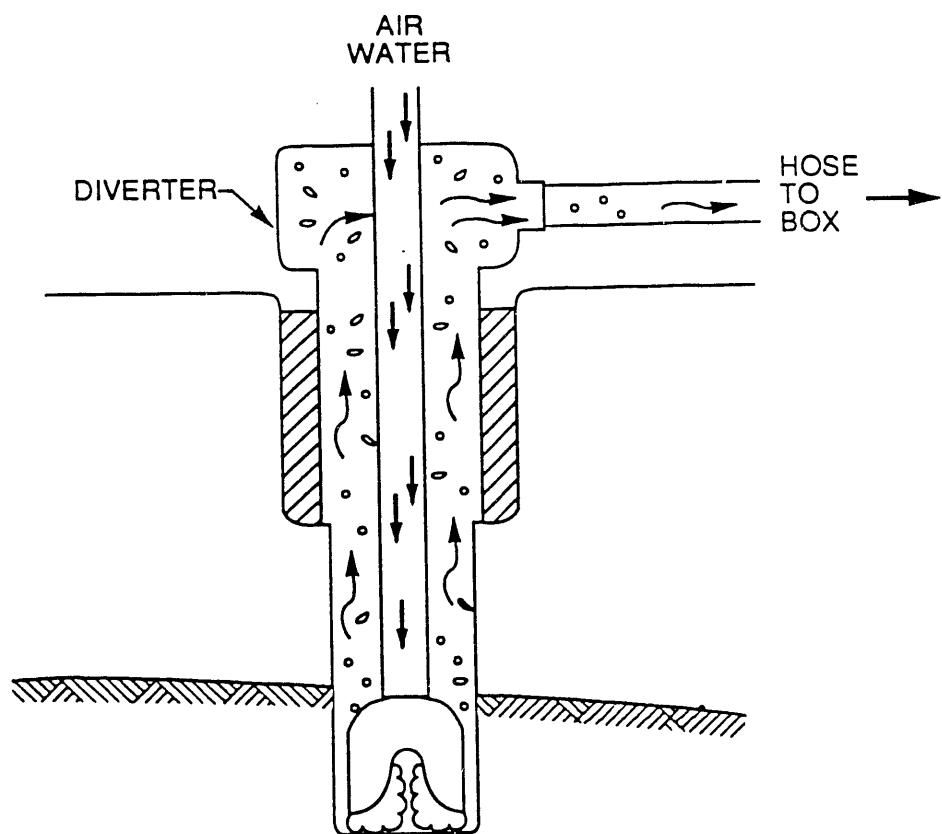


Fig. 2. Cross section of air rotary drilling.

ORNL-DWG 91M-11457

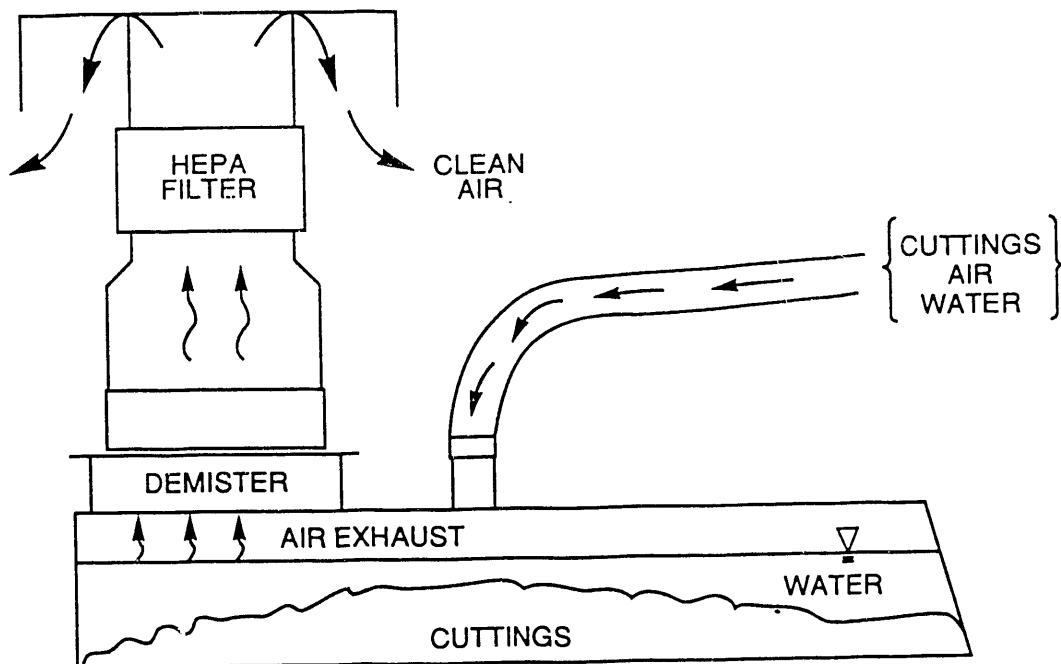


Fig. 3. Cross section of air rotary drilling containment box.

After drilling and bailing the borehole, the first step in well installation was placement of the centralized stainless steel screen and casing to the specified depths. All the materials used in the well construction were accompanied with a material certification form from the manufacturer or supplier to ensure that the product met the project specifications. (The certification forms are kept on file at the ER Documentation Management Center.) All stainless steel casing and screen were precleaned and sealed in plastic by the manufacturer and were not opened until the moment of installation into the borehole. The cleaning procedure specified by Engineering Division is included in Appendix D.

The next step was the installation of the sandpack. The sand was placed by washing it through a funnel and tremie pipe with potable water. The sand was added to a depth of 2 ft over the top of the screen. Next, a bentonite clay seal was added by pouring pelleted bentonite pellets to create a 1.5- to 2-ft-deep bentonite seal. If no water was present in the annulus, potable water was added to hydrate the pellets.

After allowing 45 min for the pellets to swell, the annulus was grouted with a Portland cement grout to the ground surface through a tremie pipe. Cross-sectional sketches of shallow and deep wells are shown in Fig. 4.

3.6 WELL FINISHING

Each well was completed with a steel protective casing, locking cap, steel guardposts, and a concrete pad. The well number assigned by Engineering Division during the excavation permitting process was stamped on a stainless steel nameplate and attached to the casing. Wells installed after June 1989 were painted high-traffic yellow; plans are under way to paint the original 55 wells. The use of a consistent color for all water quality wells will provide a means of instant identification of well type in the field. The paint will not only protect the metal from weathering but will also make the wells highly visible to help protect them from damage by vehicles.

3.7 WELL DEVELOPMENT

The development of wells was required after well installation to remove drilling fluids and disturbed sediments. The goal for development was the removal of a minimum of three well volumes and a final turbidity of 5 Nephelometric turbidity units (NTU) or lower. The methods used for well development were refined and improved during the course of the project to speed the process in local conditions. The methods evolved into the procedure included in Appendix E. The procedure followed for disposal of well development water is included in Appendix C.

3.8 HYDRAULIC CONDUCTIVITY TESTING

After development, the wells were slug tested by the subcontract hydrogeologist to determine the coefficient of hydraulic conductivity for the aquifer in the area of the well screen. The procedure used is included in Appendix F.

ORNL-DWHM 91M-11459

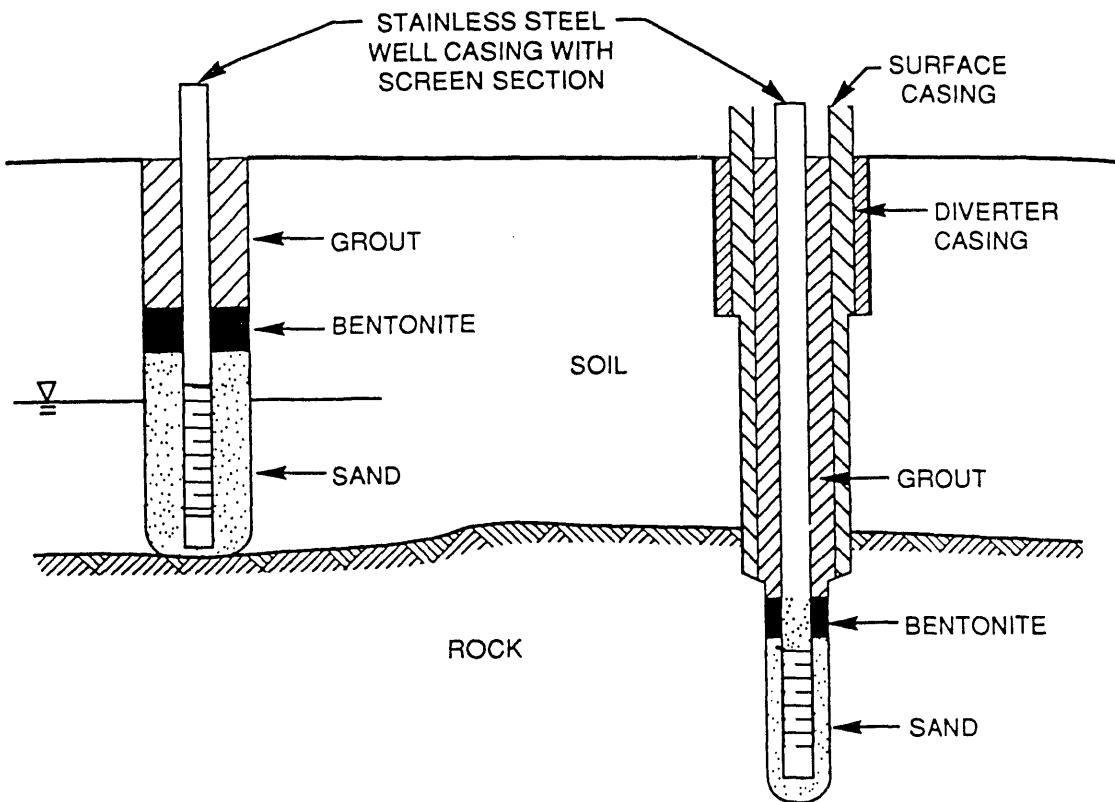


Fig. 4. Cross section of a shallow well and a deep well.

4. SPECIAL ITEMS

Several problems encountered during the course of the project required special solutions, some due to site conditions and others due to changing company policies. Some examples follow.

4.1 STEAM CLEANING AREA

The cleaning procedures required for the drill rigs and tools necessitated the steam cleaning of equipment after drilling at each well. Equipment was checked for contamination with field instruments and, if found to be contaminant free, was "green tagged" and transported to an area for washing. The area used for this activity from February 1987 through October 1987 was a site located north of Trench 7 in Melton Valley. In the autumn of 1987 when radioactivity was detected in vegetation nearby (radioactivity resulted from past waste disposal activities at the pits and trenches and not from well installation activities), this area was closed to prevent exposure to workers. Until installation activities were ceased in April 1988, permission was given by the ORNL environmental compliance group to use an existing gravel pad and containment pit built for the Hydraulic Head Measuring Station near Chemical Waste Pit No. 6.

Preceding start-up of the second drilling contract, a new steam cleaning area was completed east of Solid Waste Storage Area (SWSA) 5 in Melton Valley in June 1989. The area consists of a large, sloped, gravel-covered area underlain by layers of compacted soil and plastic sheeting. Two holding basins at the lower edge collect runoff from the washing operations while a third basin holds contents from the air rotary containment boxes (see Appendix C). When a basin became full of water, a sample was collected and analyzed for gross alpha, gross beta, and sometimes tritium* depending upon the area being drilled at the time of the testing. When the water was determined to be free of contaminants, it was pumped out of the pit and released through a dispersion system into a silt fence.

A separate, indoor cleaning facility (the Equipment Cleaning Facility, Building 7935), which was equipped for cleaning low-level contaminated equipment, was built during the course of the drilling project. However, use of the facility was never required because any contamination detected on tools was removed when the mud was scraped off during precursory cleaning at the drill site.

4.2 DRILLER'S STAGING AREA AND OFFICE TRAILERS

A large gravel area east of the ORNL main plant was set aside for the drilling subcontractor to use as a staging and field office area. Both the drilling company and the hydrogeologic subcontractor placed office trailers on site. The area proved essential as a

*Testing for tritium will be done for the pit if activities involved wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

central location for receiving and storing supplies and tools and for employee parking. The hydrogeologists' office trailer provided a place for a desk so that paperwork could be done and a fireproof file cabinet for storage of data packages. Field instruments and sampling supplies were also stored there.

4.3 CASING SUPPORT SYSTEM

During the first phase of drilling, an incident occurred when a steel surface casing, which was being installed and grouted in place, "floated up," possibly allowing grout to seep underneath. Subsequently, a requirement was added to the specifications that the rig must remain at the well site after grouting to hold down the casing until the grout hardened. Although this additional requirement caused increased expense as the rig time was charged at the "standby time" rate, it was considered necessary to prevent poor well construction. This problem was resolved during the second phase of drilling by use of a casing support system designed by Geotek Engineering. It consisted of a metal tablelike structure which was placed over the surface casing after grouting and loaded with dead weight. With the support system in place, the rig was free for use at the next well site.

4.4 GO/NO-GO GAUGE

Some of the initial borings drilled had deviation problems that made pump installation difficult. A test for well straightness was devised for the second contract. It was stipulated that before the wells would be accepted from the driller, they must pass a deviation test using what was called a go/no-go gauge. The gauge consisted of a specially constructed 6-ft piece of stainless steel casing (either 2-in.- or 4-in.-diam) which was lowered into each completed well using a workover rig.

4.5 TWO-WAY RADIOS

The use of two-way radios to communicate during well construction and development proved indispensable for orchestrating the movements of the various organizations and field crews that supported the project. Since each hydrogeologist monitoring the well construction carried a radio on the same laboratory frequency as the construction manager, the manager could always be contacted for information and guidance. The communication network also allowed contact with the plant emergency personnel in case of an emergency.

4.6 DEVELOPMENT METHODS

The first group of wells completed (WAG 6) was developed with the use of one crew, which proved slow and inefficient. An air-lift pump that required cleaning between wells was used to purge water from the wells, and a Well Wizard brand dedicated bladder pump was installed in each well for future sampling. Since some of the wells had extremely slow recharge rates, much time was spent waiting for the wells to fill.

After WAG 6, wells were developed by using a combination of special equipment, including a surge block, a development pump, and dedicated well pumps. The surge block was designed by Engineering Division and was made of solid stainless steel. The surge block was raised and lowered in the well as specified in the procedure in Appendix E. The development pump, which required cleaning between wells, was capable of pumping large volumes of muddy water and was therefore used on the muddiest wells. It had Teflon surge rings outside the pump body to agitate the water in the well as the pump was raised and lowered. The dedicated pumps for these wells were Geoguard pumps with threaded extension tube attachments to remove sediment from inside the bottom of the screen. The pumps can be used in either the air lift mode to pump large volumes of water or in the bladder mode, which does not pump as much water but maintains the integrity of the water sample by preventing mixing with air. Sketches of these pumps are shown in the figure included with Appendix E.

The method used to measure the turbidity of the water in the well was also improved during the second phase of the project. A Cole-Parmer brand turbidimeter was used, which measures NTUs by passing a lens-focused light beam through a test tube filled with the sample. The intensity of the exiting light beam is detected by a photosensor, indicating the turbidity of the sample, which is displayed on an analog scale. This represented significant improvement over the old method, which depended upon the visual comparison of the sample to prepared standards.

4.7 WASTE DISPOSAL

A general waste management plan was written for the disposal of waste produced during the project. Late in the project, the need for a specific procedure for disposing of contaminated containment box cuttings was recognized. Since solids with free liquids present were not accepted for disposal at SWSA 6 and since a full containment box contains about 60% water, a method of dewatering the contents was required.

A method developed by Bechtel National, Inc., was used to transfer the contaminated water and cuttings to drums. The method utilized a vacuum with a HEPA-filtered exhaust to first remove the water and then the cuttings. A sketch of the setup is shown in Fig. 5. Once the transfer was made to the drums, the clear liquid could be treated at the wastewater treatment plant. The drums containing sludge mixtures were left sealed at a drum storage area until the sediment settled to the bottom and the clear liquid could be decanted off the top. The remaining sludge was solidified by placing the drum on a tilting device. The drum tilter allowed the sludge to be poured into a second drum while intermittent layers of cement/bentonite powder were mixed in with a wooden paddle to absorb the free liquids.

ORNL-DWG 91M11459

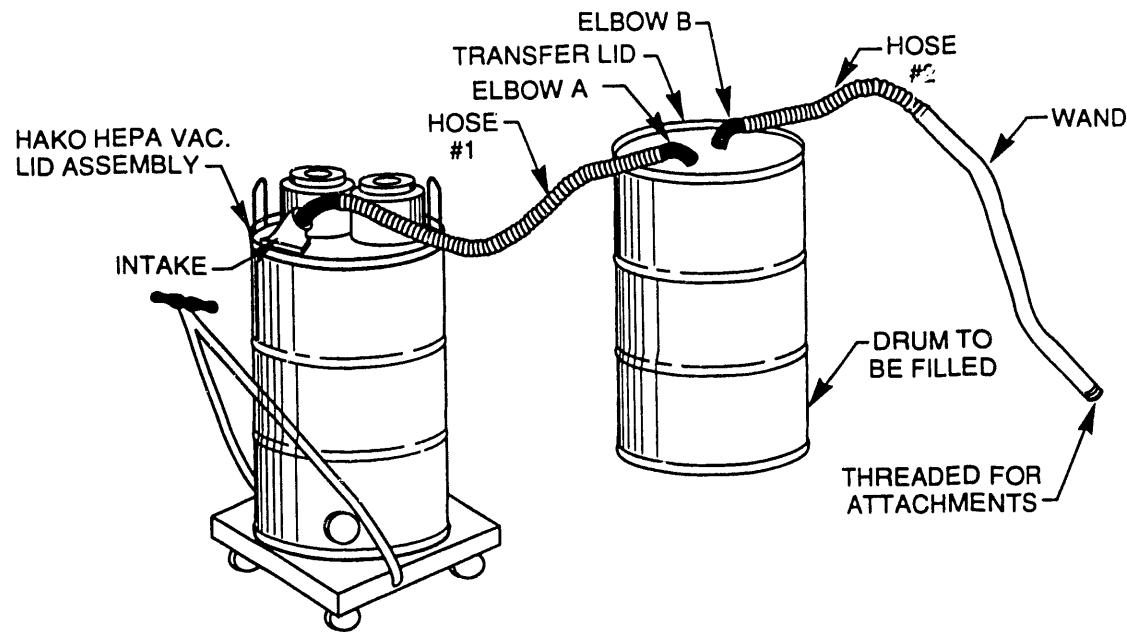


Fig. 5. HEPA vacuum setup.

APPENDIX A

GUIDELINES FOR DRILLING GROUNDWATER QUALITY MONITORING WELLS IN HEALTH PHYSICS CATEGORY 3 AREAS

APPENDIX A

**GUIDELINES FOR DRILLING GROUNDWATER QUALITY
MONITORING WELLS IN HEALTH PHYSICS CATEGORY 3 AREAS**

Note: This document is not intended to be a strict procedure or specification. Its objective is to give basic guidelines for drilling in areas rated Category 3 by Health Physics (but not Industrial Hygiene Category 3). It may be adjusted and refined according to conditions in the field.

A Category 3 area is the same as a Category 2 area, except the probability of drilling into contamination is higher. Therefore, a slightly different method will be used to install Category 3 wells. Drilling and hydrologic personnel who will be entering the C-zone will go to the change house (Bldg. 2069) to change into khakis or coveralls to be worn under Tyvek suits supplied at the drill site by Engineering. The health physicist (HP) on site will assist the workers in dressing out at the drill site. Workers within the C-zone will follow the rules taught in Category 3 training. Respirators in protective plastic bags will be kept on site and ready for use when called for by the HP or an industrial hygiene (IH) representative. When exiting the C-zone, the HP will provide guidance in proper removal and disposal of protective clothing, segregating disposable waste and reusable clothing in plastic bags.

The first step will be to lay down a double layer of plastic sheeting over the drill site. Covering of equipment and tools with plastic and/or tape will be done if recommended by the HP on site. Initially, a 6-in.-diam hollow stem auger will be used to drill through soil at each location. Split-spoon samples will be collected through the 6-in. augers. When soil from the original ground surface below the gravel pad is brought to the surface in a sample tube or on the augers, the HP may detect radioactivity. The auger cuttings will be collected in the auger pan, as usual. The HP will check the auger cuttings and soil samples and will indicate if he is detecting any radioactivity. He will inform the drillers when the cuttings should be shoveled into drums. Cuttings that do not read significantly will be scattered in the vegetation away from any streams. The hydrogeologist will check the borehole, cuttings, and soil samples intermittently with the organic vapor analyzer (OVA). (If volatiles are detected, an IH representative will be called to advise.) The hydrogeologist will handle all samples with gloves and will perform bulk density tests on samples with detectable contamination by weighing the sample in a jar. All soil samples will be disposed of along with the auger cuttings (unless a sample for analysis is requested by the HP or IH representative). The HP will stop the drilling if readings on the soil cuttings are higher than 10 mrem/h. At that point, he may ask that the augers be pulled up and the excess cuttings be removed so that a reading of the auger can be taken. The HP will advise Engineering if he believes that the auger or tools will still read higher than 10 mrem/h after excess soil is removed. [The limit that will be accepted at the Equipment Cleaning Facility (ECF) is 10 mrem/h.] Depending upon the depth drilled and specific conditions, Engineering will decide whether to abandon the hole and backfill with soil or sacrifice augers in order to complete the boring. Any tools or equipment that become contaminated will be prepared for cleaning at the ECF. (Engineering will decide the

disposition of any items that read greater than 10 mrem/h after precursory cleaning in the field.) The HP will advise Engineering to stop work when inclement weather or unusual conditions inhibit containment of contaminated material.

If Engineering decides to complete the boring, the hole will be drilled to the desired depth and reamed with a larger auger. If the well is a planned Type B well, a 22-in.-diam auger will be used to about 10 ft and a 16-in.-diam diverter casing will be set. Then the hole will be reamed the rest of the way to rock with a 15-in.-diam auger. At that point, a 15-in.-diam air rotary bit will be used with the containment box to drill 2 ft into rock, and a 10-in.-diam surface casing will be set. A 9 7/8-in.-diam air rotary bit will be used to complete the boring in rock, and the well will be installed at that point. (Routine setup times for bentonite and grout will be used.)

If the well is a planned Type A well, the 6-in.-diam auger hole will be reamed with a 12-in.-diam auger with a stainless steel plate pressed in place at the bottom to prevent any groundwater or cuttings from entering the center of the auger. When the auger reaches the termination depth, the center of the auger will be filled with potable water. The plate will be knocked loose from the bottom of the auger by using a stainless steel rod. The well will be installed at that point through the center of the auger. The auger will remain in the borehole and the stainless steel screen and casing will be lowered through the center. The sandpack will be tremied into the annular space between the screen and the auger. The auger will be slowly lifted to allow the sand to flow out into the open borehole. Next, bentonite pellets will be poured into the annular space as the auger is slowly lifted. After the bentonite plug has set up, the auger will be removed from the borehole as the remaining annular space is tremie grouted. The well will be completed as usual.

While drilling with the containment box, special care will be taken to ensure that all seals are performing properly. When the containment box becomes full, the hydrogeologist will check for volatiles through a port with the OVA. If volatiles are present, an IH representative will be called to advise. The HP will collect a sample and deliver it to the Analytical Chemistry Division (ACD) where it will be analyzed for gross alpha, gross beta, and tritium*. ACD will phone the results to Jill Greene when they are ready. (A 1.5-h turnaround time is planned.) If the gross beta reads 100 Bq/L or less, gross alpha reads 10 Bq/L or less, and tritium* reads 75,000 Bq/L or less, the containment box may be dumped in the steam cleaning area pit. If it reads greater than the above limits for tritium*, it will require decanting at the treatment plant. If it reads greater than 100 Bq/L gross beta, the sample will be further analyzed for Co, Sr, and Cs. (These analyses will not be short-term turnaround, so the box will have to be set aside until results are in.) If further testing shows nothing above releasable levels, the containment box may be dumped in the steam cleaning area pit. Otherwise, it will be taken to the ECF to be cleaned by Martin Marietta chemical operators. Results from any analyses requested by an IH representative will be interpreted by IH. IH and Environmental Monitoring and Compliance will determine what subsequent steps must be taken for soil, water, or cuttings disposal.

*Testing for tritium will be done for the pit if activities involved wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

APPENDIX B

**PROCEDURE FOR TAKING WATER AND SOIL SAMPLES
DURING WATER QUALITY MONITORING WELL INSTALLATION**

APPENDIX B**PROCEDURE FOR TAKING WATER AND SOIL SAMPLES DURING
WATER QUALITY MONITORING WELL INSTALLATION****I. PURPOSE**

To define a standard method of sample collection of soil and water during well installation that assures quality samples for accurate data recovery.

II. REQUIREMENTS**A. Sample Jars**

1. Shall be sterile glass jars with Teflon-lined lids.
2. Shall be labeled with indelible ink and the lids sealed with a custody seal that must be broken to open the jar.
3. The samples shall be numbered as shown in Fig. B.1. The well and sample numbers shall be written in this format on the sample label, all chain-of-custody forms, and throughout the data package.

B. Soil Samples

1. Soil borings from split spoon samples shall be logged by the on-site hydrogeologist for visual and physical characteristics.
2. In drilling through the soil, a sample shall be taken from the unsaturated zone, the screened interval (saturated zone), and any suspect or unusual intervals.
3. The sample shall be touched only with sterile gloves.

C. Wet Bulk Density Test

1. Approximately 30 cm of core that is as undisturbed as possible should be cut from the split spoon. A clean vertical cut should be made with the knife so that the volume of the split spoon can be calculated.
2. The length of the core should be measured to the nearest 0.1 cm. If at least 10 cm of undisturbed core cannot be obtained, the physical parameters should not be measured.
3. The core should be weighed to the nearest 0.1 g.
4. The volume and the wet bulk density are computed.

SITE NAME	DATE
WAG 7	1/12/89
ANALYSIS	TIME
ACD Request form on file	15:20
PRESERVATIVE	
<u>0832501</u>	

Fig. B.1. Sample label.

5. If a different sample is available, a duplicate measurement should be made.
6. From one of the samples used to calculate wet bulk density, a 100- to 150-g representative subsample shall be collected for analytical work. Weigh it to the nearest 0.1 g.
7. The weight and the average bulk density should be recorded on the drill log.
8. The samples should then be delivered to the ORNL Analytical Chemistry Division (ACD) with a chain-of-custody form.

D. Drilling Water Samples

1. One sample shall be taken per tank per well from the pump outlet.
2. The samples shall be taken so that no free air space is present in the jar.
3. The water samples shall be kept cool until transferred to ACD with chain-of-custody forms.

E. Well Water

1. Undeveloped well water samples shall be taken only when unusual circumstances are encountered. The need for a sample is determined by the subcontract hydrogeologist or requested by Energy Systems.
2. Samples shall be taken with a clean bailer.
3. The sample shall be taken so that no free air space is present in the jar.
4. The water sample shall be kept cool until transferred to ACD with a chain-of-custody form.

F. Rock Cuttings

Because rock cuttings must be contained in the containment box, samples will not be representative of any particular stratum encountered. Therefore, samples shall be taken only when deemed necessary by the subcontract hydrogeologist or when requested by Energy Systems.

APPENDIX C

OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM WELL DRILLING AND DEVELOPMENT OF THE GROUNDWATER QUALITY MONITORING WELLS

APPENDIX C

OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM WELL DRILLING AND DEVELOPMENT OF THE GROUNDWATER QUALITY MONITORING WELLS

1. PURPOSE

The purpose of this document is to cite the steps that are followed to handle water and soil produced during the installation and development of wells.

2. SCOPE

This document applies to well drilling and development associated with the Groundwater Quality Monitoring Wells Installation Program at Oak Ridge National Laboratory (ORNL).

3. REFERENCE

Health, Safety, and Environmental Protection Procedures for Excavating Operations, ORNL/M-116/R1, Oak Ridge National Laboratory, March 3, 1988.

4. DEFINITIONS

Well Ratings. Ratings assigned during the excavation permit cycle by Radiation Protection (RP) and Industrial Hygiene (IH) to indicate the probability of encountering radioactive and chemical contamination, respectively. These ratings are based on historical information or from previous drilling or excavation activity. The ratings are marked on the excavation permits. (RP ratings on permits may sometimes be called "HP" for "Health Physics"; the two designations are interchangeable.) Protective measures required for the three categories are stated in Table 1, "Excavation-classification categories," in ORNL/M-116/R1. The categories for soil handling are stated in Appendix B, "Radiological Soil Handling Criteria," in ORNL/M-116/R1.

RP Category 1. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is low and that intermittent monitoring is required.

IH Category 1. A rating assigned by IH which indicates that the probability of encountering chemical contamination (i.e., organics) is low and that monitoring is not required by IH. An IH and/or Environmental Monitoring and Compliance (EM&C) representative will be called in anytime chemical or hazardous contamination is suspected.

RP Category 2. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is moderate and that continuous monitoring is

required. The RP representative will determine the necessary level of protective clothing to be worn.

IH Category 2. A rating assigned by IH which indicates that the probability of encountering chemical contamination is moderate and that respirators must be on site and ready for use by the workers when indicated by the IH or RP representative on site. Location will be checked periodically with an IH field instrument, such as a photovac or OVA.

RP Category 3. A rating assigned by RP which indicates that there is a high probability of encountering radioactive contamination. Therefore, continuous monitoring by an RP representative is required, and protective clothing must be worn. In addition to the training listed above, workers must have successfully completed the Category 3 driller training course that is administered by Environmental and Health Protection Division (E&HP) personnel.

IH Category 3. A rating assigned by IH which requires that workers wear respirators as a minimum. Additional protection deemed appropriate by IH will be designated for each location. Continuous monitoring by IH personnel is required.

Training Requirements. Training requirements for workers include the basic radiation training administered by E&HP personnel and the 40 h of training required by the Superfund Amendment Reauthorization Act (SARA) through a company-approved course. There is an additional training course required for Category 3 drilling.

Air rotary containment box. A box specially designed to contain the cuttings and water that are blown from the borehole during air rotary drilling. The box is equipped with a high-efficiency particulate air (HEPA) filter to prevent particles that possibly contain contaminants from being dispersed into the air. Air rotary drilling is generally used only for drilling into bedrock.

Auger pan. A metal catch pan with a hole cut in the middle. The pan surrounds the borehole and contains soil cuttings as they are augered up.

Proper On-Site Disposal. Disposal of noncontaminated soil and water produced from work on a well at a location near the well that is not openly visible to the public and has no risk of causing erosion or direct discharge into a stream. The construction engineer (CE) will indicate to the drillers which areas are acceptable for on-site disposal. The pH will have been checked and adjusted to the 5-to-9 range before releasing. This precise definition is intended wherever this term is used in this procedure.

Proper Contaminated Waste Disposal. Generally, radioactively contaminated soil will be packaged in drums and tagged by the RP representative for disposal by ORNL Waste Operations. However, Category-2-level soil may be used on site as backfill in remote areas when covered by 1 ft of noncontaminated soil as stipulated in ORNL/M-116/R1. The CE will specify to the drillers when a well location has been

approved by EM&C for on-site disposal of contaminated soil. This definition is intended wherever this term is used in this procedure.

Temporary Drilling Equipment Cleaning Facility. An outdoor area located in Melton Valley for steam cleaning of drill rigs and associated equipment, referred to as the steam cleaning area.

Containment Box Holding Pit. A lined pit at the Temporary Drilling Equipment Cleaning Facility. The contents of the pit will be sampled and tested for gross alpha, gross beta, pH, and tritium*, before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.

Steam Cleaning Pits. Two lined pits at the Temporary Drilling Equipment Cleaning Facility that collect runoff from the steam cleaning operations. The contents of the pits will be sampled and tested for gross alpha, gross beta, pH, and tritium* before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.

5. RESPONSIBILITIES

- 5.1 Radiation protection personnel monitor and determine the presence of detectable radioactive contamination in drill cuttings during well-drilling activities; provide guidance to ensure that exposure to the workers, public, and environment are kept as low as reasonably achievable; and provide radiation monitoring during the precursory cleaning by the drillers.
- 5.2 Well-drilling personnel perform well drilling and completion activities; package soil and water in appropriate containers and transport it, if necessary; perform precursory cleaning of low-level contaminated equipment; and clean equipment between the drilling of each well.
- 5.3 EDGe hydrogeologists observe all crucial well installation activities and record data for all boreholes drilled; visually inspect the cuttings produced during augering, noting any unusual occurrences and obvious deleterious material encountered during the drilling process; and check the cuttings and water with a Photovac or OVA or similar instrument and pH of water when necessary.
- 5.4 Construction engineer serves as the field contact and provides guidance to the drillers during field activities.

*Testing for tritium will be done for the pit if activities involved wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

6. PROCEDURE

6.1 EXPLANATION OF THE WELL RATING SYSTEM

Each well is assigned a rating by RP and IH before drilling begins. Because additional information is gained during drilling, well ratings may be changed by RP and IH as the work progresses. A lower RP category rating will be changed to a Category 3 rating upon encountering radioactive contamination within the Category 3 range defined in ORNL/M-116/R1. Likewise, an IH Category 3 may result if chemical contamination is detected in a well with a lower rating. The RP and/or IH representative on site will notify the on-site personnel when conditions warrant a rating change. Any additional actions or modifications in protective clothing required by the rating change will be executed at that time. The change will be documented immediately by the on-site hydrogeologist in the well data package and the RP and/or IH representative by a signed written statement indicating the well number, the old and new ratings, and the rationale supporting the change. The statement will be sent by the RP and/or IH representative to the CE for filing with the original excavation permit, and a copy will be sent to the ER Well Installation Manager by the CE.

A well category may also be changed from a higher rating to a lower rating. For example, if no contamination is encountered while drilling a Category 2 or 3 well, the rating may be changed to a lower one after drilling to a certain depth or for development purposes, depending on the history of the area. The documentation procedure stated above for an increase in rating must also be followed for a decrease in rating.

6.2 CATEGORY 1 WELLS (RP OR IH)

6.2.1 Category 1 Drilling

6.2.1.1 Category 1 Auger Cuttings

- a. Auger cuttings will be collected in a catch pan.
- b. An RP representative will scan the cuttings intermittently to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor by the hydrogeologist.
- c. If there is no contamination detected, proper on-site disposal or disposal at the steam cleaning area will be done.

6.2.1.2 Category 1 Air Rotary Drilling

- a. Cuttings will be collected in a containment box.

- b. When the containment box is full, one of the following will be done to empty cuttings and/or decant water from the containment box:
 - (1) proper on-site disposal or
 - (2) disposal at the containment box holding pit.

6.2.2 Category 1 Well Development

- a. Water removed from the well will be contained in drums.
- b. The pH of the water will be measured and will be adjusted to be between 5 and 9 by the CE if it is above or below that range.
- c. Drums of water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.

6.3 CATEGORY 2 WELLS (RP AND IH)

6.3.1 Category 2 Drilling

6.3.1.1 Category 2 Auger Cuttings

- a. Auger cuttings will be collected in a catch pan.
- b. An RP representative will scan the cuttings continuously to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor and tested with a Photovac or OVA by the hydrogeologist for presence of RCRA materials.
- c. If no contamination is detected, proper on-site disposal or disposal at the steam cleaning area will be done.
- d. Cuttings will be contained in drums if contamination is detected. Proper disposal will be arranged by Martin Marietta Energy Systems through Waste Operations.

6.3.1.2 Category 2 Air Rotary Drilling

- a. Rock cuttings and drill water will be collected in a containment box.
- b. When the containment box becomes full, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for the presence of RCRA materials by the hydrogeologist.

- c. If no contamination is detected, one of the following will be done to empty cuttings and/or decant water from the containment box:
 - (1) proper on-site disposal or
 - (2) disposal at the containment box holding pit.
- d. If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems through Waste Operations to properly dispose of the water. Further laboratory testing of the contents of the box may be done.

6.3.2 Category 2 Development

- a. Water removed from the well will be contained in drums.
- b. When the drums are ready to be emptied, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for presence of RCRA materials by the hydrogeologist. The pH will be adjusted if necessary.
- c. If no contamination is detected, the water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.
- d. If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems to properly dispose of the water. Further laboratory testing may be done.

6.4 CATEGORY 3 WELLS (RP AND IH)

6.4.1 Category 3 Drilling

6.4.1.1 Category 3 Augering

- a. When a well is classified as an RP Category 3 or an IH Category 3, continuous monitoring will be required by RP and IH. Wearing of respirators will be required. Cuttings will be inspected for any unusual discoloration or odor. Tests for chemical contamination (i.e., organics) will be performed with IH field instruments by an IH representative for IH Category 3 wells. Specially trained personnel will be required to do the drilling.
- b. If no contamination is detected by RP or IH while augering through soil to bedrock, a rating may be changed by RP or IH to a Category 2 depending on the depth, type of contamination expected, and history of the area.

- c. If contamination is detected during augering, cuttings will be drummed. Proper disposal of all cuttings and water will be arranged by Martin Marietta Energy Systems.

6.4.1.2 Category 3 Air Rotary Drilling

- a. Rock cuttings and drill water will be collected in a containment box.
- b. When the containment box becomes filled with water and/or cuttings, a sample will be collected by EM&C and will be tested by the Analytical Chemistry Division for gross alpha, gross beta, and tritium* for an RP Category 3. If it is an IH Category 3, the IH representative on site will determine which (if any) laboratory testing is necessary for chemical contaminants.
- c. Proper disposition of the contents of the containment box will be decided by consensus of E&HP, the IH or RP representative, EM&C, and the CE, based on the results from Analytical Chemistry Division of the above tests.

6.4.2 Category 3 Development

- a. Water pumped from Category 3 wells will be contained in drums. Samples, collected by EM&C, will be tested by Analytical Chemistry Division for gross alpha, gross beta, tritium*, and pH. Also, IH representatives will test for the presence of RCRA materials by using IH field instruments.
- b. Based on test results, E&HP and Engineering will decide whether to continue development.

6.5 BOREHOLE CLEANING

When sludge and water have accumulated in the bottoms of boreholes drilled in soil, the boreholes must be cleaned out prior to setting casings. A decision based on the location of the borehole and its rating will be made between the RP and/or IH representatives whether the sludge and water from the borehole must be contained in a drum. Water and sludge from a Category 2 well will be drummed, and a wet towel smear will be done by RP to determine proper disposal of the drum contents. Laboratory testing of the drum contents for gross alpha, gross beta, tritium*, and pH will be done if recommended by the RP or IH

*Testing for tritium will be done for the pit if activities involved wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

representative. Water and sludge removed from an RP Category 3 well will be drummed, and laboratory testing will be done for gross alpha, gross beta, tritium*, and pH. EM&C will be consulted to determine proper disposal based on the test results. Further laboratory testing to determine actual contaminants will be done if recommended by EM&C.

APPENDIX D

DECONTAMINATION OF CASINGS AND SCREENS
BY THE MANUFACTURER

APPENDIX D**DECONTAMINATION OF CASINGS AND SCREENS
BY THE MANUFACTURER****Well Screens:**

1. Immerse for 5 min in a static bath of Troy 2108 acid mix (phosphoric acid).
2. Pressure rinse/wash with a prescribed mixture of Troy 2702 detergent and cool water.
3. Rinse with warm water.
4. Rinse with isopropyl alcohol.
5. Rinse with deionized water.
6. Allow to air dry.

Well Casings:

1. Pressure rinse/wash with a prescribed mixture of Troy 2702 detergent and cool water.
2. Rinse with warm water.
3. Rinse with isopropyl alcohol.
4. Rinse with deionized water.
5. Allow to air dry.

All screens and casings are individually wrapped in 4-mil protective polyethylene prior to shipment.

APPENDIX E

**GROUNDWATER QUALITY MONITORING WELL DEVELOPMENT
USING THREE 2-MAN CREWS AND A WORKOVER RIG**

APPENDIX E**GROUNDWATER QUALITY MONITORING WELL DEVELOPMENT USING
THREE 2-MAN CREWS AND A WORKOVER RIG****I. WELL DEVELOPMENT**

Well development shall be accomplished using three 2-man crews and sufficient hydrogeologic representatives to monitor the well development, take readings, perform necessary tests, and provide recommendations to the Company. The development crews shall be instructed by the Company.

- A. Each development crew shall pick up two properly numbered Geoguard pumps for the wells to be developed, two compressors, a roll of plastic, six 55-gal drums with lids, four pallets, and necessary gasoline and tubing. One crew shall cover development of two wells at one time.**
- B. Developers shall set up the well site:**
 1. Spread plastic over the work area and secure.
 2. Set up at each well site two 55-gal drums with lids on a pallet.
 3. Set up compressor.
 4. Install Teflon surge blocks on well "snorkels." (Certain wells may require a different attachment to be connected to the bottom of the pump in place of the snorkel.)
- C. Hydrogeologic representative determines information on the well:**
 1. Measure depth of well.
 2. Determine length of screen.
 3. Calculate well volume.
 4. Place pump on plastic and measure with a clean tape to verify that plastic is the correct length.
- D. Developers should carefully install the pump in the well to ensure proper fit and should remove two to five well volumes (as recommended to the Company by the hydrogeologist) while the hydrogeologic representative measures and records the following:**

1. pH
2. Specific conductance ($\mu\text{S}/\text{cm}$)
3. Turbidity (NTU or ppm)
 - a. Turbidity readings taken when water is still relatively turbid may be read in parts per million. When using a turbidity reading to determine acceptance, readings should be read in nephelometric turbidity units.
 - b. Samples for taking the measurements stated above shall be obtained by sampling the water from the bottom of the well screen after the pump has been agitated in the well by the developer ten times to stir sediment at the bottom of the well. Samples tested shall be obtained from the development water typical of the most turbid discharge obtained after well agitation.

E. By visual examination of the water, the hydrogeologic representative will estimate whether the well appears to clear rapidly or slowly. The representative will recommend and the Company shall instruct the developers to do one or more of the following:

1. remove five well volumes from the well while agitating the pump in the well several times every 5 to 10 min while the hydrogeologic representative takes readings as above in Section I.D, or
2. surge well with the stainless steel surge block for 10 to 20 min as instructed by the Company.

F. After readings are recorded, the hydrogeologic representative shall determine if the water meets Acceptance Criteria II.A below. If so, developers shall remove the Teflon surge block snorkel, clean it for use on the next well, and install the pump as a bladder pump according to the manufacturer's directions. The Company shall instruct whether to proceed with the completion procedure in Section IV below. If the criteria are not met, the hydrogeologic representative shall recommend, and the Company shall instruct the developers, whether or not to continue with steps E.1 and E.2 above. Upon removal of ten well volumes, Acceptance Criteria II.B shall be followed.

G. If development has continued on any well for three days without meeting the acceptance criteria in Section II.A or II.B, the developers shall remove the Teflon surge block snorkel, install a factory-made snorkel, and replace the pump in the well. Clean surge block according to the standard procedure, and begin with step I.B at the next well designated by the Company.

H. Equipment used in the wells shall be either precleaned and wrapped by the manufacturer or cleaned by the developer before use in each well according to the

standard cleaning procedure for water quality monitoring well equipment. Workover rigs shall be sufficiently steam cleaned so that no contamination is transferred to the well.

- I. Whenever pump is removed from the well, it shall be protected from contamination by placing it on plastic and covering with plastic if necessary.
- J. When surging the well with the stainless steel surge block and workover rig, stops shall be set to prevent the surge block from traveling below one foot off the bottom of the screen or above the top of the screen
- K. When 55-gal drums are full, the pH of the water shall be checked by the CE or his designee. Disposal of water shall be determined by the CE. Drums shall either be emptied on site or transported for emptying into the steam cleaning area holding pit. Any water suspected of being contaminated shall be tested by the Company. Disposal of water found to be contaminated shall be handled by the Company.

II. ACCEPTANCE CRITERIA

- A. The following acceptance criteria apply to wells which clear rapidly:
 1. a minimum of three well volumes have been removed with water withdrawn from the base of the well, and
 2. water pH and conductance are stable within $\pm 5\%$ of the mean of the last three successive measurements, and/or
 3. turbidity of the raw discharge water is 5 NTUs or less.
- B. For wells which do not clear rapidly, the following shall be used to determine the duration of development activities:
 1. The above prescribed records shall be maintained by the hydrogeologic representative.
 2. Upon removal of each tenth well volume of development water, a filterability test shall be performed.
 3. Passage of the filterability test and concurrence with the pH and specific conductance criteria of II.A.2 will constitute acceptability of the development process. Failure of the test will signal the continuation of development procedures until the water clears or until the subsequent tenth well volume, at which time the filterability test shall be performed again.

4. If the filterability test is not passed upon removal of 30 well volumes of development water, the Company may elect to accept the well as is or to continue development. Such determination shall be made on an individual well basis.

II. FILTERABILITY TEST PROCEDURE

- A. The filterability test shall be performed on water pumped from within 2 ft of the bottom of the screen immediately after pump agitation and purge rate pumping.
- B. A new filter shall be used for each successive filterability test. If in-line filters are used, they shall be contained in a plastic bag to prevent fluid release in the event of filter housing rupture due to filter clogging and back pressure.
- C. To pass the filterability test, it must be possible to pump 3 gal of water through the filter in 30 min or, for low-yield wells, to pump the maximum well yield through the filter with a maximum turbidity of 5 NTUs.
- D. Records of the filterability test shall be kept by the hydrogeologic representative.

III. GEOGUARD PUMP CONVERSION

- A. Remove Geoguard pump from well and place on plastic sheeting.
- B. Remove top fitting from pump body and pull pump apart (Fig. E.1).
- C. Remove dip tube check valve assembly at $\frac{1}{2}$ -in. compression coupling and $\frac{1}{8}$ -in.
- D. Remove pipe cap from bladder pump and attach twin tube adaptor to bladder pump (Fig. E.2).
- E. Attach $\frac{1}{2}$ -in. and $\frac{1}{4}$ -in. compression fittings from top fitting of Geoguard pump to bladder pump (Fig. E.2).
- F. Install bladder pump in pump body and tighten top fitting (Fig. E.2).
- G. Remove "snorkel" pipe and install pump in well.

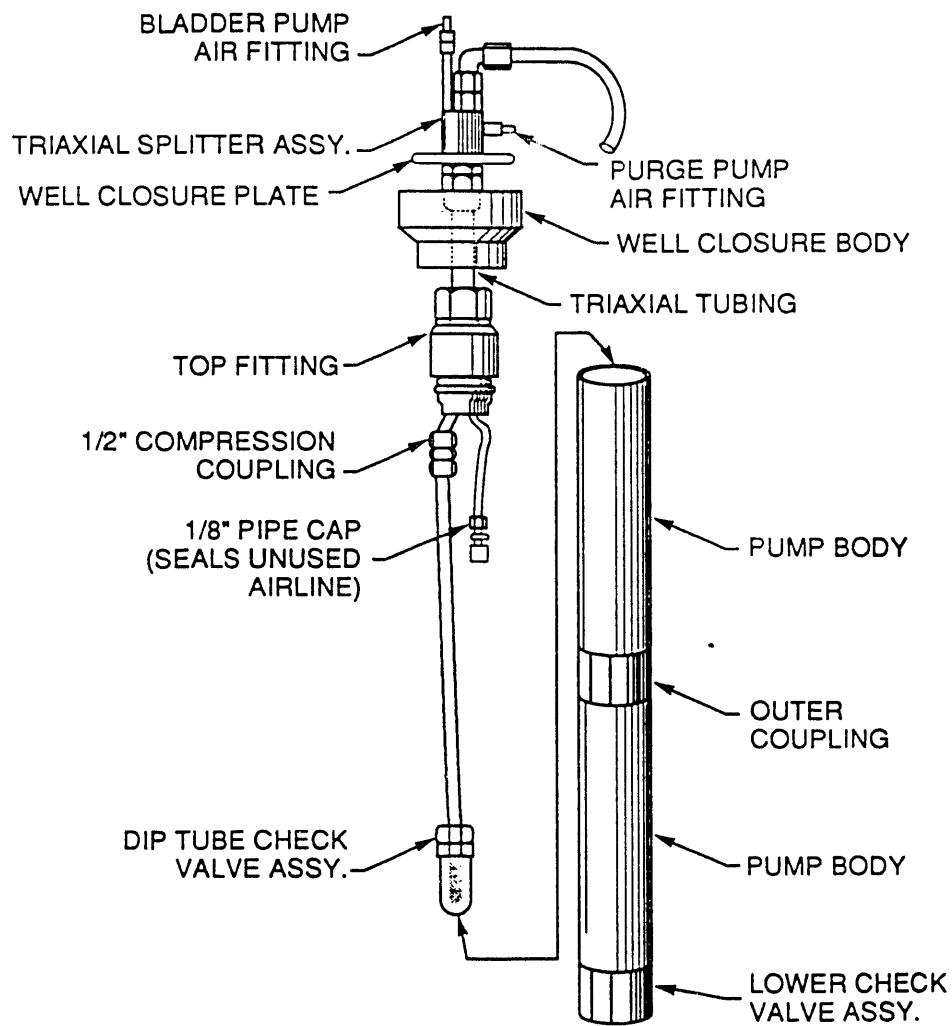


Fig. E.1. Down well development pump assembly.

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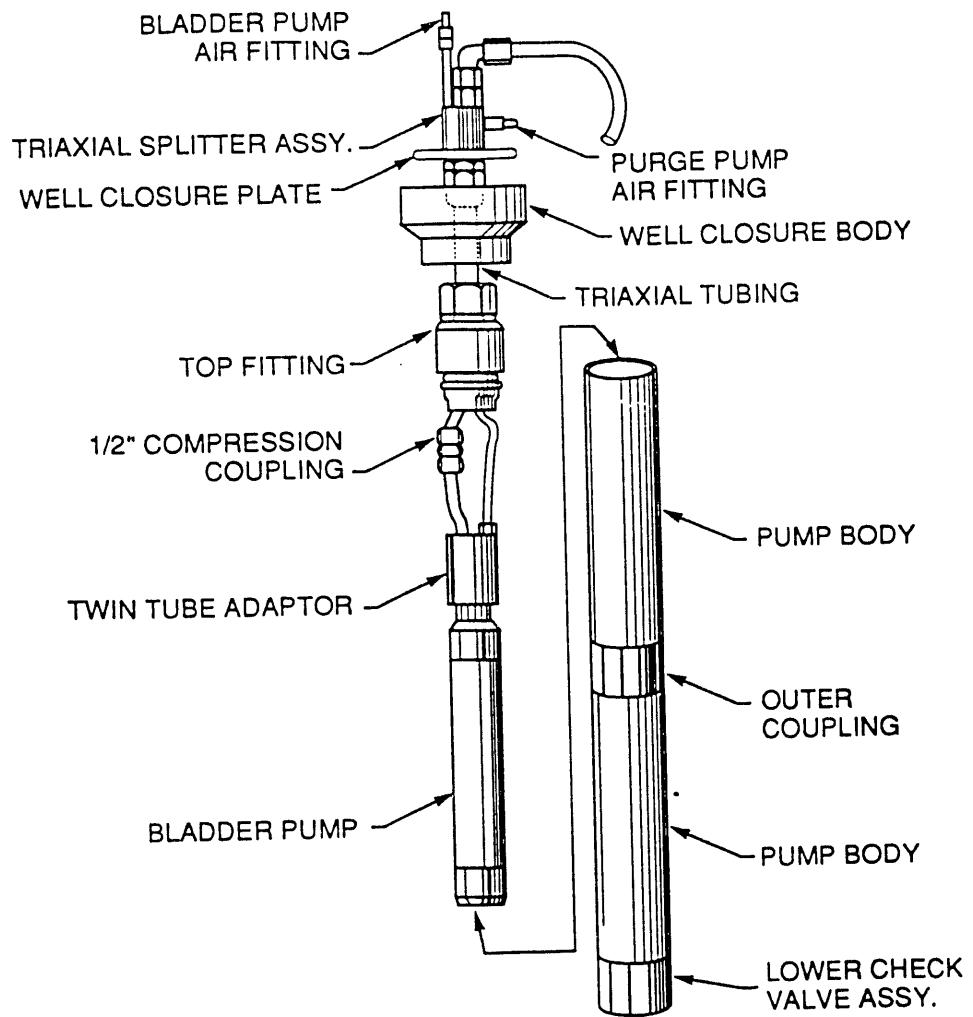


Fig. E.2. Down well development pump showing twin tube adaptor and bladder pump.

APPENDIX F
**PROCEDURE FOR PERFORMING HYDRAULIC
CONDUCTIVITY TEST**

APPENDIX F

PROCEDURE FOR PERFORMING HYDRAULIC
CONDUCTIVITY TEST

Test Equipment:

- Completed installation diagram
- Data log form
- Stop watch
- Water level reader
- Stainless steel funnel
- Stainless steel placement slug
- Druck DPI 600 pressure indicator
- Bucket
- Measuring tape
- Teflon tubing
- Deionized water

Decontamination Equipment:

- Two large buckets
- Detergent
- Rinse water
- Alcohol
- Deionized water
- Plastic sheeting
- Plastic garbage bags
- Sterile gloves
- Brushes

Procedure:

1. Have all equipment on hand, in working order, and decontaminated.
2. Unlock the well casing.
3. Lay a sheeting of clean plastic over the ground, surrounding the work area.
4. Put on sterile gloves.
5. Remove the dedicated sampling pump from the well and allow the water in the well to come to its static level. Be very careful not to let the pump and tubing touch the uncovered ground. When completely removed, cover the pump with additional plastic to prevent contamination.
6. Lay out the equipment.
7. Measure the static water level and record on the data form.
8. Compare the static water level with the installation diagram:
 - (a) If the water level is above the screened interval, a falling head test will be conducted by injecting 1 gal of deionized water for a 2-in.-ID well and 2 gal of deionized water for a 4-in.-ID well.

- (b) If the water level is in the screened interval, a rising head test will be conducted. This will be accomplished by inserting a stainless steel cylinder that will displace 0.5 gal of water. When the water level has reached equilibrium, the slug will be removed from the well, which is equivalent to bailing 0.5 gal.
- (c) If the water level is in the screened interval but not high enough to completely submerge the stainless steel cylinder, 2 gal of deionized water will be injected for the falling head test. The validity of the data using this method is questionable due to the injected water flowing into the unsaturated zone above the water table.

9. Measure out the needed amount of deionized water.
10. Assemble the pressure indicator.
11. Insert the Teflon tube into the well and record all the needed information specified on the log sheet.
12. Pressurize the Druck instrument to achieve desired stability. Stability is achieved when all the water is pumped out of the Teflon tube and the air slowly bubbles from the bottom of the tube.
13. Insert the funnel into the well casing.
14. Clear the stopwatch.
15. Pour the deionized water into the funnel as quickly and carefully as possible. Start the stop watch when you hear the water splash against the water standing in well.
16. Record the Druck instrument readings on the log sheet at the designated time intervals. (See field log sheet attached.)
17. The test is complete when the Druck pressure readings are within 0.1 ft of the static reading. A minimum 10 min of pressure readings will be recorded for all tests regardless of the water level recovery. If the pressure readings do not return to within 0.1 ft of the static level, the test will be continued for a full 35 min.
18. When the test is completed, remove the tape, funnel, and instrument.
19. Carefully reinsert the pump, wearing sterile gloves.
20. Lock the well.
21. Decontaminate the equipment as outlined in the drilling specifications.
22. Remove all plastic and waste and put in garbage bags. Place in approved waste receptacles.

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Y-12 COORDINATE GRID SYSTEM

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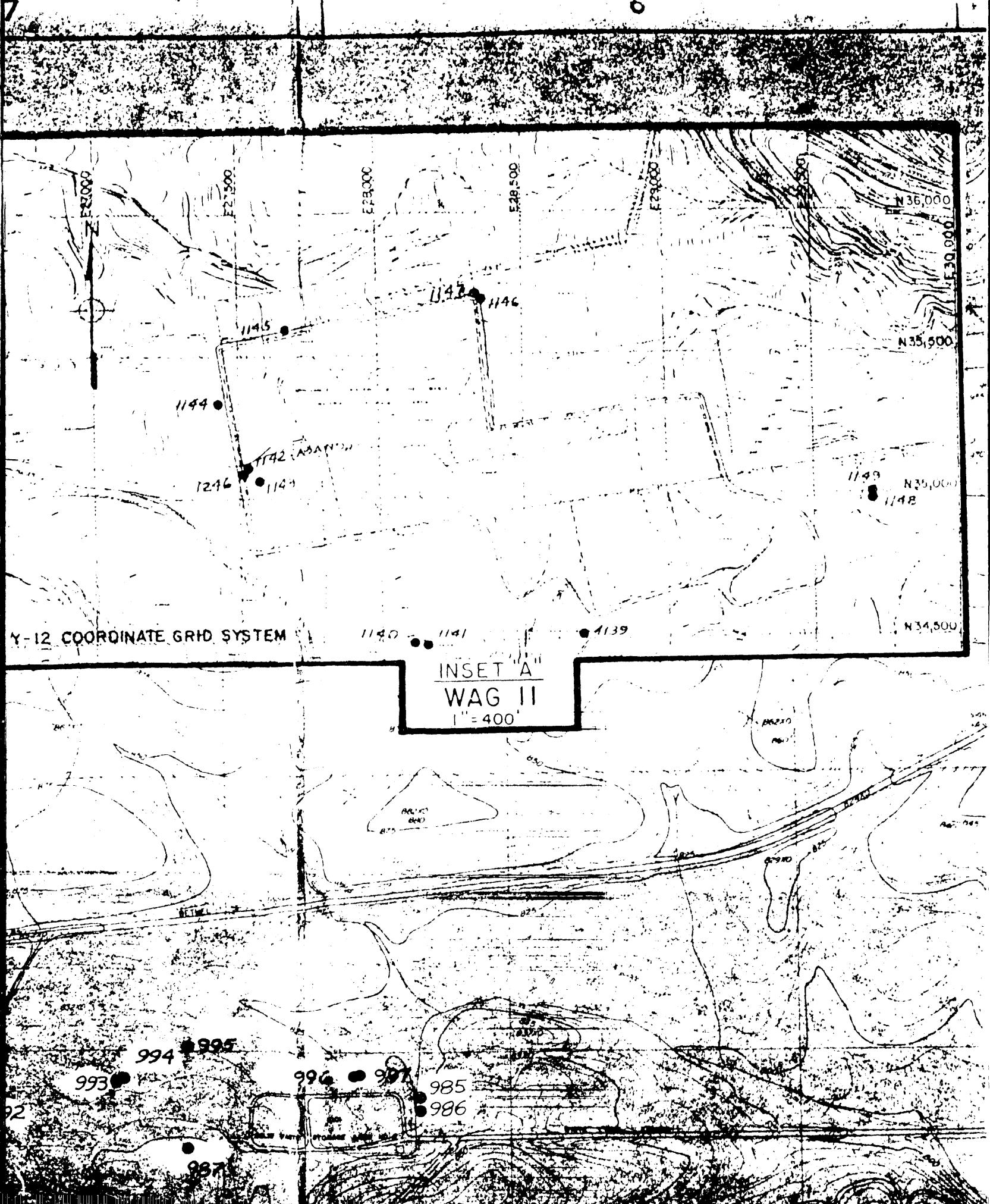
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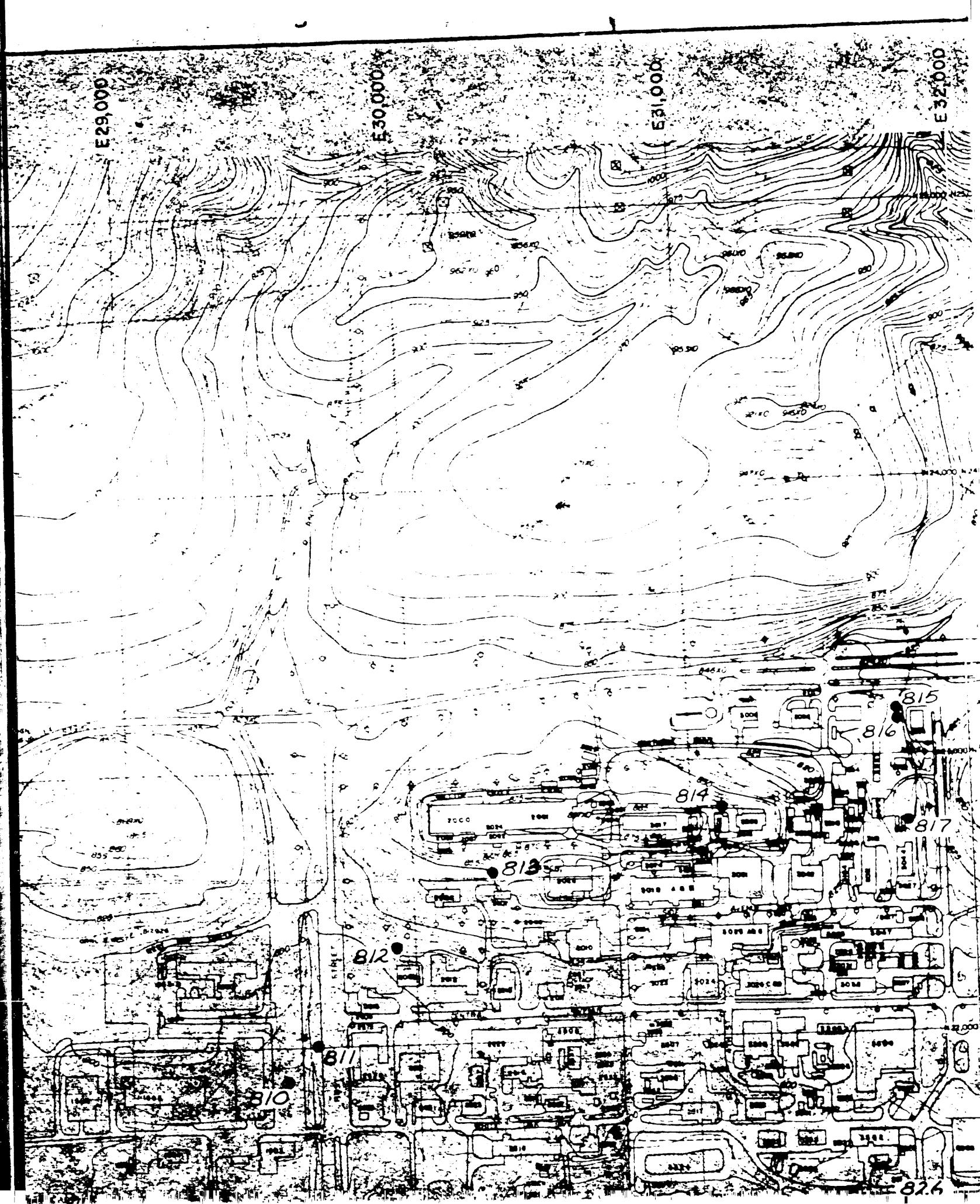
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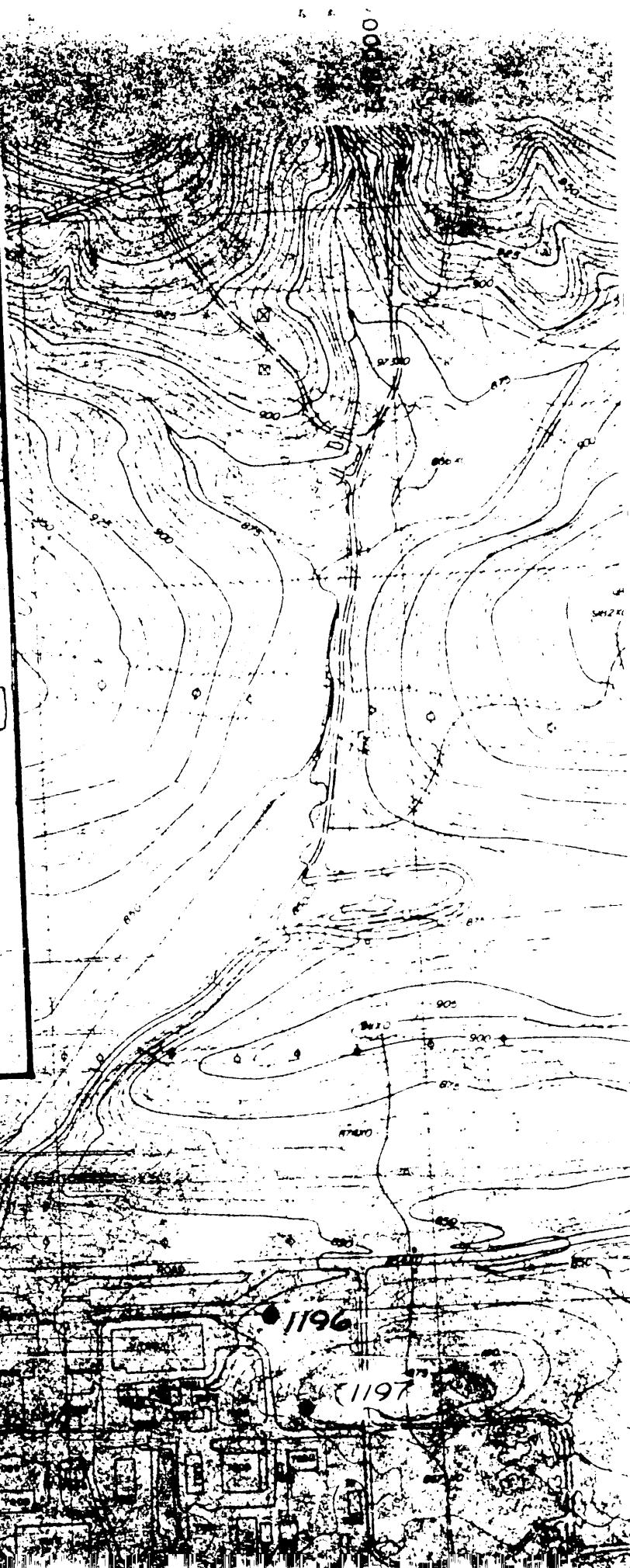
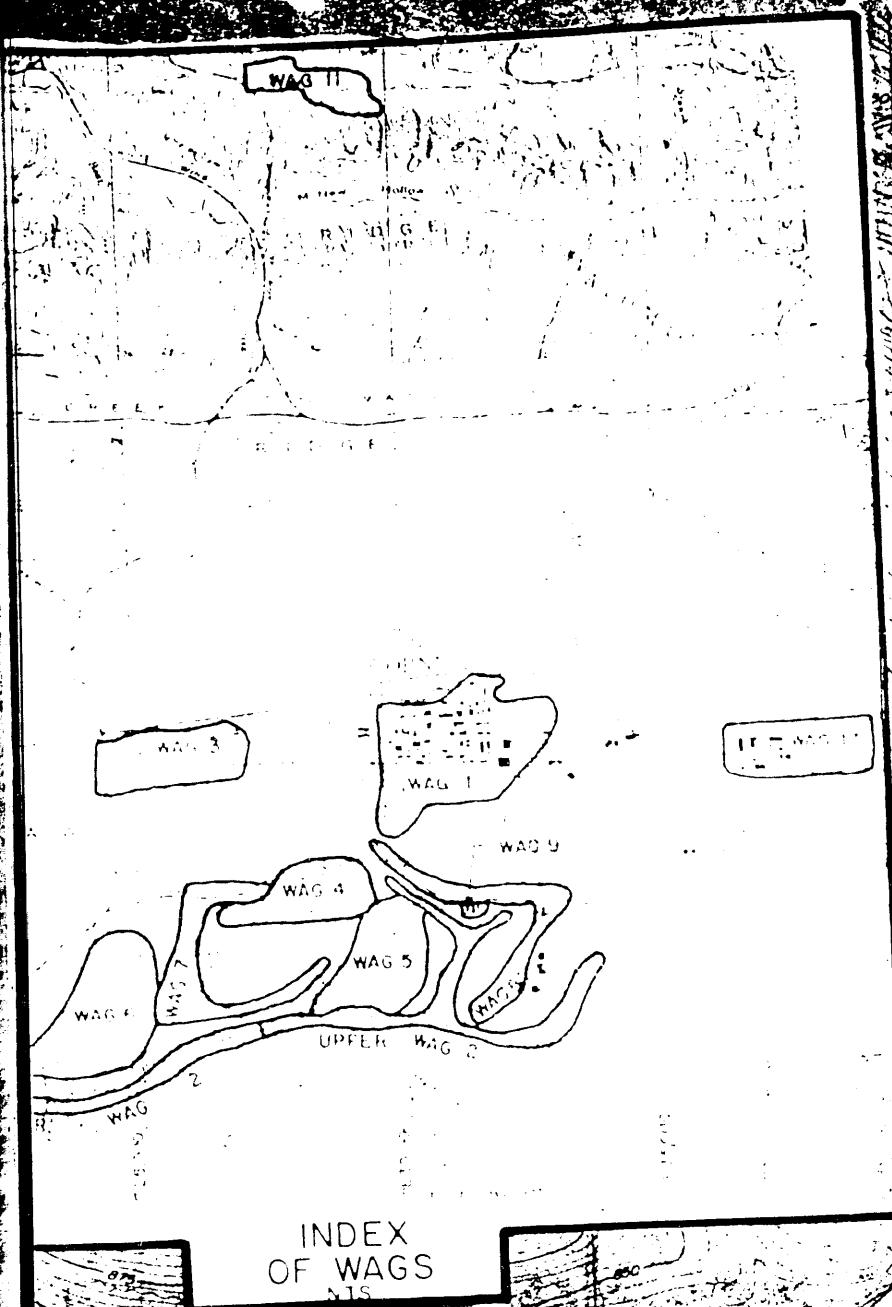
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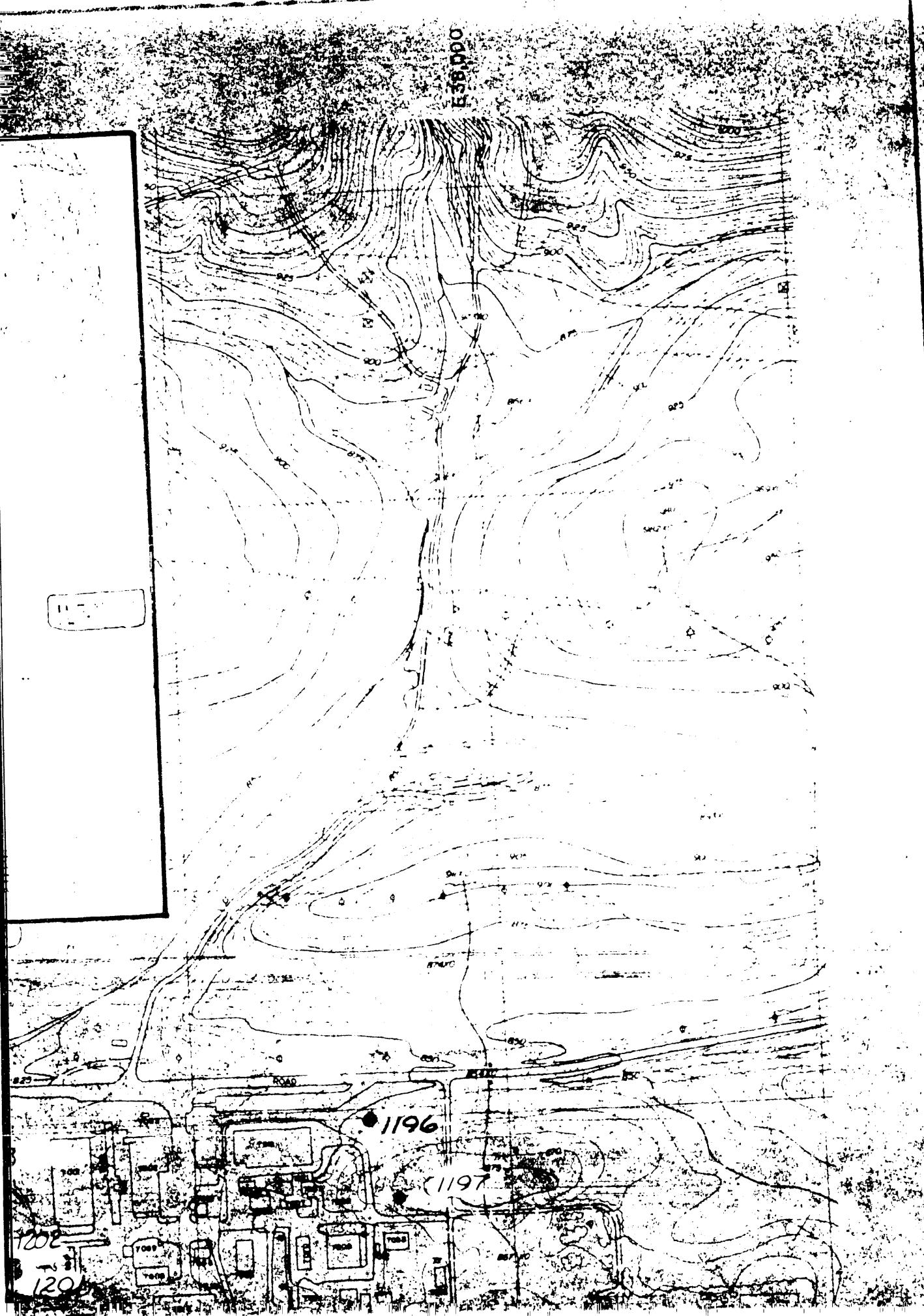








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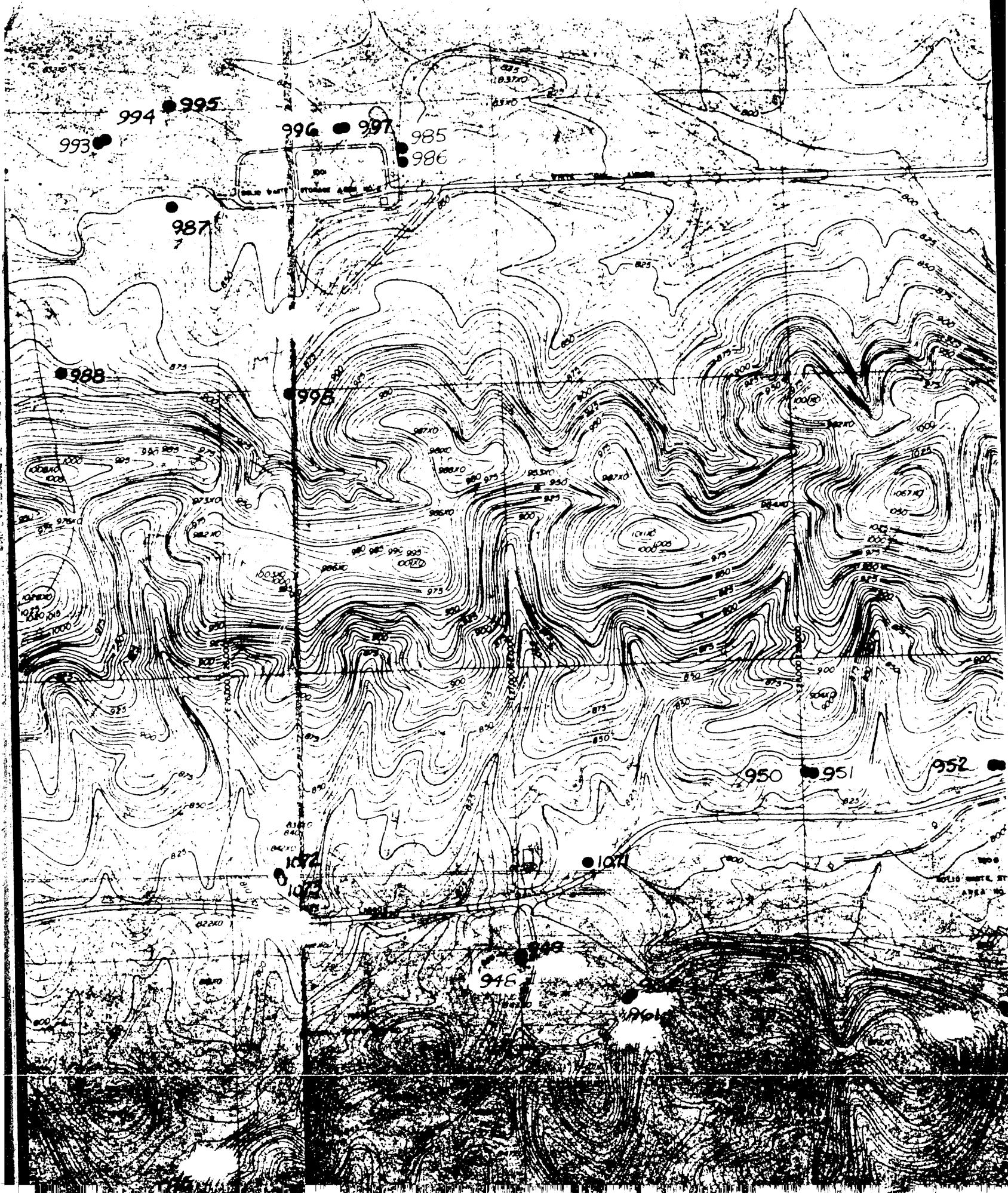
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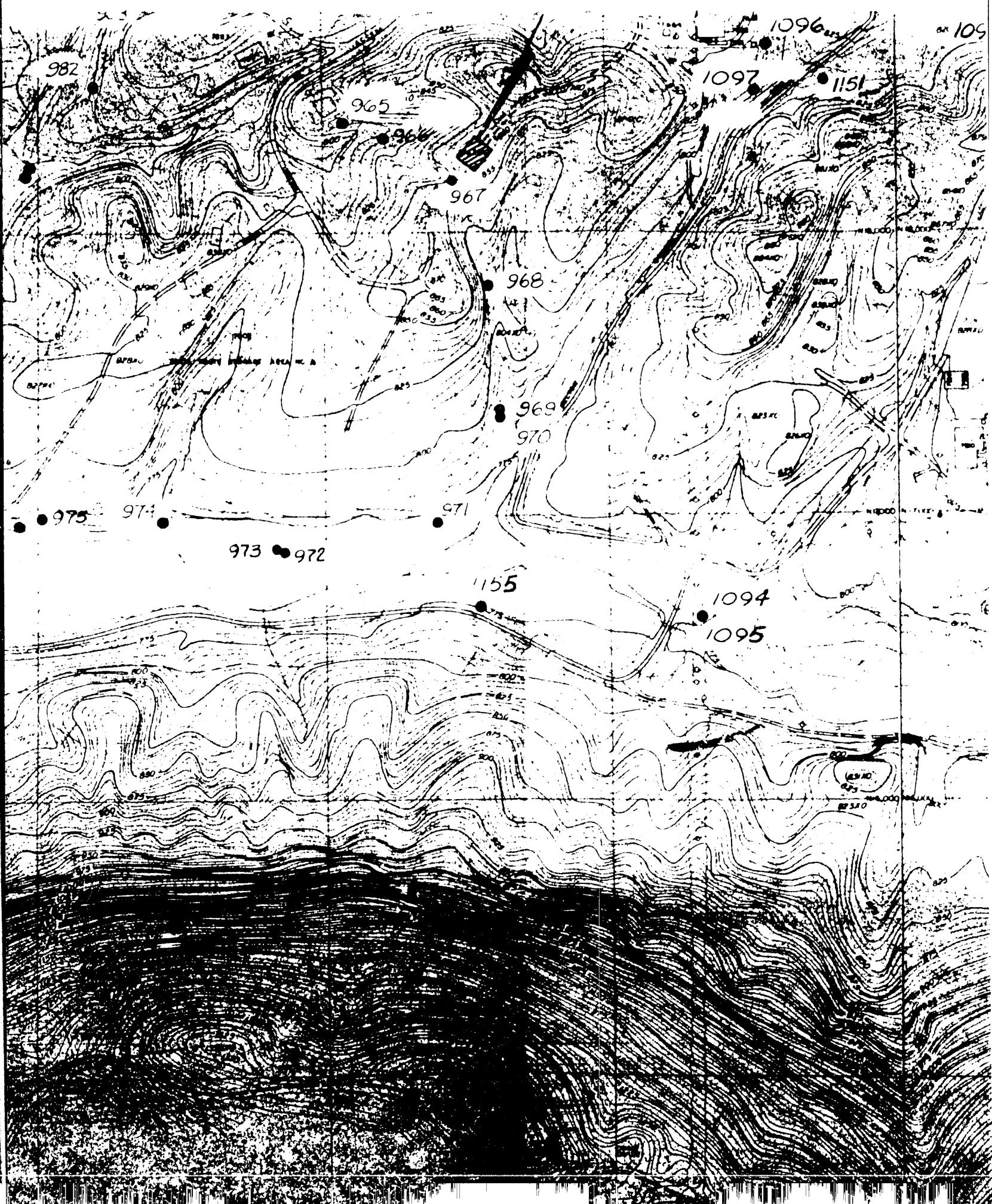
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SEE MATCH LINE
"B" INSET

A topographic map with contour lines and various numbered locations. The map includes elevation labels (15,000, 16,000, 17,000, 18,000) and a vertical scale. A vertical line on the left is labeled 'SEE MATCH LINE' and 'INSET B'. A road is labeled 'ROAD' and 'WHITE CROWN'. A lake is labeled 'LAKE'. Numerous points are marked with dots and labeled with numbers: 855, 858, 857, 856, 854, 853, 849, 848, 847, 844, 843, 841, 838, 839, 834 (ABAND), 833, 835, 836, 837, 830, 820, 810, 800, 790, 780, 770, 760, 750, 740, 730, 720, 710, 700, 690, 680, 670, 660, 650, 640, 630, 620, 610, 600, 590, 580, 570, 560, 550, 540, 530, 520, 510, 500, 490, 480, 470, 460, 450, 440, 430, 420, 410, 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220, 210, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, 0.

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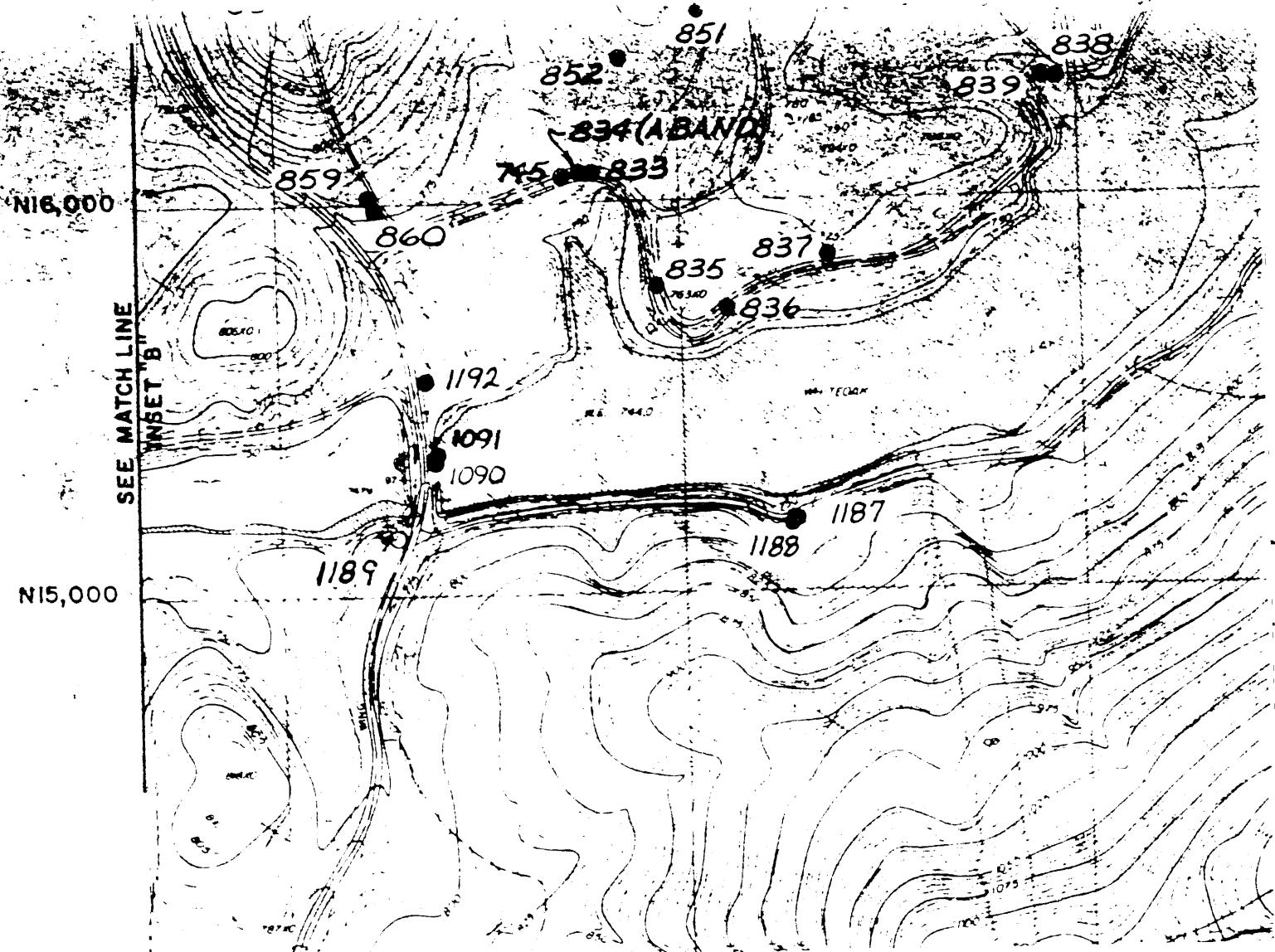


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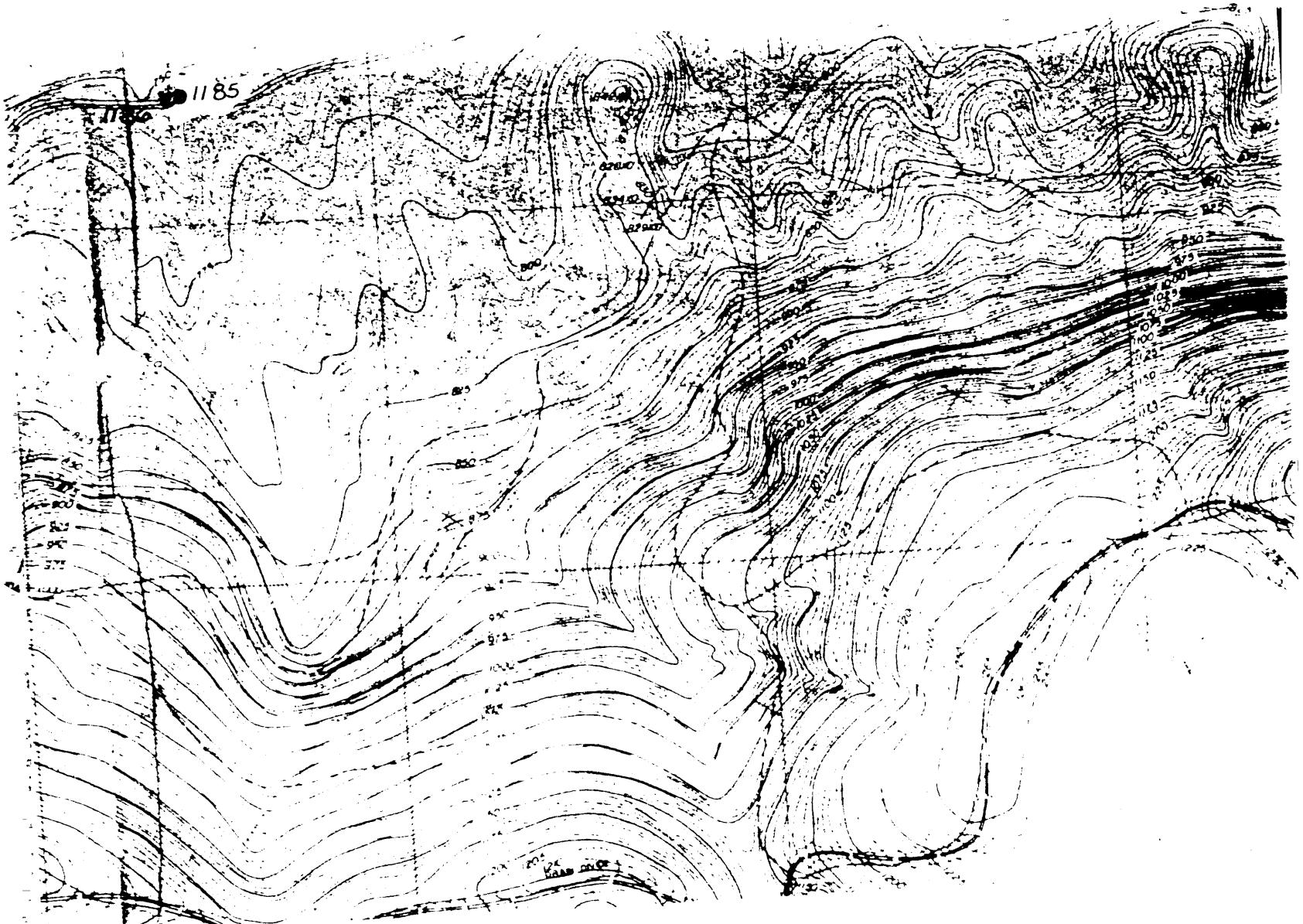
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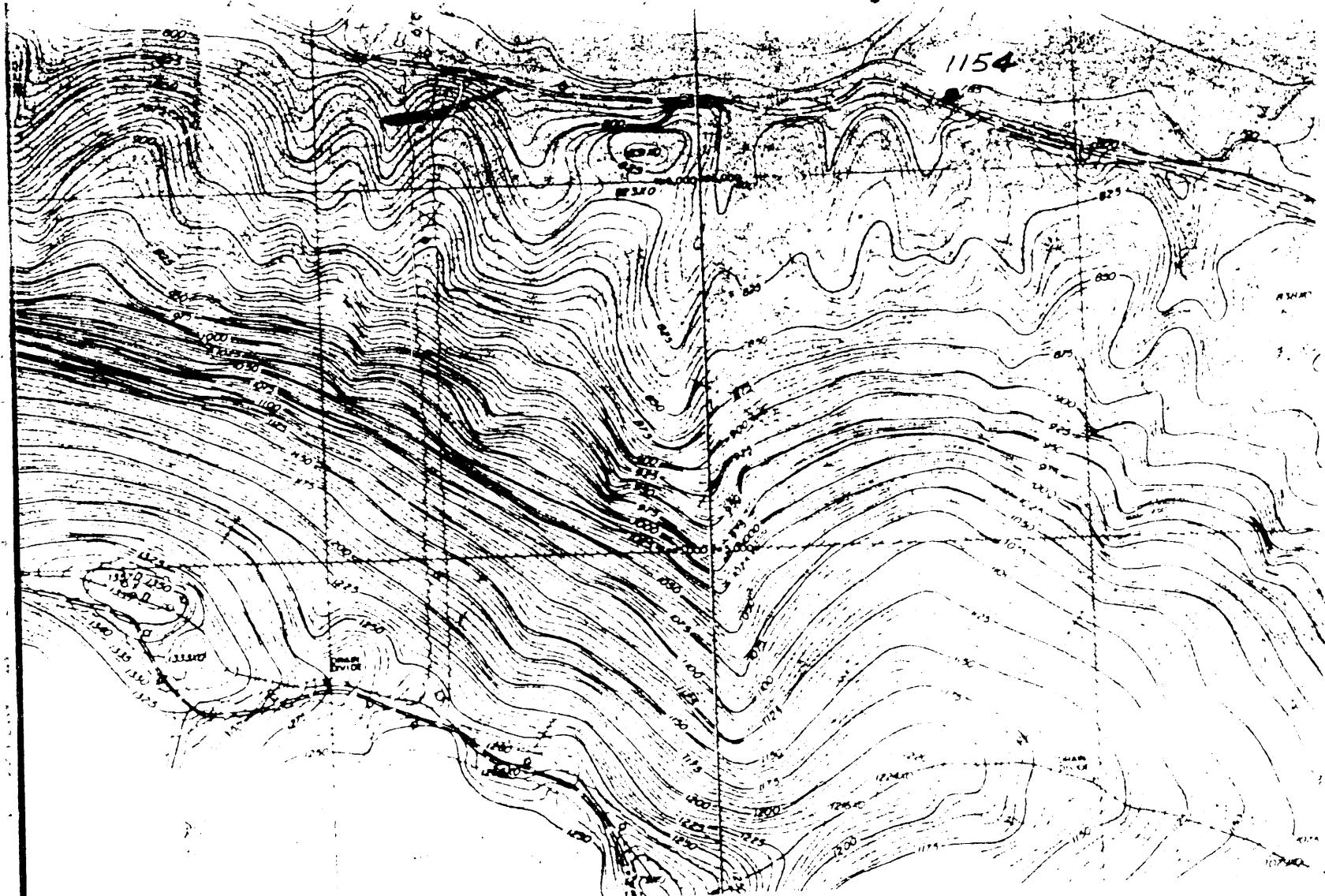
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MARTIN MARIETTA

MARTIN MARIETTA ENERGY SYSTEMS INC
Operated for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT CONTRACT NO. DE-AC05-84ER21400
OAK RIDGE, TENNESSEE & PADUCAH, KENTUCKY

WAG PERIMETER GROUNDWATER QUALITY MONITORING WELLS

OVERALL MON. WELL LOC. MAP

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