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DESIGN FOR REMEDIATION OF THE GREAT MIAMI AQUIFER SOUTH FIELD PHASE II MODULE

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MAY 2002

U.S. DEPARTMENT OF ENERGY

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DRAFT FINAL

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LIST OF ACRONYMNS

CMT	continuous multi-channel tubing
DFM	Data Fusion Modeling
FEMP	Fernald Environmental Management Project
FRL	final remediation level
IEMP	Integrated Environmental Monitoring Plan
SWU	southern waste unit
µg/L	micrograms per liter

1.0 INTRODUCTION

This report provides an updated characterization of the uranium plume in the Great Miami Aquifer beneath the southern portion of the Fernald Environmental Management Project (FEMP) property and a modeled design for the South Field Phase II Module located in that area. The modeled design consists of the following components:

- Four additional extraction wells, one in the southern waste unit (SWU) area and three along the eastern edge of the on-property portion of the southern uranium plume.
- One additional re-injection well in the SWU area.
- Converting Extraction Well 31563 (EW-16) into a re-injection well.
- Installing and operating one active re-injection basin to flush treated groundwater back into the aquifer to supplement re-injection through re-injection wells.

OBJECTIVE

The objective of the characterization work conducted in support of the South Field Phase II Module Design was to assure that the latest uranium plume characterization and aquifer characteristics were used to support the design of the aquifer remediation system. Specifically, the objectives were to:

- Prepare an updated characterization of the vertical and lateral extent of the uranium plume
- Refine the number and location of groundwater extraction wells, re-injection wells, and re-injection basins that are required for the South Field Phase II Module based on groundwater modeling predictions using the latest uranium plume characterization.

BACKGROUND

A large portion of the area being addressed in this design has had various names over the years. Figure 1-1 depicts the former location of three Operable Unit 2 waste units known as the Inactive Flyash Pile, the South Field, and the Active Flyash Pile. Collectively these units are known as the SWUs. The wastes in these units have been removed and the area has largely been certified as clean; and as a result, making way for the installation of some of the wells proposed in this design.

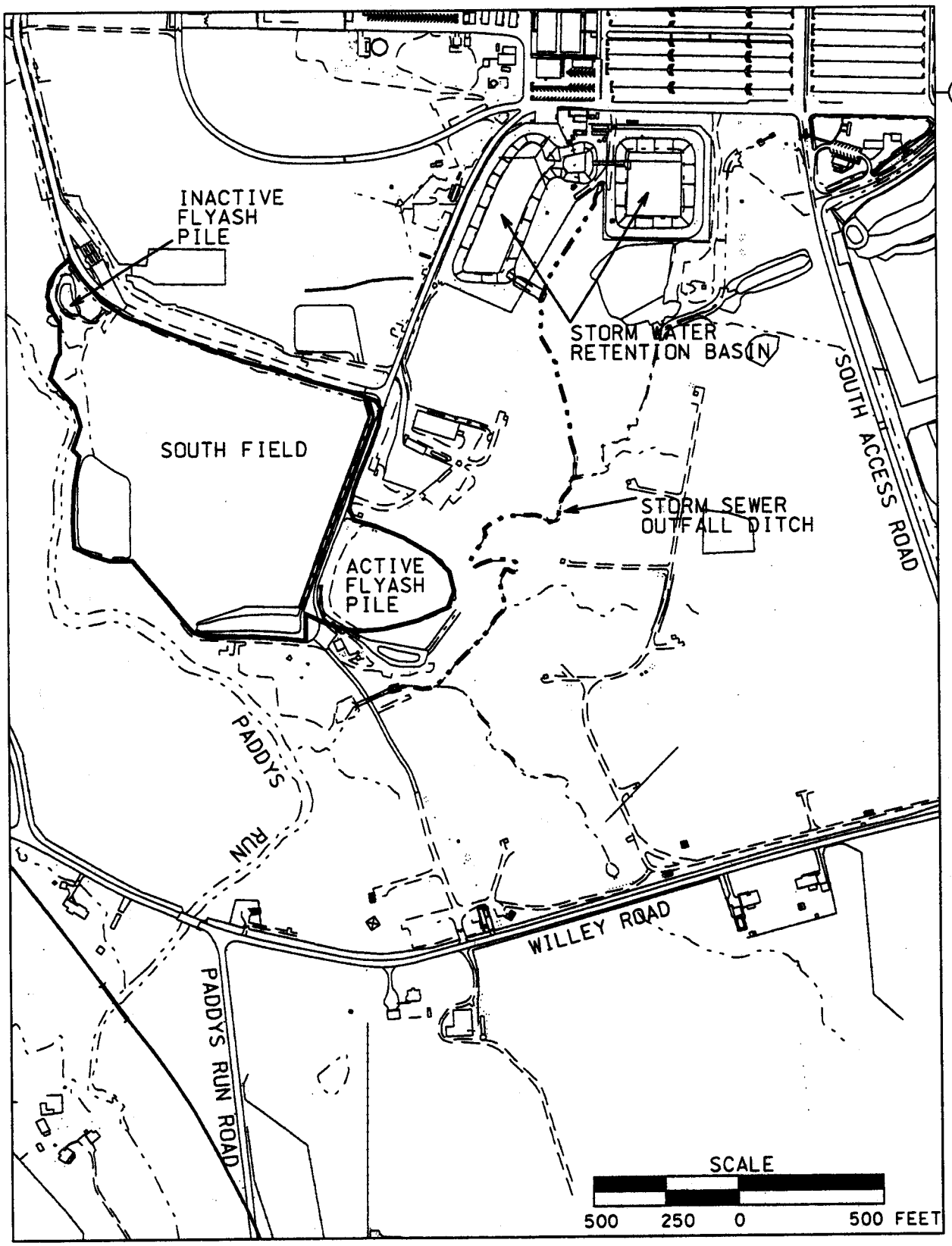
According to the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996), the Great Miami Aquifer will be remediated using pump-and-treat technology. The remediation design presented in the Operable Unit 5 Record of Decision called for pumping 28 extraction wells for approximately 27 years. Figure 1-2 illustrates the remedy design specified in the Operable Unit 5 Record of Decision.

Subsequent to release of the Operable Unit 5 Record of Decision, the Aquifer Restoration Project adopted a more aggressive clean-up schedule than that specified in the report. The design for the more aggressive aquifer remedy is presented in the Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (DOE 1997). This more aggressive design incorporated the use of re-injection to supplement the pump-and-treat system. Figure 1-3 illustrates the number and location of extraction and re-injection wells in the Baseline Remedial Strategy Report Remedy Design. A comparison of the Operable Unit 5 Remedy Design (Figure 1-2) with the more aggressive Baseline Remedial Strategy Report Remedy Design (Figure 1-3) shows that the Baseline Remedial Strategy Report Remedy Design has a greater number of wells, including 37 extraction wells, 10 re-injection wells, and three extraction to re-injection well conversions in the South Field.

A large portion of the Baseline Remedial Strategy Report Remedy Design became operational in 1998. The portions that became operational in 1998 in the area covered by this design report are known as the South Field Extraction (Phase I) and the Re-Injection Modules, as shown in Figure 1-4. In this and past aquifer remedy reports, South Field has been used to refer to a much larger area than that shown for just the South Field component of the SWU in Figure 1-1. The South Field Module covers the area surrounding the Storm Sewer Outfall Ditch, the area beneath the SWU, and the area between the SWU and Willey Road.

The more aggressive Baseline Remedial Strategy Report Remedy Design targeted a uranium plume that was characterized using groundwater data collected prior to 1994. An update to the 1994 characterization was needed to document changes to the plume and to assess if South Field Phase II Module Design changes were warranted. The biggest change that had taken place since 1994 was the source removal of the SWUs, which was completed in 2001. The removal of the source material resulted in several deep excavations in the area, which made areas accessible for aquifer testing that were previously inaccessible.

Section 2 of this report presents findings of the additional characterization work. Aquifer conditions have changed since 1994. In short, it appears that a fewer number of extraction wells will be required to remediate the aquifer in this area. Groundwater modeling was conducted based on results of the updated plume characterization. Groundwater modeling is presented in Section 3 while Section 4 of this report presents conclusions.



LEGEND:

APPROXIMATE SOUTHERN WASTE UNITS (SWU) BOUNDARY

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FIGURE 1-1. SOUTHERN WASTE UNITS (SWU)

v:\65fig01\dgn\south\lum-p2\sp-p2-03.dgn
STATE PLANAR COORDINATE SYSTEM 1983
14-MAY-2002

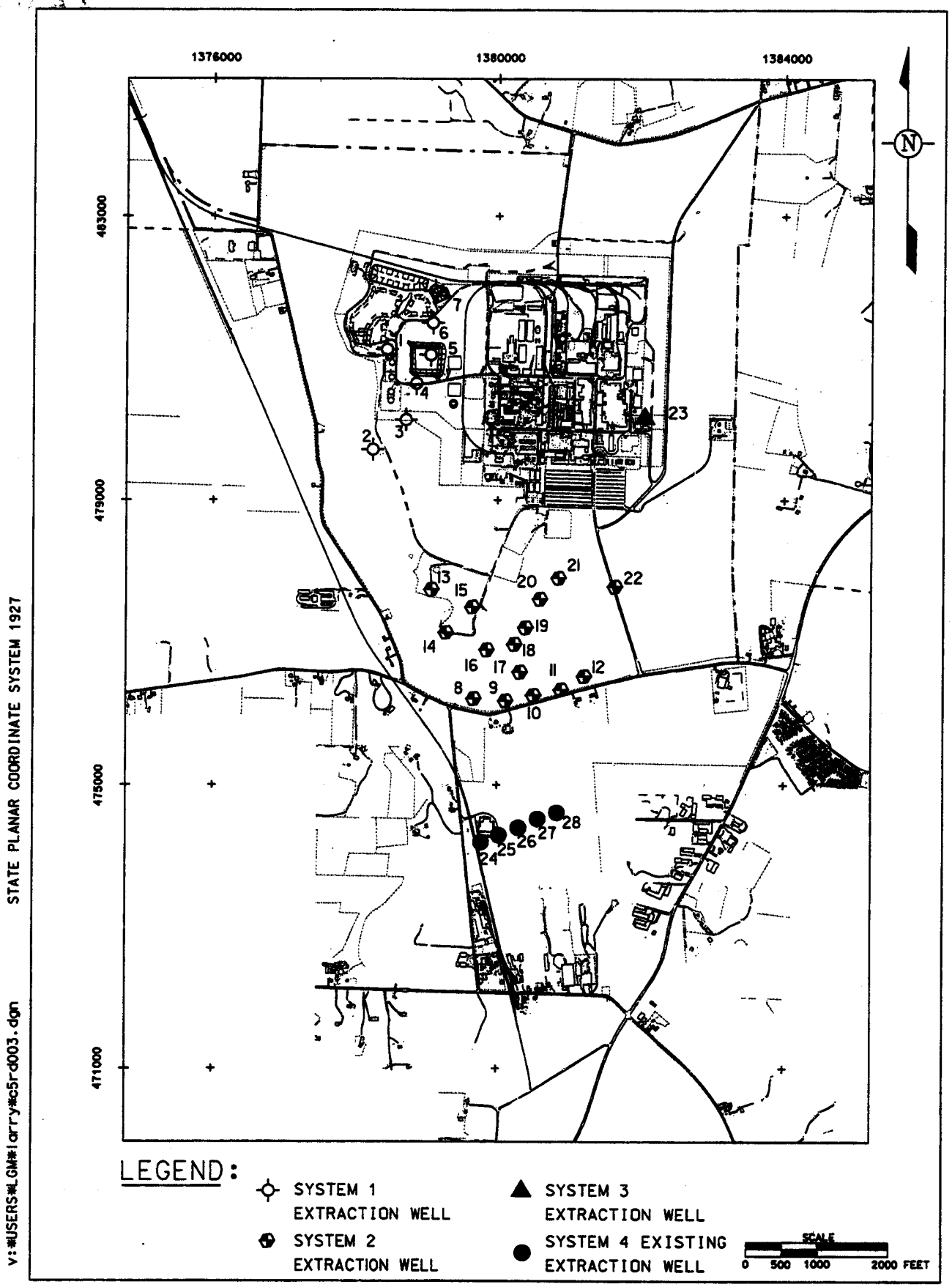
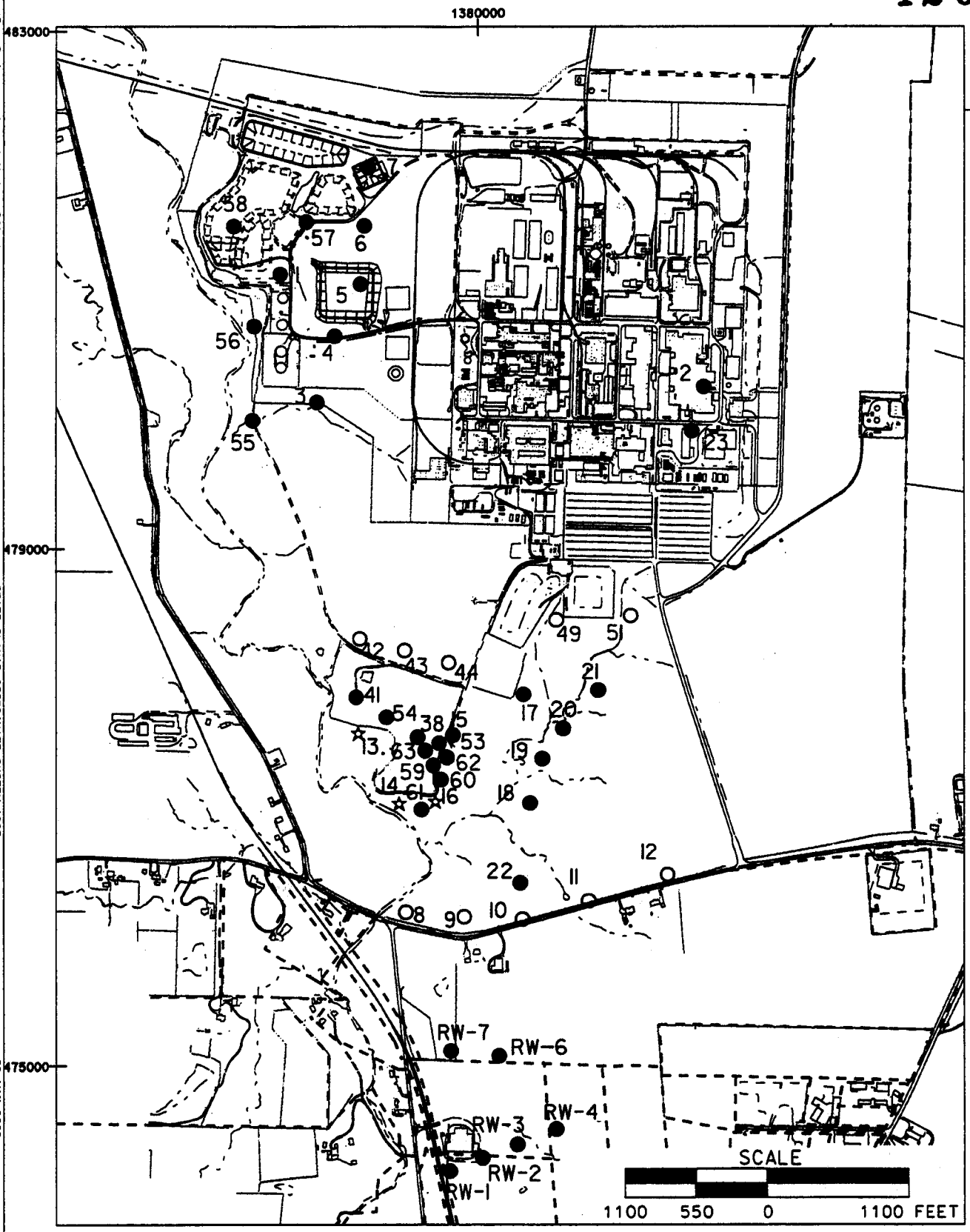


FIGURE 1-2. PROJECTED EXTRACTION WELL LOCATIONS FOR THE OU5 ROD (1996)



LEGEND:

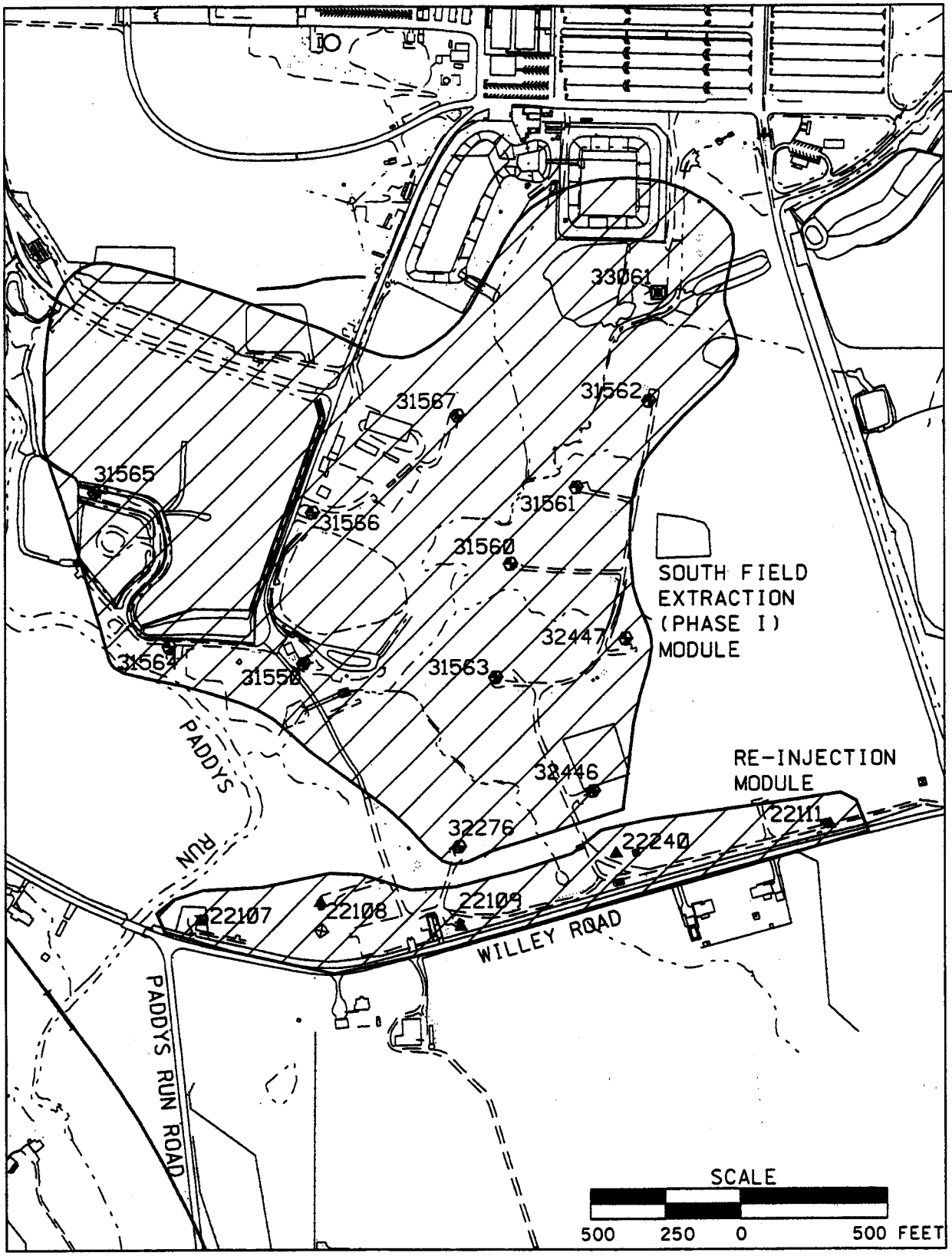
- - - - - FEMP BOUNDARY

○ INJECTION WELL

● EXTRACTION WELL

☆ EXTRACTION/INJECTION WELL

FIGURE 1-3. WELL LOCATIONS FOR THE BASELINE GROUNDWATER REMEDIAL STRATEGY (1997)



LEGEND:

- EXTRACTION WELL
- RE-INJECTION WELL
- EXTRACTION WELL (PUMPING TO BEGIN IN 2002)
- CURRENT ACTIVE MODULE

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FIGURE 1-4. SOUTH FIELD AND RE-INJECTION MODULES

x:\ms\fgp1\dgn\SOUTHPLUM-P2\sp-p2-02.dgn
STATE PLANAR COORDINATE SYSTEM 1983
08-MAY-2002

2.0 CHARACTERIZATION RESULTS

The characterization effort conducted to support the South Field Phase II Module Design consisted of the following activities:

- Groundwater sampling at 28 direct-push sample locations
- Routine sampling of Integrated Environmental Monitoring Plan (IEMP) (DOE 2001) wells
- Non-routine sampling at seven wells not in the IEMP program.

Twenty-eight locations were sampled from 2000 to 2002 using a direct-push sampling tool. The objective was to provide an up-to-date characterization of the uranium plume to support the South Field Phase II Module Design.

Figure 2-1 presents the results of all direct-push sampling, which has occurred to date, and the updated 30 micrograms per liter (μg/L) uranium plume characterization for the area of interest. The 28 direct-push sample locations sampled between 2000 and 2002 are identified in blue and green on Figure 2-1, respectively. These are referred to as "recent" direct-push sample locations in the discussion below. Those sampled prior to the recent sampling are identified in Figure 2-1 by color also; red for those locations sampled in 1999, and black for those locations sampled prior to 1999. The recent direct-push sampling focused on four areas where the need for additional plume profile concentration data were warranted to support the design.

1. Sixteen of the recent direct-push sample locations (12814, 12815, 12816, 12818, 12824, 12825, 12826, 12827, 12828, 12837, 12838, 12839, 12840, 12842, 12844, and 12845) were located in and immediately around the SWU area, as identified in Figure 1-1.

2. One of the recent direct-push sample locations (12818) was located just south of the SWU area, situated west of Extraction Well 31563 (EW-16), as identified in Figure 2-2.

3. Three of the recent direct-push sample locations (13241, 13247, and 13248) were located in the area of the leading southeast edge of the South Field uranium plume, just west of the FEMP's South Access Road.

4. Eight of the recent direct-push sample locations (12817, 12819, 12820, 12833, 12834, 12835, 12836, and 12843) were located around the east chamber of the Storm Water Retention Basin.

The uranium concentrations that are posted in Figure 2-1 are the maximum uranium concentrations at each direct-push sample location, regardless of depth. Attachment A provides a complete listing of uranium concentration data by depth for each recent direct-push sample location. The uranium plume interpretation shown in Figures 2-1, 2-2, and 2-4 also honors monitoring well data. Specifically:

- IEMP groundwater monitoring well data from the fourth quarter of 2001
- Data from seven existing monitoring wells (21064, 21065, 2048, 2065, 3065, 2399, and 2400) that were sampled, above and beyond the IEMP, in the second quarter of 2001 to support this characterization.

Figure 2-2 shows these data, along with the locations of extraction wells in the same area. Figure 2-2 also shows the latest concentration data collected from six monitoring wells in the area of the SWU (2016, 2047, 2401, 2943, 2945, and 2954). These data are posted in black. Some of these data were collected as far back as 1996. Data from Monitoring Wells 2945 and 2954 are posted to illustrate how high concentrations once were in this area.

The depicted plume interpretation is conservative in that it is a projection of the maximum uranium concentration measured, regardless of depth. The plume was contoured in the following manner:

- The highest representative total uranium concentration of Type 2, 3, or 4 wells sampled during the fourth quarter of 2001 at a cluster was posted (refer to Figure 2-2). The highest concentration associated with each direct-push sample location was also posted (refer to Figure 2-1).
- If a fourth quarter 2001 concentration from a well was greater than the previously mapped concentration contour value at that location, then the plume was re-contoured to honor the higher concentration.
- At some locations, the plume is migrating between the Type 2 and the Type 3 well screen. Therefore, if the fourth quarter 2001 concentration from a well was less than what was previously contoured for that location, then the new data were posted but the plume contours were not adjusted to honor the new data. Therefore, it is possible to see lower concentrations posted for an area that is contoured at higher concentrations.
- If vertical profile data provided by direct-push sampling indicated that the plume concentrations had decreased, then the map was re-contoured to honor the direct-push data.

The latest plume interpretation shows two plumes that have co-mingled as they slowly migrate to the east in the direction of groundwater flow. The source of one plume was from infiltration through Paddys Run west of the SWUs and runoff from, and infiltration through, the former Inactive Flyash Pile that was located on the edge of the glacial overburden that overlies the aquifer. The source of the second plume was from various locations along Paddys Run, the Storm Sewer Outfall Ditch, and runoff which previously flowed along the eastern edge of the South Field component of the SWU (refer to Figure 1-1). The two plumes appear to be commingled northeast of the Active Flyash Pile excavation boundary (refer to Figure 2-1). Figure 1-1 shows the location of the Active Flyash Pile excavation boundary.

Prior to this latest characterization work, the plume footprint beneath the SWUs was much larger. Figure 2-3 illustrates the pre-characterization interpretation. This figure depicts the plume interpretation in the third quarter of 2000. It appears that source removal, regional groundwater flow, continuing infiltration of uncontaminated water through Paddys Run, deep surface excavations, and various points along the Storm Sewer Outfall Ditch in conjunction with active pumping of downgradient extraction wells, have worked to flush uranium from portions of the plume. The result is a much smaller plume footprint today in the area of the SWU. Evidence of this occurring can be seen by comparing Figure 2-1 to Figure 2-3. The area west of the former Inactive Flyash Pile (by direct-push sample locations 12814 and 12815 in Figure 2-1) is considerably cleaner today than it was in the past.

Figure 2-4 is a cross-section location map. Nine cross sections (A-A' through I-I') are provided to better illustrate the depth dimensions of the uranium plume beneath the SWUs and how this plume is commingling with a larger uranium plume to the east of it. Five of the cross-sections run east-west (A-A', B-B', C-C', H-H', and I-I') and four of the cross-sections run north-south (D-D', E-E', F-F', and G-G'). Figure 2-4 shows the location of each of the nine cross-sections relative to the uranium plume. The locations of the direct-push sampling points and monitoring wells used to construct the cross-sections are also posted on the figure. Each cross-section is discussed below.

Cross-Section A-A'

Figure 2-5 shows cross-section A-A'. The section is oriented east-west and extends from a deep excavation point located along the western edge of the SWUs to Extraction Well 31562 (EW-21) in the east. The section runs through the middle of the SWU area, and illustrates the uranium plume that is present beneath the SWU. Groundwater flow is from west to east. The trailing edge of the 30 μg/L uranium plume appears to be located in the west, near direct-push sample location 12814. The area west of this location has been flushed clean of contamination by the mechanisms noted above. The uranium plume in this cross-section is relatively thin (approximately 10 feet) except at direct-push sample location 12824 where the plume is approximately 30 feet thick. During the fourth quarter of 2001, the water level in this area was approximately five feet lower than it was when Monitoring Wells 2385 and 2065 were installed. Therefore, only the lower five feet (approximately) of the screens in these wells were below the water table. When installed, the 15-foot screens in these wells were positioned so that the lower 10 feet were in the saturated zone.

Cross-Section B-B'

Figure 2-6 shows cross-section B-B'. This section is oriented east-west and extends from monitoring well cluster 402 in the west to direct-push sample location 12836 in the east. It runs through the northern portion of the SWU area east to a location that is downgradient of the Storm Sewer Outfall Ditch. This section illustrates the uranium plume beneath the SWU and the commingling of this plume with another plume to the east that originated from infiltration through the Storm Sewer Outfall Ditch. The plume beneath the SWU ranges up to approximately 40 feet in thickness at direct-push sample location 12837. Direct-push sample location 12405 was sampled in 1999 when water levels were higher. The shallowest groundwater sample collected at that time had a uranium concentration of 208 µg/L. Fourth quarter 2001 water levels are lower than 1999 levels. This implies that uranium contamination may be sorbed to soils above the water table. A pump-and-treat remediation strategy is only effective in the saturated zone.

Cross-Section C-C'

Figure 2-7 shows cross-section C-C'. The section is oriented east-west and extends from Monitoring Well 2016 in the west to direct-push sample location 12408 in the east. It runs through the southern portion of the former SWU area to a location that is east of the Storm Sewer Outfall Ditch. It illustrates the uranium plume beneath the SWU and the commingling of this plume with another plume to the east that originated from infiltration through the Storm Sewer Outfall Ditch. During the fourth quarter of 2001, the uranium concentration of the water pumped from Extraction Well 31561 (EW-20) averaged 59 µg/L. The uranium plume beneath the SWU along this southern east-west trace is relatively thin, approximately 15 feet in thickness. The uranium plume to the east that originated from the Storm Sewer Outfall Ditch is approximately 30 feet thick.

Cross-Section D-D'

Figure 2-8 shows cross-section D-D'. The section extends in a north-south direction from Monitoring Well 2047 in the north to Monitoring Well 2016 in the south. It runs through the western edge of the 30 µg/L uranium plume located beneath the SWU. In the past, this area of the plume has had some of the highest uranium concentrations. For example, in 1996 a groundwater sample collected from Monitoring Well 2945 had a uranium concentration of 1,790 µg/L. This well has since been abandoned to make way for removal of the Inactive Flyash Pile. Although Monitoring Well 2945 is shown on the cross-section, the plume contours do not honor the 1,790 µg/L concentration because recent direct-push sampling data from the area indicate much lower uranium concentrations and lower water levels. The highest recent uranium concentration in the section (64 µg/L) was at direct-push sample location 12815. With lower water levels, the possibility exists that some uranium is sorbed in the aquifer sediments above the present water level surface. The plume in this area is relatively thin, approximately 10 feet thick. It is believed that the mechanisms noted above have all contributed to the rapid drop in uranium concentrations in this area.

Cross-Section E-E'

Figure 2-9 shows cross-section E-E'. The section extends in a north-south direction from direct-push sample location 12825 in the north to direct-push sample location 12841 in the south. It runs down the center of the western portion of the SWU area. This area of the plume also had some of the highest uranium concentrations in the past. For example, Monitoring Well 2954 had a uranium concentration of 1,670 µg/L in November of 1996. This well has since been abandoned to make way for removal of the Inactive Flyash Pile. Although shown on the cross-section, the contours do not honor the 1,670 µg/L concentration. As the cross-section shows, when the screen for this well was installed, the water level was higher. This raises a concern that uranium contamination may be sorbed to soils above the water table. A pump-and treat strategy is only effective in the saturated zone. The uranium plume in this area is relatively thick. For instance, at direct-push sample location 12824, it is approximately 40 feet thick. However, the concentrations are very close to 30 µg/L for approximately 30 feet of this 40-foot thickness.

Cross-Section F-F'

Figure 2-10 shows cross-section F-F'. The section extends from direct-push sample location 12417 in the north to monitoring well cluster 045 in the south. It is oriented in a north-south direction just east of the center of the former SWU area. The cross-section illustrates that the 30 µg/L uranium plume is thicker in the north than it is in the south. For instance, at direct-push sample location 12837, the 30 µg/L uranium plume is approximately 40 feet thick, while at direct-push sample location 12826, the plume is approximately 25 feet thick.

Cross-Section G-G'

Figure 2-11 shows cross-section G-G'. The section extends from direct-push sample location 12820 in the north to monitoring well cluster 049 in the south. It is oriented in a north-south direction just east of the western chamber of the Storm Water Retention Basin and the SWUs. In the northern portion of the section (direct-push sample location 12820), the extreme northwest edge of a uranium plume beneath the Storm Water Retention Basin is shown. The eastern portion of the uranium plume that was sourced from the SWU is shown in the middle of the section (direct-push sample locations 12844, 2065, and 12845). The western trailing edge of a plume that originated from infiltration through the Storm Sewer Outfall Ditch and from surface water runoff that formerly ran down the east side of the South Field component of the SWU is shown in the southern portion of the cross-section (Monitoring Well 2049). This surface water runoff would then infiltrate down into the aquifer in the vicinity of Monitoring Well 2049. The section illustrates that the leading edge of the plume located beneath the SWU is relatively thin, approximately 10 feet thick.

Cross-Section H-H'

Figure 2-12 shows cross-section H-H'. The section extends from Extraction Well 31564 (EW-14) in the west to monitoring well cluster 049 in the east. It is oriented in an east-west direction. The objective of sampling in this area was to provide a status on the extent of the 30 µg/L uranium plume in the area of Extraction Well 31563 (EW-16). As the cross-section illustrates, the trailing edge of the 30 µg/L uranium plume is close to monitoring well cluster 049. This cluster is located east of Extraction Well 31563 (EW-16). When operating, this extraction well pulls most of its water from the west. The closest monitoring well (Monitoring Well 2045) west of Extraction Well 31563 (EW-16) has shown a dramatic decrease in uranium concentrations since pumping began in 1998. Figure 2-13 is a uranium concentration versus time plot for Monitoring Well 2045. The plot clearly illustrates the uranium concentration decrease that has taken place since 1998. The conclusion is that if Extraction Well 31563 (EW-16) continues to operate, it will only pull clean water into it from the west, as the trailing edge of the 30 µg/L uranium plume is now located to the east of Extraction Well 31563 (EW-16).

Cross-Section I-I'

Figure 2-14 shows cross-section I-I'. The section extends from monitoring well cluster 049 in the west to direct-push sample location 13247 in the east. Direct-push sample location 13247 is one of three recent direct-push sample locations (13241, 13247, and 13248) sampled in early 2002 to refine the definition of the leading edge of the plume. Figure 2-1 shows the three locations.

Cross-section I-I' is oriented west to east from the southeastern corner of the SWUs to just west of the FEMP's South Access Road. The western trailing edge of the plume that originated from infiltration through the Storm Sewer Outfall Ditch and from infiltrating surface water runoff that formerly drained down the east side of the South Field component of the SWU is shown on the western portion of the section (monitoring well cluster 049). The remaining portion of the section goes through the center then defines the eastern edge of the part of the plume with the highest remaining uranium concentrations that was sourced primarily from the Storm Sewer Outfall Ditch.

Although the highest concentration on the cross-section for direct-push sample location 12433 is 373 µg/L, previous concentrations in this area have been as high as 845 µg/L (Monitoring Well 62433 in March of 2001). This higher uranium concentration is contoured on Figures 2-1, 2-2, and 2-4. Continuous multi-channel tubing (CMT) Well 82433 was also installed in the same area as direct-push sample location 12433. The highest uranium concentration in CMT Well 82433 was 475 µg/L in December of 2001.

A concern with the existing South Field Extraction (Phase I) Module in this area is that the current extraction wells will not be able to effectively remediate this eastern area of the plume due to its thickness and extent east of the current extraction wells. Therefore, additional extraction wells appear to be needed.

Around and Southeast of the Storm Water Retention Basin

Eight of the recent direct-push sample locations were completed around the perimeter of the east chamber of the Storm Water Retention Basin. An additional extraction well (33061 [EW-25], as shown in Figure 2-2) has already been installed to accelerate remediation in this area. The drilling package was submitted to the EPAs along with the Waste Storage Area Module Design. Extraction Well 33061 (EW-25) began pumping on May 7, 2002.

SUMMARY

- Uranium concentrations beneath the SWU are much lower today than they were in previous years. The lower concentrations are attributed to source removal, natural flow of clean groundwater from the west into the area, the continued flushing of clean water through Paddys Run to the west, increased flushing of clean water through deep surface excavations in the Inactive Flyash Pile, and remedial pumping of the extraction wells to the east of this area.

- The water table beneath the former Inactive Flyash Pile was lower in the fourth quarter of 2001 than it was in previous years, raising the concern that uranium contamination may be sorbed to sediments above the present surface of the saturated zone. Pump-and-treat operations will only remove uranium from the saturated zone. Additional pumping will serve to lower the water table even more with the potential for having even more uranium out of the influence of the pump-and-treat operation.

- Remedy design beneath the former Inactive Flyash Pile will need to address variations in plume thickness. In the middle of the plume, which lies beneath the former Inactive Flyash Pile, the 30 μg/L uranium plume was measured as being approximately 40 feet thick. However, the concentrations are very close to 30 μg/L for approximately 30 of the 40 feet. Along the edges the plume thins to approximately 10 feet.

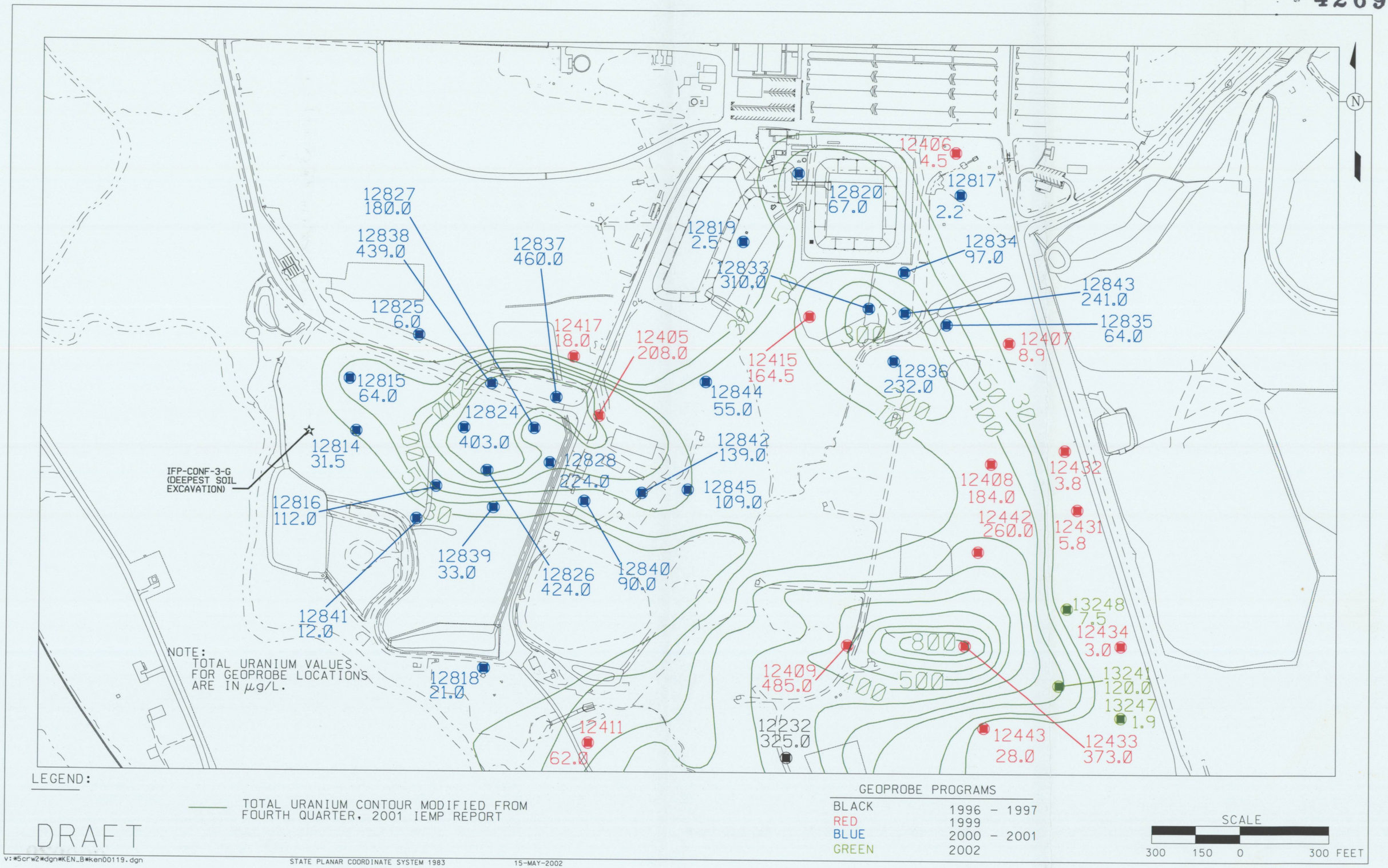
- Pumping rates beneath the former Inactive Flyash Pile need to consider the effects of partial penetration in light of the plume being approximately 10 feet thick in several areas. Large pumping rates might draw a lot of uncontaminated water from beneath the plume and lower system efficiencies for uranium removal.

- Extraction Well 31563 (EW-16) is now situated just west (upgradient) of the trailing edge of the 30 μg/L uranium plume. It is an ideal candidate for conversion to re-injection to accelerate remediation of the uranium plume east (downgradient) of the well.

- Extraction Wells 31565 (EW-13) and 31564 (EW-14) are no longer situated in locations that will provide a pumping benefit to the aquifer remedy. Pumping should stop in these wells, and they should be used for monitoring the ongoing decline of uranium concentrations in this area of the aquifer.

- Additional extraction wells will be beneficial in the southeastern edge of the South Field plume to address the large mass of uranium located east of existing Extraction Well 32447 (EW-23).

- Efforts need to be taken to keep the water level as high as possible in the SWU area. Re-injection, either through basins or wells, should be utilized when possible. The remedy should take advantage of natural aquifer flushing through the use of infiltration basins, etc. Such flushing might serve to release some of the uranium sorbed to soils above the current water table, particularly in/near the former source areas.



LEGEND:

TOTAL URANIUM CONTOUR MODIFIED FROM FOURTH QUARTER, 2001 IEMP REPORT

GEOPROBE PROGRAMS

BLACK	1996 - 1997
RED	1999
BLUE	2000 - 2001
GREEN	2002

SCALE

300 150 0 300 FEET

DRAFT

v:*5crw2*dgn*KEN_B*ken00119.dgn STATE PLANAR COORDINATE SYSTEM 1983 15-MAY-2002

FIGURE 2-1. GEOPROBE LOCATION MAP

LEGEND:

TOTAL URANIUM CONTOUR MODIFIED FROM FOURTH QUARTER, 2001 IEMP REPORT

MONITORING WELL LOCATION

EXTRACTION WELL LOCATION

MONITORING WELL DATA

BLACK	LAST MEASURED RESULT
RED	IEMP FOURTH QUARTER 2001
BLUE	2001 SAMPLING

SCALE

300 150 0 300 FEET

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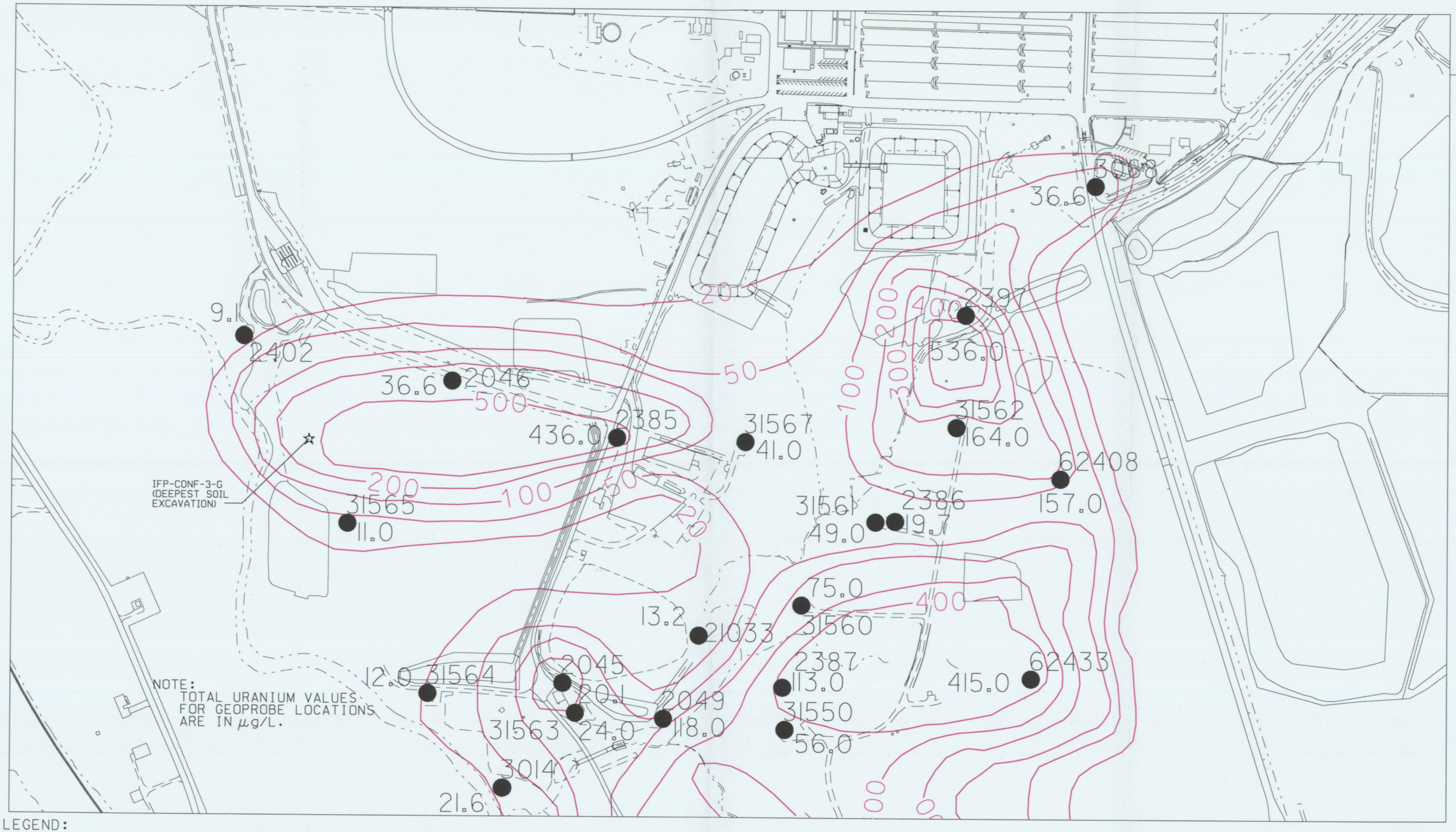
000022

v:*5crw2*dgn*KEN_B*ken00121.dgn

STATE PLANAR COORDINATE SYSTEM 1983

15-MAY-2002

FIGURE 2-2. MONITORING AND EXTRACTION WELL LOCATION MAP



LEGEND:

TOTAL URANIUM CONTOUR FROM FIRST QUARTER, 2001 IEMP REPORT

MONITORING WELL LOCATION

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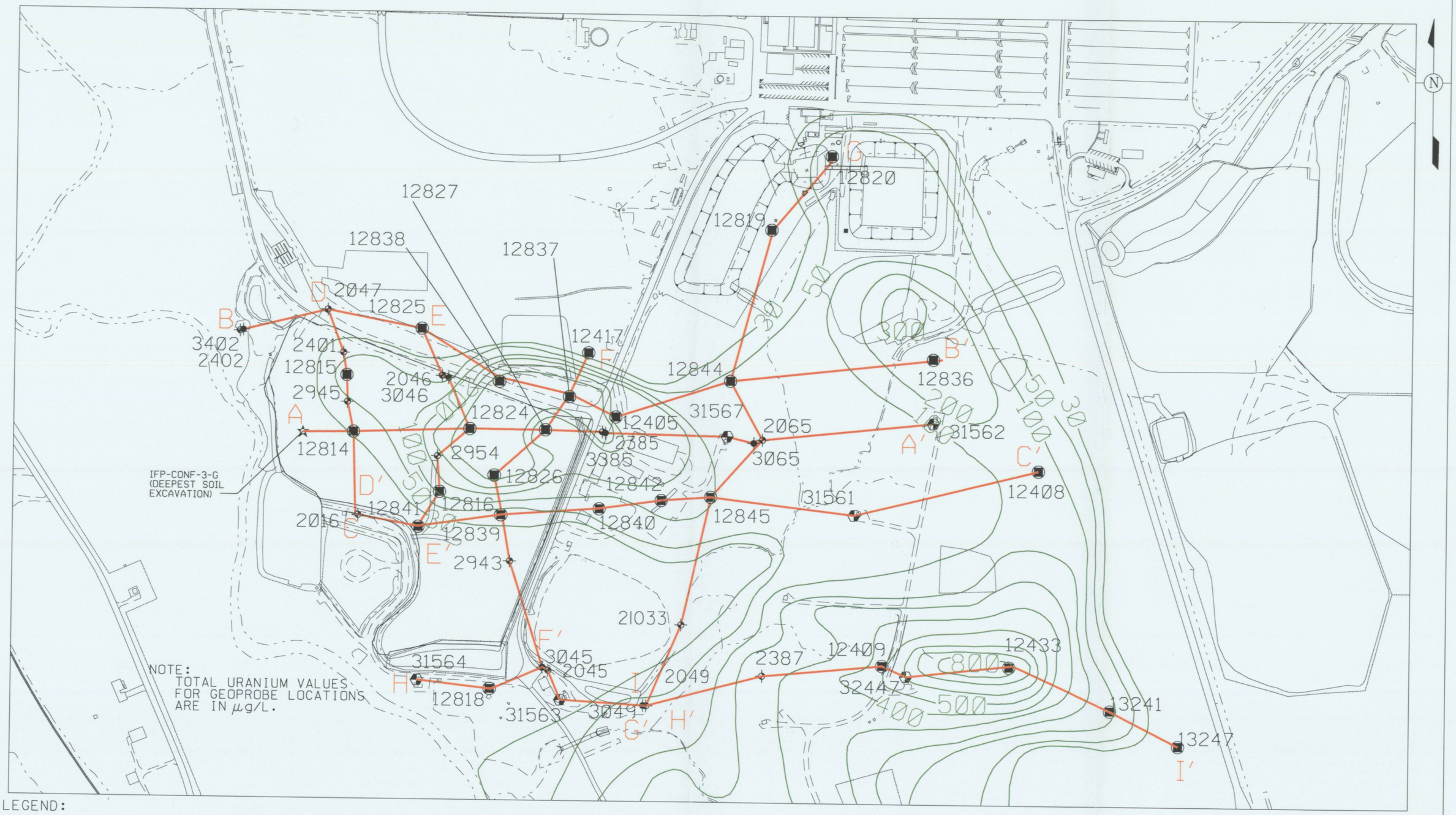
000023

SCALE

300 150 0 300 FEET

v:*5crw2*dgn*ken_b*ken00123.dgn STATE PLANAR COORDINATE SYSTEM 1983 14-MAY-2002

FIGURE 2-3. THIRD QUARTER 2000 TOTAL URANIUM CONTOURS AND WELLS



LEGEND:

TOTAL URANIUM CONTOUR MODIFIED FROM FOURTH QUARTER, 2001 IEMP REPORT

SECTION LINE

MONITORING WELL LOCATION

GEOPROBE LOCATION

DRAFT

000024

SCALE

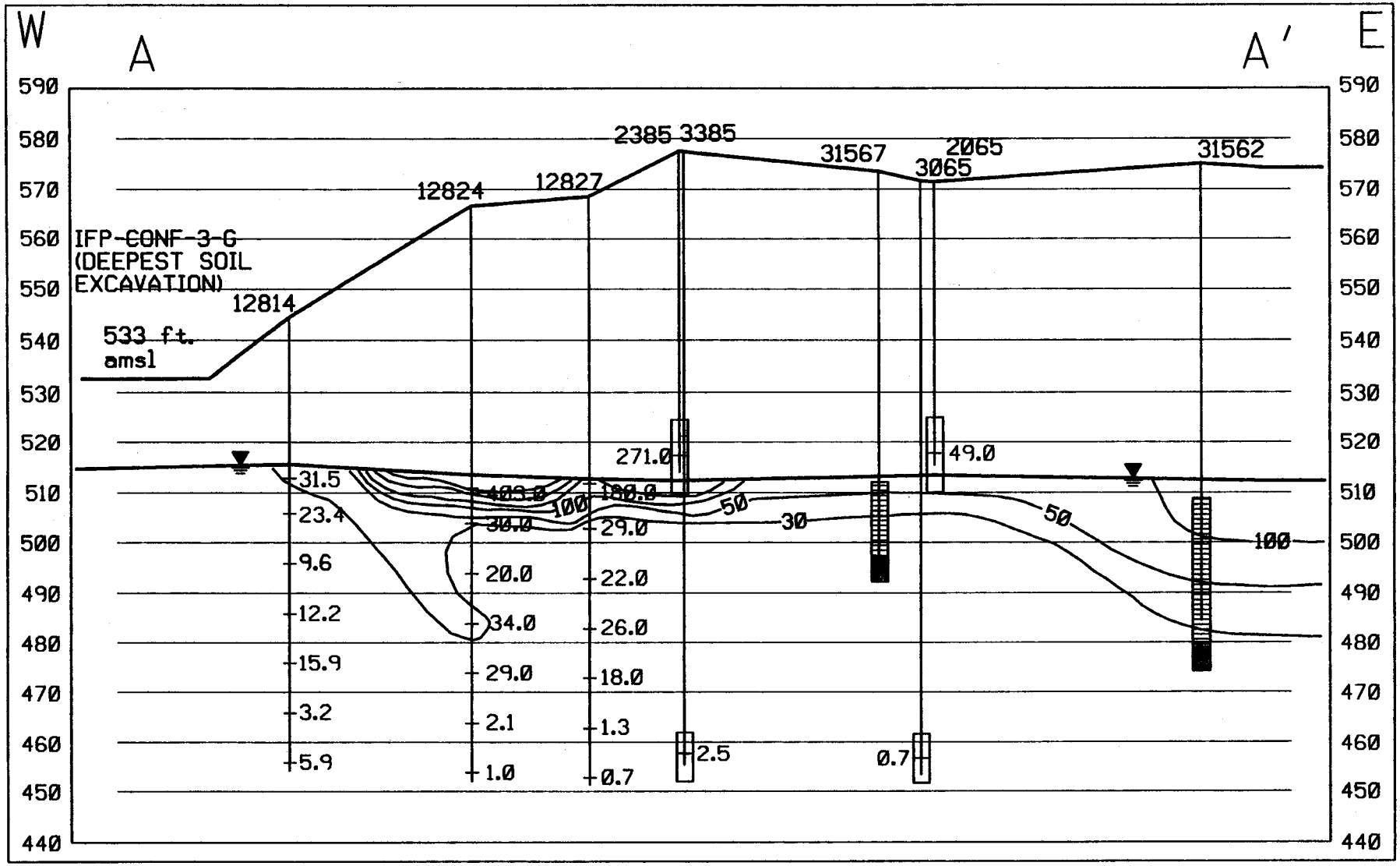
300 150 0 300 FEET

v:*5crw2*dgn*KEN_B*ken00122.dgn

STATE PLANAR COORDINATE SYSTEM 1983

15-MAY-2002

FIGURE 2-4. SECTION LINE AND CORRESPONDING WELLS LOCATION MAP



LEGEND:

1.0 TOTAL URANIUM (μg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

12814 (10-2000)	3385 (12-2001)
12824 (1-2001)	2065 (12-2001)
12827 (1-2001)	3065 (12-2001)
2385 (12-2001)	

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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v:\5crw2\dgn\KEN_B\ken00106.dgn 13-MAY-2002
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-5. CROSS-SECTION A – A'

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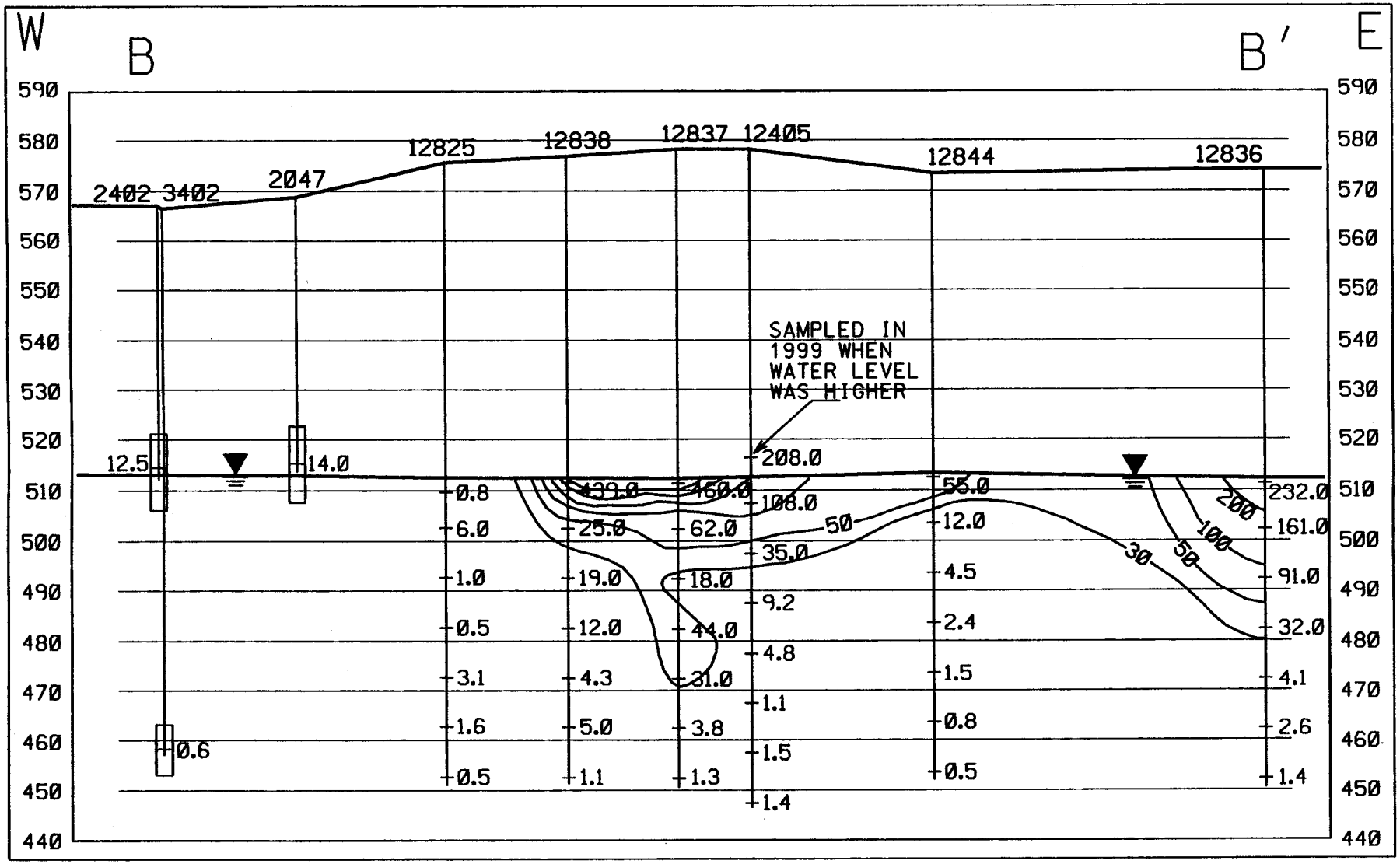

LEGEND:

1.0 TOTAL URANIUM (μg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

12405 (1-1999)	12844 (5-2001)	2047 (2-1997)
12825 (1-2001)	12836 (3-2001)	
12838 (3-2001)	2402 (12-2001)	
12837 (3-2001)	3402 (12-2001)	

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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FIGURE 2-6 CROSS-SECTION B - B'

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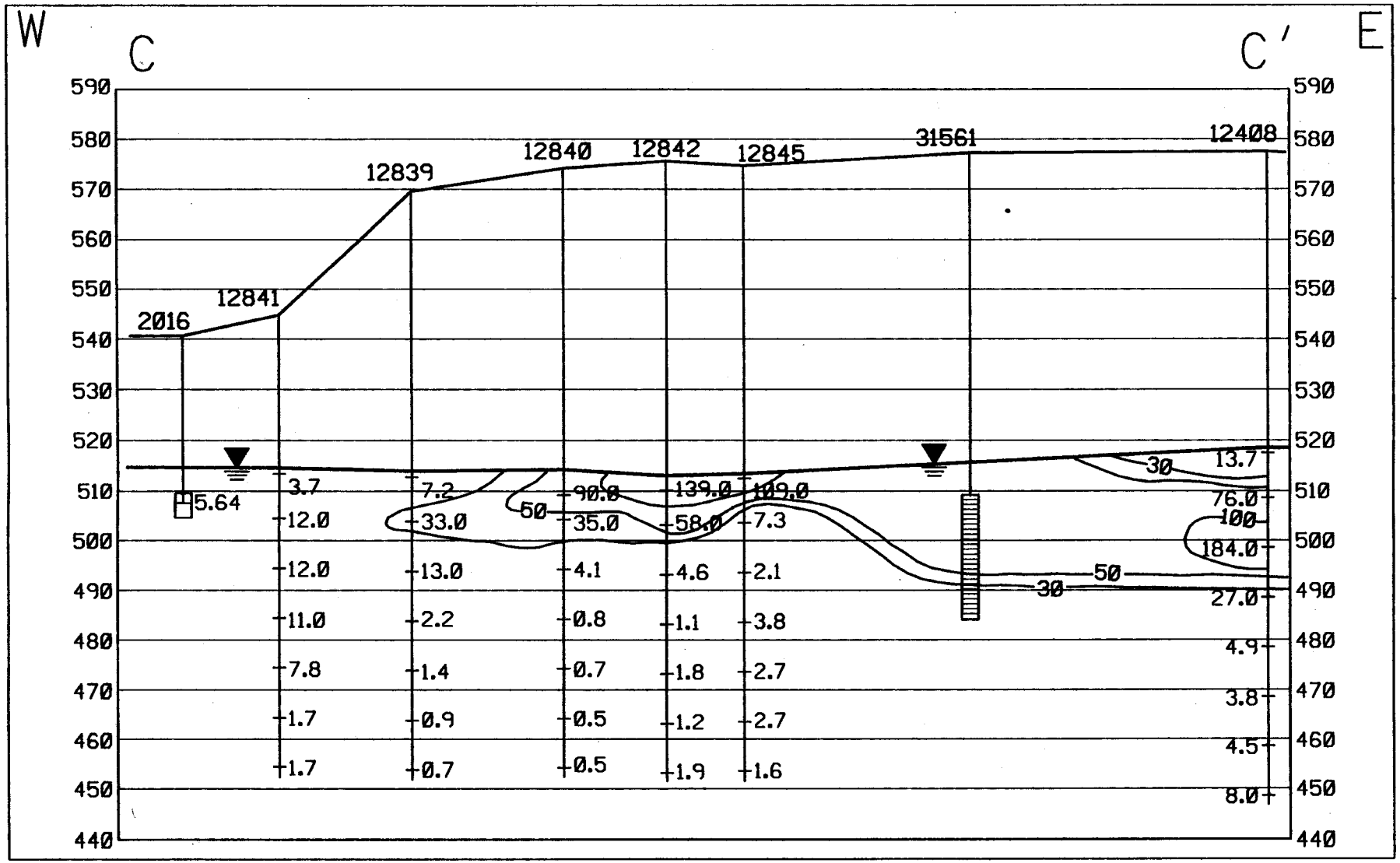

LEGEND:

1.0 TOTAL URANIUM (μg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

12408 (3-1999)	12840 (3-2001)
2016 (12-2001)	12842 (3-2001)
12841 (3-2001)	12845 (5-2001)
12839 (3-2001)	

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-7. CROSS-SECTION C - C'

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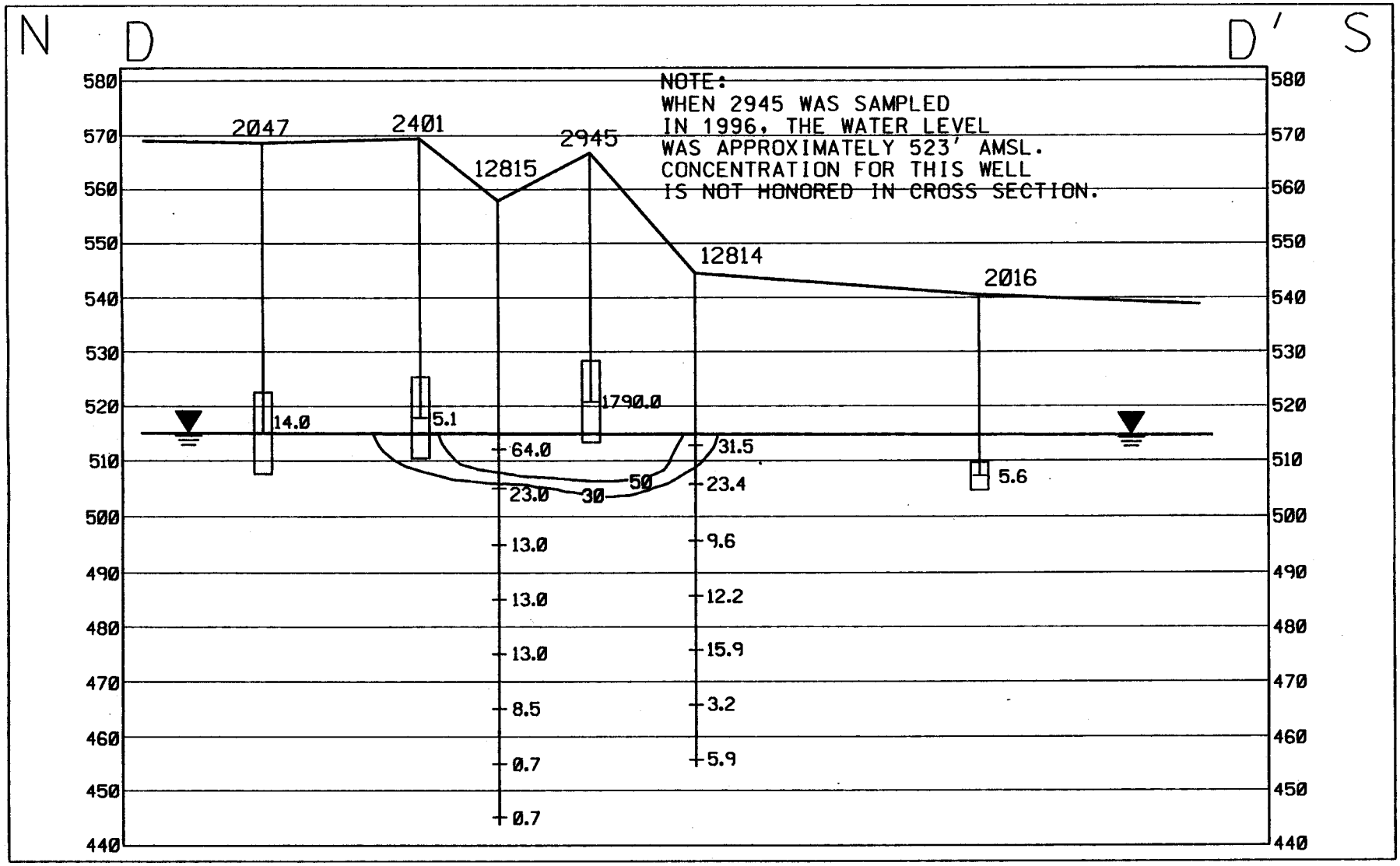
- 4269



LEGEND:

1.0 TOTAL URANIUM (μg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

2047 (2-1997)
2401 (5-1993)
2016 (12-2001)
2945 (11-1996)
12815 (10-2000)

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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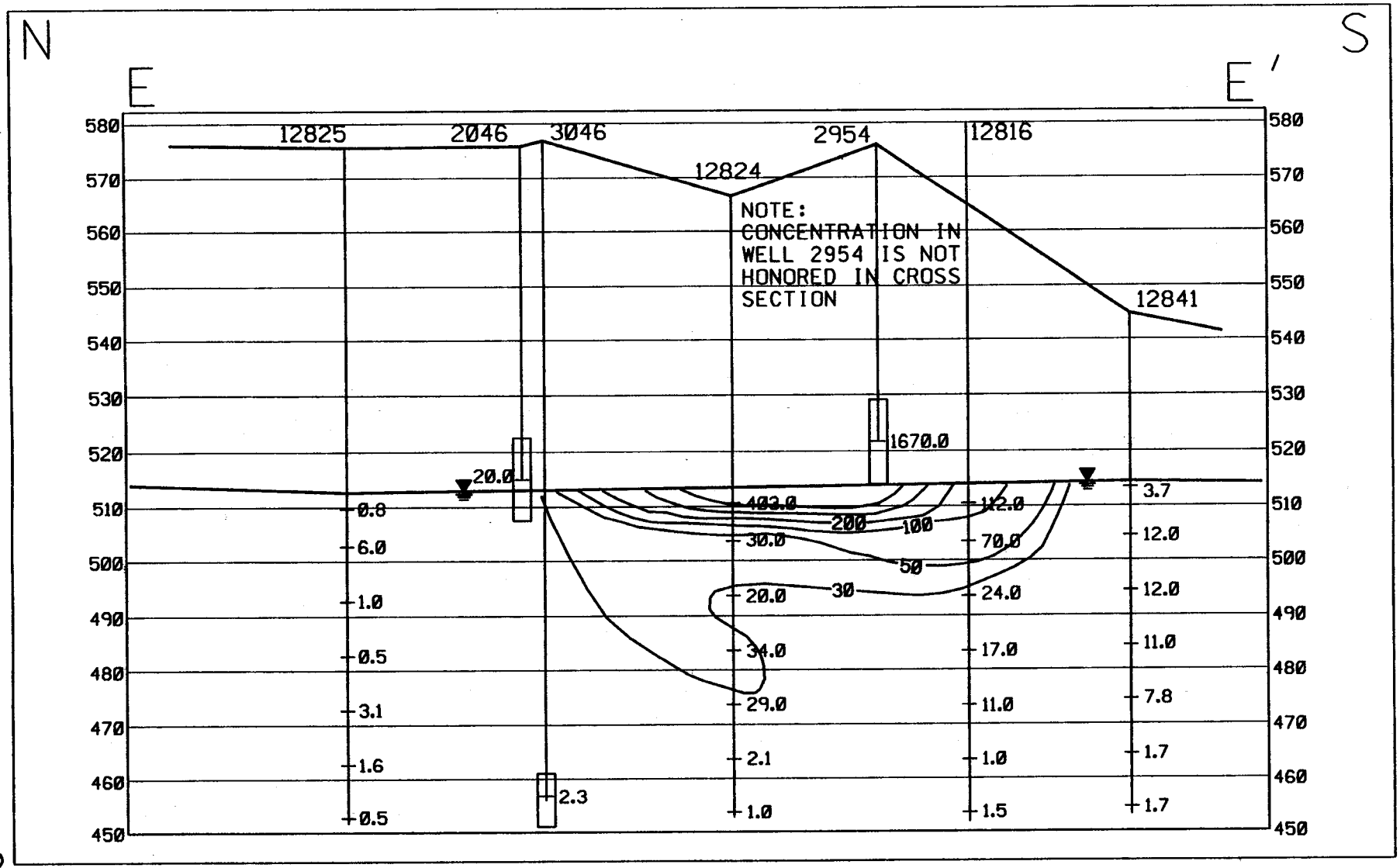
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-8. CROSS-SECTION D - D'



LEGEND:

1.0 TOTAL URANIUM (μg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

12816 (11-2000)	2046 (12-2001)
12825 (1-2001)	3046 (12-2001)
12824 (1-2001)	2954 (11-1996)
12841 (3-2001)	

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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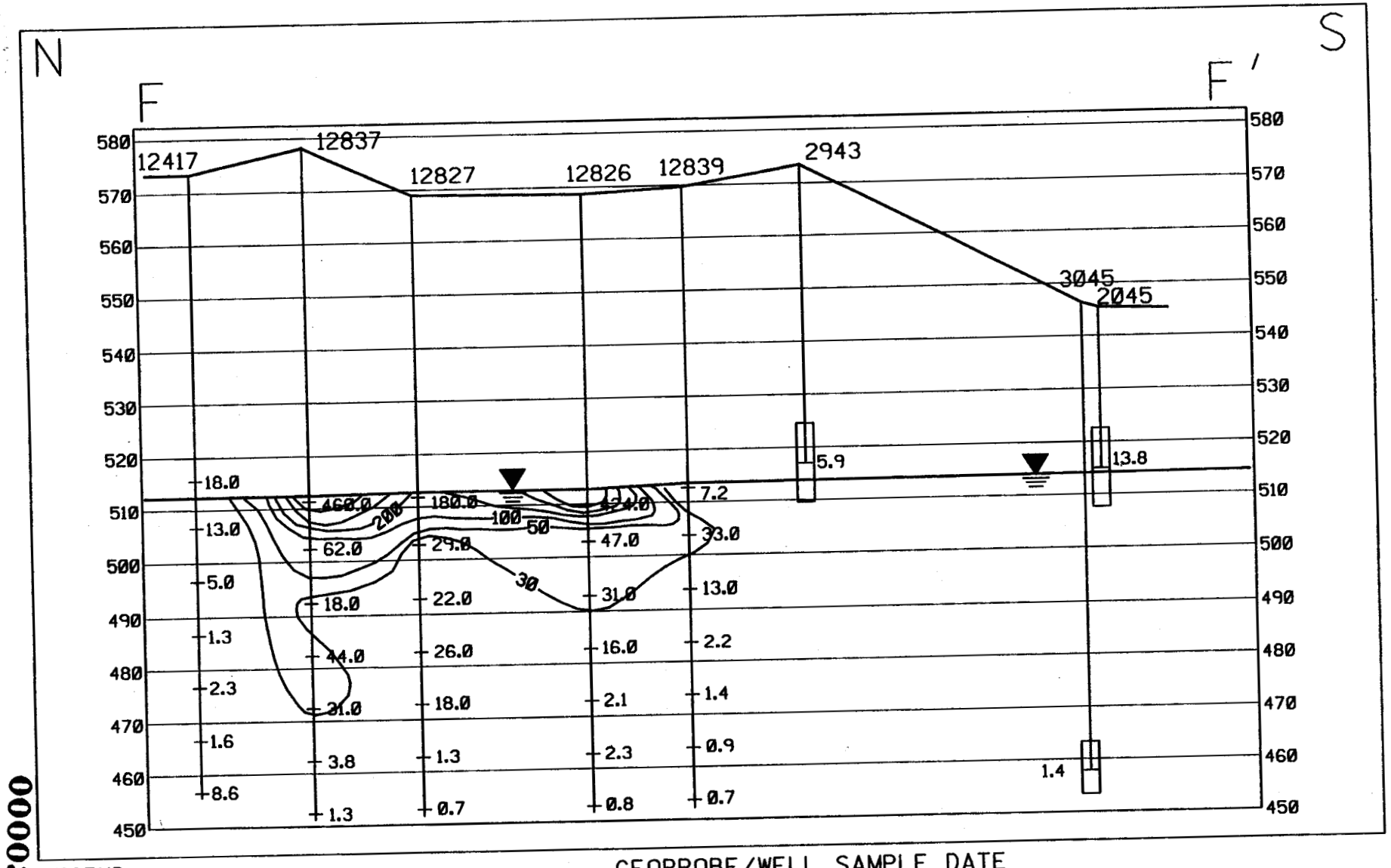
STATE PLANAR COORDINATE SYSTEM 1927

FIGURE 2-9. CROSS-SECTION E – E'



LEGEND:

1.0 TOTAL URANIUM µg/L IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

12417 (1-1999)	12839 (3-2001)
12837 (3-2001)	2943 (11-1996)
12827 (1-2001)	2045 (12-2001)
12826 (1-2001)	3045 (12-2001)

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-10. CROSS SECTION F - F'

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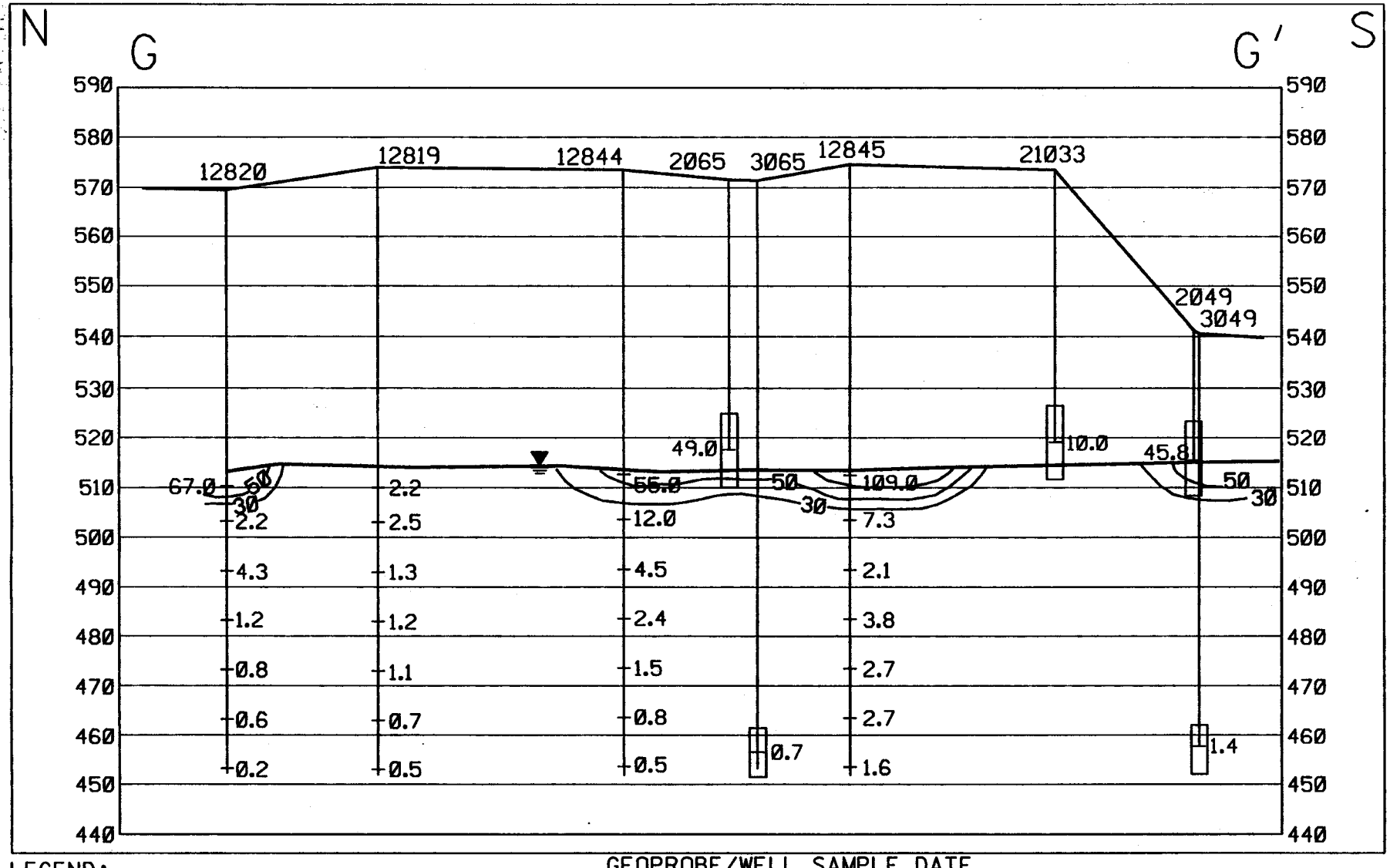

LEGEND:

1.0 TOTAL URANIUM (µg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

12819 (12-2000)	2065 (3-2001)
21033 (12-2001)	3065 (3-2001)
12820 (1-2001)	12845 (5-2001)
12844 (5-2001)	2049 (12-2001)
	3049 (12-2001)

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-11. CROSS-SECTION G - G'

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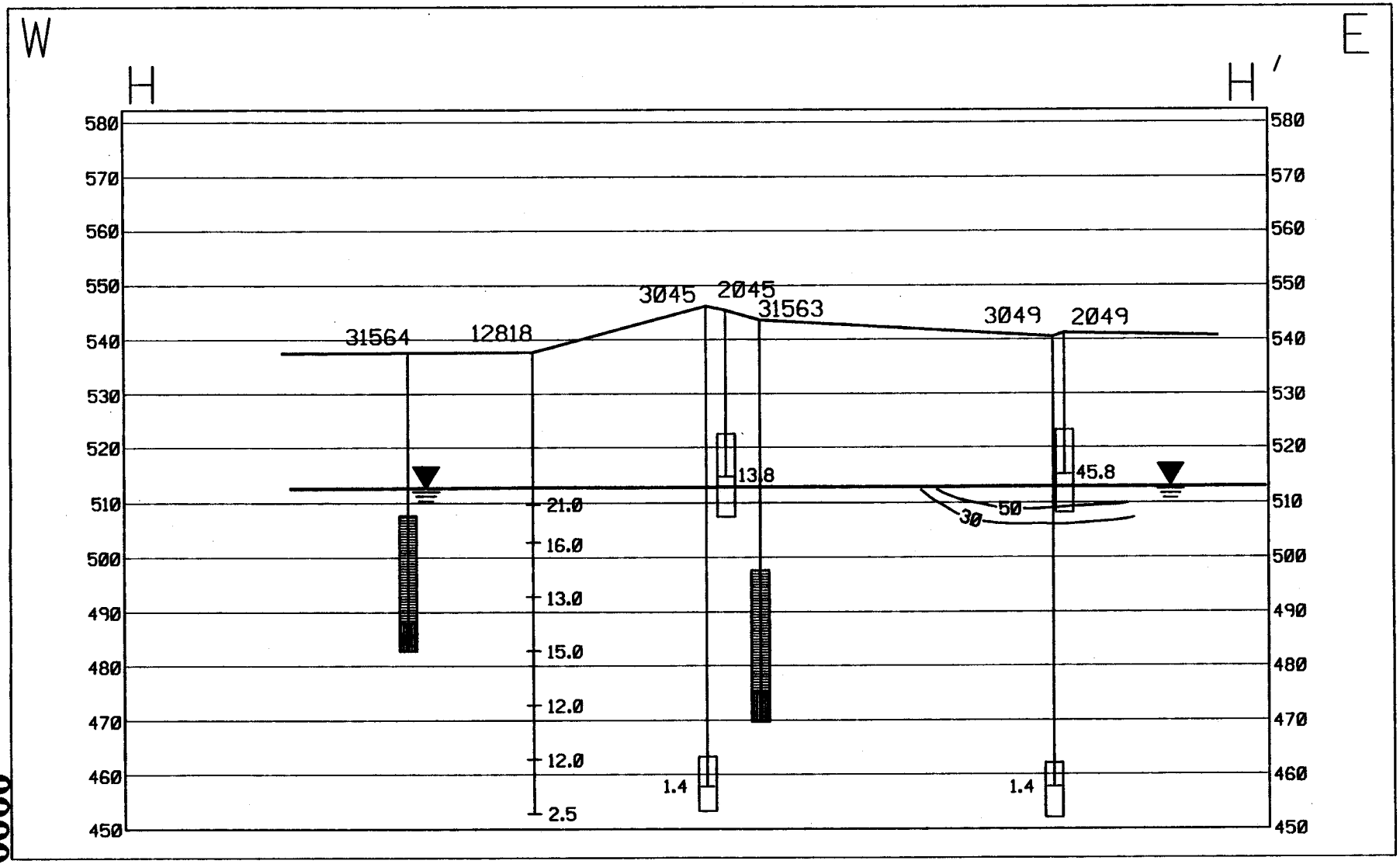

LEGEND:

1.0 TOTAL URANIUM (μg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

12818 (12-2000)
2045 (12-2001)
3045 (12-2001)
2049 (12-2001)
3049 (12-2001)

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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FIGURE 2-12. CROSS-SECTION H - H'

000032

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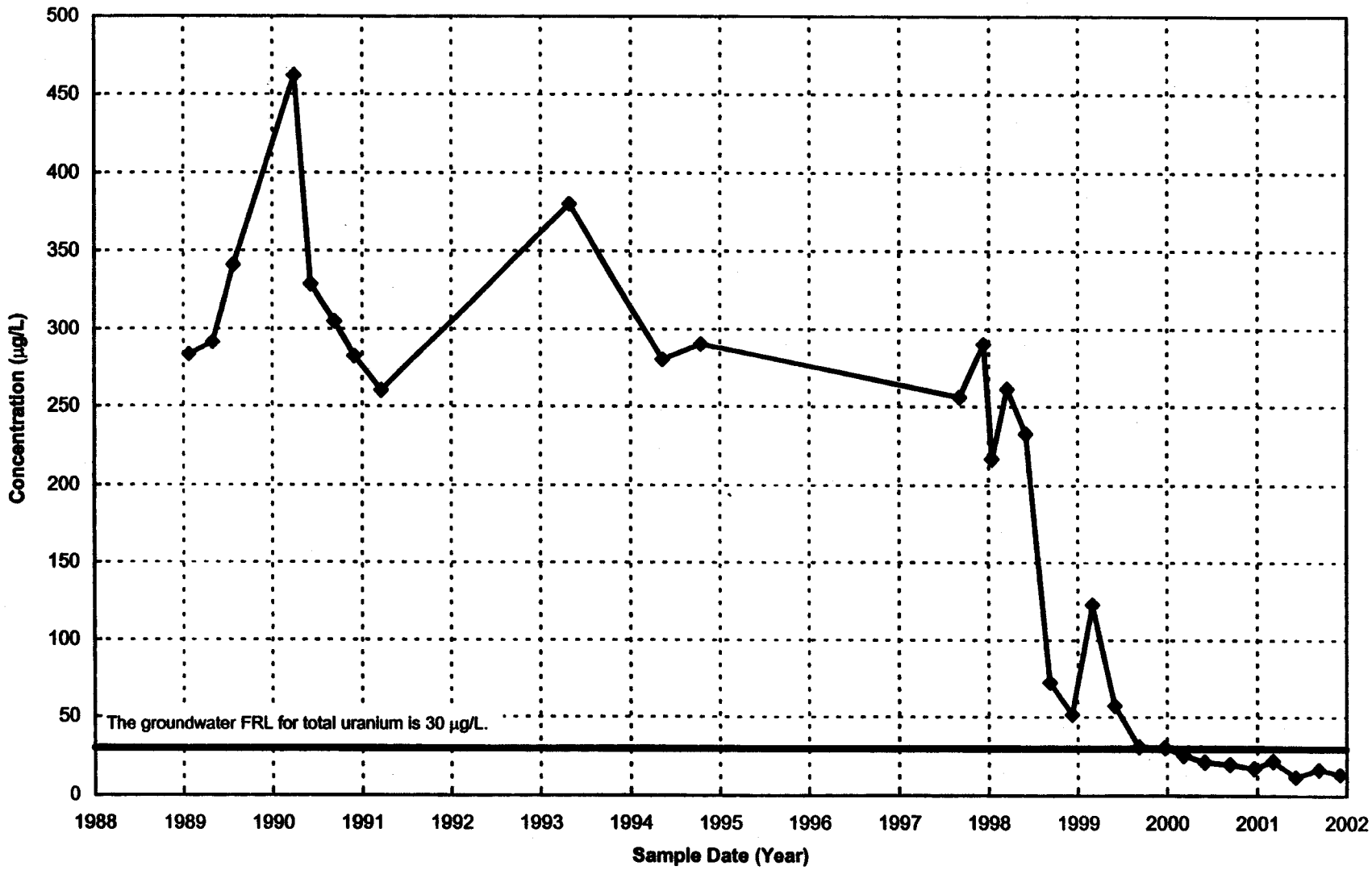
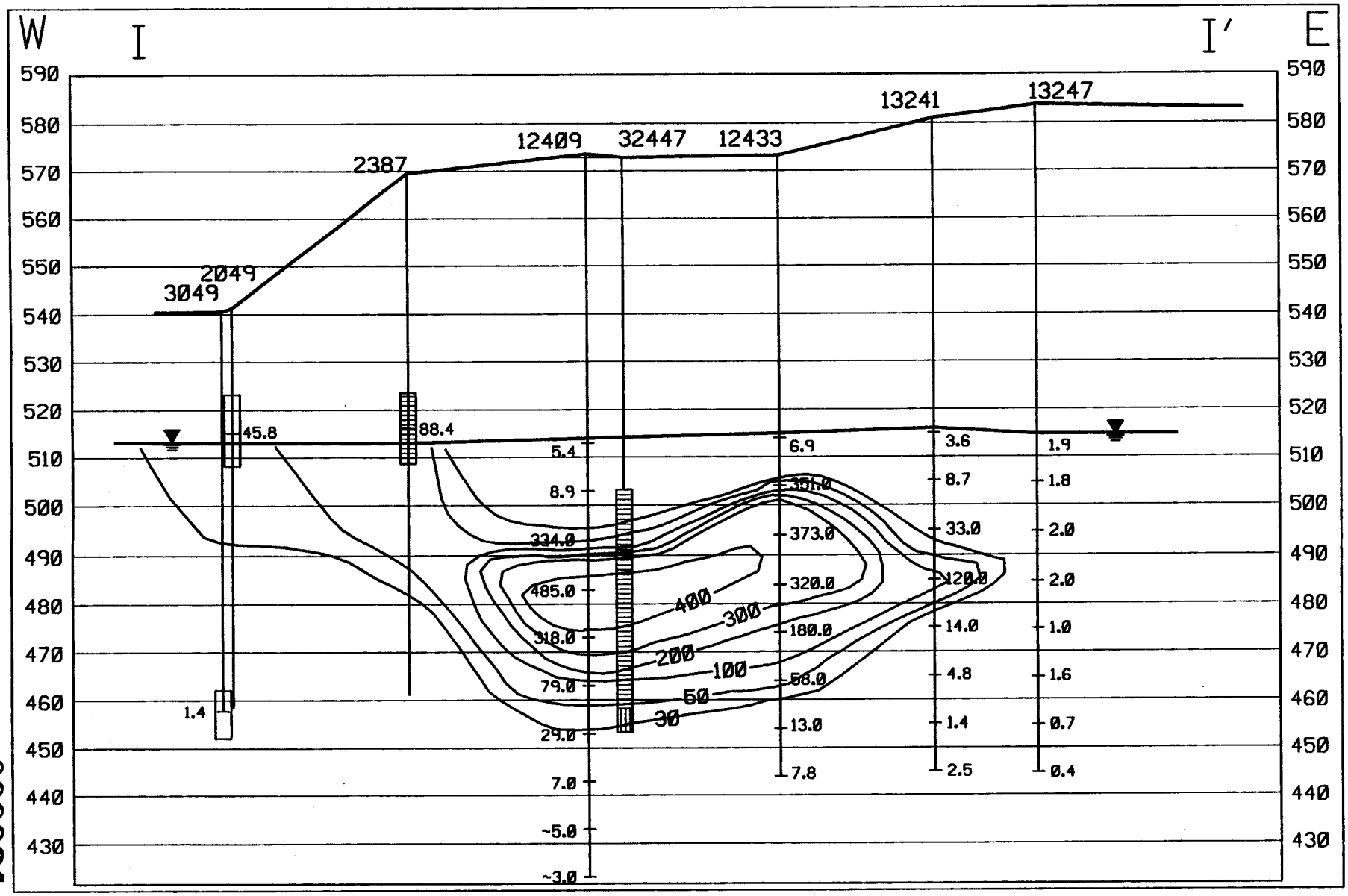


FIGURE 2-13. TOTAL URANIUM CONCENTRATION VS. TIME FOR MONITORING WELL 2045



LEGEND:

1.0 TOTAL URANIUM (μg/L) IN GROUNDWATER

GEOPROBE/WELL SAMPLE DATE

13241 (1-2002)
13247 (1-2002)
12409 (4-1999)
12433 (4-1999)

NOTE:
SEE FIGURE 2-4 FOR CROSS SECTION LOCATION.

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STATE PLANAR COORDINATE SYSTEM 1927

FIGURE 2-14. CROSS-SECTION I - I'

000034

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3.0 NUMBER AND LOCATION OF EXTRACTION/RE-INJECTION WELLS

3.1 INTRODUCTION

The Baseline Remedial Strategy Report presented a remedial design for the South Field area consisting of two phases (Figure 3-1). The first phase consists of 10 extraction wells located east and south of the former Inactive Flyash Pile and along the Storm Sewer Outfall Ditch. Additional direct-push sampling conducted since 1997 has resulted in installation of three supplemental wells to the South Field Extraction (Phase I) Module (Extraction Wells 32446 [EW-24], 32447 [EW-23], and 33061 [EW-25], as shown in Figure 3-2). Extraction Wells 32446 (EW-24) and 32447 (EW-23) are operational and located on the east side of the South Field area; whereas Extraction Well 33061 (EW-25) is located near the southeastern corner of the Storm Water Retention Basin, and began pumping on May 7, 2002.

Phase II of the Baseline Remedial Strategy Report South Field Remedy Design consisted of nine additional extraction wells in the SWU area and five additional re-injection wells, three along the northern edge of the SWU area and two near the Storm Water Retention Basin. The Baseline Remedial Strategy Report Phase II Remedy Design also called for conversion of three Phase I extraction wells to re-injection wells (31563 [EW-16], 31564 [EW-14], and 31565 [EW-13]).

As discussed in Section 2 of this report, uranium concentrations in the Great Miami Aquifer have been significantly reduced in the SWU area due to source removal, increased surface water infiltration, natural groundwater flow, and remedial pumping. Additional uranium contamination in the Great Miami Aquifer has been characterized between the Storm Sewer Outfall Ditch and the FEMP's South Access Road. These changes in interpretation of plume size and shape require a revised South Field Phase II Module Design.

The revised South Field Phase II Module Design consists of four additional extraction wells, one in the SWU area and three along the eastern edge of the uranium plume in the South Field area (Figure 3-2). The design also consists of changing South Field Extraction Well 31563 (EW-16) into a re-injection well and adding a re-injection well upgradient of the SWU area to help maintain water levels in the area. Surface water re-injection through existing basins in the SWU area will be used to supplement wellhead re-injection.

As shown in Table 3-1, pumping and re-injection is expected to continue in the South Field and South Plume areas through 2006. It is anticipated that re-injection at the southern property boundary will no

longer be needed and that pumping in the off-property portion of the South Plume will be complete. However, it is anticipated that additional pumping will be required in the South Field and in the Waste Storage Area Modules through 2011. Pumping from the South Field Phase II Module wells will commence as soon as the wells are installed and the surface infrastructure/pipelines are completed. Table 3-1 also indicates that South Plume Extraction Well 3927 (RW- 4) and Re-injection Well 22111 (IW-12) can be shutdown.

Groundwater modeling indicates the aquifer will be remediated to the 30 μg/L final remediation level (FRL) by the end of 2011. Modeling results in support of this design are described below.

3.2 CHANGES TO THE VAM3D MODEL

The FEMP is currently upgrading the VAM3D modeling code to incorporate Data Fusion Modeling (DFM) technology into the groundwater modeling process at the FEMP (HydroGeologic, 2000). The DFM methodology is currently in testing and verification, and is not yet available to support aquifer remediation. However, a VAM3D zoom model constructed for the DFM process and covering the uranium plume is available and was used for this design (Figure 3-3). This smaller zoom model will be required for future DFM runs to allow reasonable run times and will be used in future modeling activities for design and performance tracking.

The zoom model is oriented in a north-south direction extending 10,000 feet from south of the South Plume Extraction Module to north of the Waste Storage Area Module. The model extends 5,000 feet in an east-west direction from the western FEMP boundary to the eastern edge of the former production area. The model consists of 101 cells north to south and 51 cells east to west with square model cells 100 feet by 100 feet. In order to increase vertical resolution for transport runs, two layers from the large VAM3D model were split in the zoom model resulting in 14 layers instead of 12 (Figure 3-4). The zoom model layers are numbered from bottom to top whereas the large VAM3D model layers are numbered from top to bottom.

Figure 3-5 shows a side view of the top half of the zoom model looking north. Model layers 8 through 14 represent the upper Great Miami Aquifer above the blue clay layer. Because the uranium contamination is confined to the upper Great Miami Aquifer, the bottom zoom model layers (layers 1 through 7) are not shown in this figure. The hydraulic conductivity zones from the large model were incorporated into the zoom model as shown in Figure 3-6.

Operational experience, sediment samples, and boring logs from Extraction Well 31566 (EW-15) and the shape of the uranium plume indicates the presence of a relatively low conductivity zone in the top part of the aquifer east of Paddys Run and south of the SWU area. The horizontal hydraulic conductivities in this local area within model zone 4 were changed from 638 feet per day and 544 feet per day to 200 feet per day in zoom model layers 9 through 14 (original VAM3D layers 1 through 4). Vertical conductivities were changed from 51 and 49.6 feet per day in these layers to 34 feet per day (refer to Figure 3-6). These values are consistent with the hydraulic conductivities in the lower half of the aquifer.

Surface water infiltration rates in the zoom model were increased in the SWU area to account for additional aquifer surface exposed by soil excavation activities. The dashed line in Figure 3-7 shows the pre-excavation limit of the glacial overburden taken from the Remedial Investigation Report for Operable Unit 5, Plate 3-3 (DOE 1995). The elevation of this pre-excavation limit was compared with the final excavation surface elevations to determine the area where additional Great Miami Aquifer material was exposed by removal of the glacial overburden. Surface water infiltration rates were increased from six inches per year to 30 inches per year for six model nodes as shown in Figure 3-7. Infiltration rates for exposed Great Miami Aquifer material are normally set at 15 inches per year in the model but the rate was increased to 30 inches per year for these six nodes to account for run on from the remaining glacial overburden immediately north of the SWU area.

3.3 FLOW MODEL RESULTS

The zoom model was designed to encompass the uranium plume in the aquifer. Therefore, some extraction wells are located close to the zoom model boundaries and could give erroneous results due to boundary effects. The large VAM3D model was used in this design to set boundary conditions for the zoom model. For each pumping scenario, the large VAM3D model was run to steady state. Steady state head values from the large model at nodes closest to the zoom model boundary nodes were assigned to the zoom model using a Fortran program. The zoom model was then run to steady state with the constant head boundaries derived from the larger model.

The zoom model calibration was checked against the October 1998 groundwater elevation data to confirm the zoom model could predict groundwater elevations to within one foot at each monitoring well. This is the same data and calibration criterion used in The Great Miami Aquifer VAM3D Flow Model Recalibration Report (DOE 2000b). Pumping rates were set equal to the operational rates when the October 1998 data were collected, and constant head zoom model boundaries were derived from steady

state heads in the large VAM3D model. All residuals between the zoom model elevations and observed groundwater elevations are less than one foot as shown in Table 3-2.

Figure 3-8 shows the modeled groundwater elevations and six-year particle tracks with current operational conditions for the South Field Phase I, South Plume, and South Plume Optimization Modules. The design pumping rates for the recently installed South Field Extraction Well 33061 (EW-25) (began pumping on May 7, 2002), and Waste Storage Area Extraction Wells 32761 (EW-26), 33062 (EW-27), and 33063 (EW-28) (began pumping on May 8, 2002) were incorporated into the pumping scenario. Also planned are the shutdown of Re-Injection Wells 22107 (IW-8), 22108 (IW-9), and 22111 (IW-12) and the installation of new re-injection wells 8A, 9A, and 10A. As an additional check of the zoom model, Figure 3-9 compares the modeled groundwater elevations for this current operational scenario from the large VAM3D model and the zoom model. The figure shows the modeled groundwater elevation contours to be almost identical in both cases.

As discussed in Section 3.2 of the Conceptual Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2000a), the large VAM3D flow model has been calibrated to an October 1998 groundwater monitoring data set (nominal aquifer conditions). Validation was done to wet and dry season data sets from July 1998 and October 1999, respectively. Boundary conditions for the zoom model were generated from the large VAM3D model for all three of these seasonal periods for the design pumping rates. Predicted groundwater elevations and particle tracks for the design pumping rates are shown for all three of these seasonal conditions in Figures 3-10 through 3-12.

Figure 3-13 shows the additional drawdown modeled for the South Field Phase II Module Design. Contours in this figure were obtained by subtracting the predicted groundwater elevation surface with the design pumping wells and rates (Figure 3-10) from the current operational scenario groundwater surface (Figure 3-8). Most of the additional drawdown occurs in the South Field area east of the Storm Sewer Outfall Ditch as expected. The nominal October 1998 model calibration boundary conditions were used for these flow runs.

Figures 3-14 through 3-16 show the predicted groundwater elevations for years 2007 through 2011 under the nominal, dry, and wet boundary conditions when the South Plume Module wells and most of the South Field Extraction (Phase I) Module wells have been turned off. Two additional wells in the Waste Storage Area Module (WSA 5 and WSA 6) are scheduled to be pumping during these years after

excavation activities are completed. Design details for these wells were presented in the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas.

3.4 TRANSPORT MODEL RESULTS

VAM3D transport model scenarios were run to estimate how the South Field Phase II Module Design would perform given the observed aquifer concentrations (initial conditions) and the contaminant source terms remaining. Transport runs were made with all three sets of boundary conditions corresponding to nominal, wet, and dry periods. A constant Kd of 1.78 liters per kilogram was used for all groundwater model transport runs.

3.4.1 Initial Conditions

Transport model scenarios were run with initial conditions for total uranium developed from Kriged monitoring data. Monitoring well data from the first quarter of 2001 were combined with all available direct-push sampling data through the first quarter of 2002. Where more recent direct-push sampling data overlapped with older data in the same position, the more recent data were used.

The input total uranium data were Kriged using a 3,000 foot horizontal search radius and a 25 foot horizontal to vertical anisotropy ratio for an effective vertical search radius of 120 feet. These values are consistent with those used for the SWIFT Great Miami Aquifer Model Summary of Improvements Report (DOE 1994). Kriging results used as initial conditions for the zoom model are shown in Figures 3-17 through 3-21 for model layers 9 through 13.

3.4.2 Transport Model Source Terms

Because the SWU area excavation is complete, Operable Unit 5 remedial investigation/feasibility study source terms for this area were removed from the model for this design. Operable Unit 5 remedial investigation/feasibility study source terms corresponding to sources in the Storm Sewer Outfall Ditch were retained in the model through year 2008. After 2008, these source terms were removed assuming the complete remediation of all contaminated FEMP soils. Operable Unit 5 source terms corresponding to Paddys Run were retained in this model for all years to be conservative.

3.4.3 Predicted Total Uranium Concentrations and Performance Measures

Figures 3-22 through 3-26 show predicted total uranium concentrations in zoom model layer 11 for years 2003 through 2011 inclusive with a two-year interval. The model was run with nominal flow boundary conditions corresponding to the October 1998 calibration conditions. As seen in Figure 3-26, the total uranium concentrations in the aquifer are below 30 μg/L except in a small area of approximately four acres around Extraction Well 32446 (EW-24) and Re-injection Well 22240 (IW-11) in the South Field. Total uranium concentrations in this area drop below 30 μg/L before the end of year 2012. Concentrations are shown in zoom model layer 11 because this is the last model layer where concentrations drop below 30 μg/L.

Transport model runs were made with dry, wet, and nominal boundary conditions but total uranium concentrations were nearly the same for all three sets of boundary conditions. The final concentration values at the end of year 2011 for dry and wet boundary conditions are shown in Figures 3-27 and 3-28 with areas of one and five acres, respectively, above the 30 μg/L FRL for uranium. The transport run for wet boundary conditions takes approximately an additional year to remediate the aquifer when compared with the transport runs using the dry boundary conditions.

Table 3-3 presents predicted performance measures for this design. Future predictions for total uranium concentrations were made from extraction well operational data where available and from transport model results for proposed extraction wells not yet operational. Predicted concentrations from operational data were made with exponential or linear fitting functions depending on which form appeared to give the best fit to historical data. South Field Extraction Wells 31561 (EW-20) and 31562 (EW-21), and South Plume Extraction Well 3936 (RW-3) show concentrations in Table 3-3 above the 30 μg/L FRL for total uranium in 2006 when they are scheduled to be turned off. The 2006 cutoff date for these wells reflects transport modeling results. The decision to shut these wells down or any wells will be made from consideration of operational data (e.g., when wellhead concentrations and surrounding areas of the plume are below the 30 μg/L FRL for total uranium).

TABLE 3-1

SOUTH FIELD PHASE II MODULE DESIGN PUMPING RATES

Modeling Well Identification Number	Operations Well Identification Number	Pumping Rates (gpm) (-)=Pumping (+)=Injection Years 2001 - 2006	Years 2007 - 2011
South Plume 3924	RW-1	-300	0
South Plume 3925	RW-2	-300	0
South Plume 3926	RW-3	-300	0
South Plume 3927	RW-4	0	0
South Plume Opt. 32308	RW-6	-300	0
South Plume Opt. 32309	RW-7	-300	0
		-1500	0
South Field 31565	EW-13	0	0
South Field 31564	EW-14	0	0
South Field 31566	EW-15	0	0
South Field 31567	EW-17	-275	0
South Field 31550	EW-18	-200	0
South Field 31560	EW-19	-200	0
South Field 31561	EW-20	-200	0
South Field 31562	EW-21	-290	0
South Field 32276	EW-22	-300	-300
South Field 32447	EW-23	-300	-300
South Field 32446	EW-24	-300	-300
South Field 33061	EW-25	-300	0
South Field 31	EW-15a	-200	0
South Field 32	EW-30	-300	-300
South Field 33	EW-31	-300	-300
South Field 34	EW-32	-200	-200
		-3365	-1700
WSA 32761	EW-26	-400	-400
WSA 33062	EW-27	-300	-300
WSA 33063	EW-28	-300	-300
WSA 5		0	-100
WSA 6		0	-100
		-1000	-1200
Re-Injection 8A	IW-8a	200	0
Re-Injection 9A	IW-9a	200	0
Re-Injection 10	IW-10	200	0
Re-Injection 10A	IW-10a	200	0
Re-Injection 22240	IW-11	200	0
Re-Injection 22111	IW-12	0	0
South Field 31563	EW-16	200	0
Basin Re-Injection		100	0
South Field Re-Injection 1	IW-29	100	0
		1400	0
Pumping Rate Totals		-4465	-2900

TABLE 3-2

MONITORING WELLS - OBSERVED ELEVATION, MODELED ELEVATION, AND RESIDUAL

Monitoring Well	Observed Elevation Feet (AMSL)	Modeled Elevation Feet (AMSL)	Residual Feet
2002	514.20	514.16	-0.04
2008	521.20	521.26	0.06
2009	522.20	522.04	-0.16
2011	522.20	522.65	0.45
2014	518.00	518.04	0.04
2015	517.70	517.64	-0.06
2016	518.20	518.54	0.34
2017	518.40	518.55	0.15
2020	519.80	519.91	0.11
2032	522.30	521.97	-0.33
2033	521.80	521.46	-0.34
2034	522.10	521.75	-0.35
2044	520.60	520.98	0.38
2045	517.60	517.68	0.08
2046	518.80	519.22	0.42
2048	518.00	518.13	0.13
2052	520.20	520.55	0.35
2054	518.60	518.65	0.05
2065	518.40	517.77	-0.63
2068	517.90	518.11	0.21
2070	517.30	517.19	-0.11
2093	516.20	515.97	-0.23
2095	516.10	516.11	0.01
21033	517.50	517.67	0.17
2106	518.10	518.19	0.09
21063	516.80	516.62	-0.18
21064	519.20	519.45	0.25
21065	518.80	518.86	0.06
2107	520.90	520.85	-0.05
2108	522.50	522.31	-0.19
2118	518.40	518.46	0.06
2125	515.00	515.29	0.29
2126	513.90	514.59	0.69
2128	513.30	513.95	0.65
2166	517.40	517.31	-0.09
2383	523.00	523.02	0.02
2384	522.50	522.43	-0.07
2385	518.30	518.46	0.16
2386	517.50	517.42	-0.08
2387	517.40	517.43	0.03
2389	518.70	518.83	0.13
2390	518.30	517.81	-0.49
2394	512.40	513.04	0.64
2396	515.70	515.82	0.12
2397	518.00	517.90	-0.10
2398	517.40	517.32	-0.08
2399	517.40	517.45	0.05
2402	520.00	520.24	0.24
2423	518.70	519.00	0.30

TABLE 3-2
(Continued)

Monitoring Well	Observed Elevation Feet (AMSL)	Modeled Elevation Feet (AMSL)	Residual Feet
2434	517.60	517.41	-0.19
2436	519.10	519.49	0.39
2446	518.30	518.02	-0.28
2544	514.20	514.25	0.05
2545	514.70	515.09	0.39
2546	513.60	514.32	0.72
2550	517.80	517.79	-0.01
2551	518.00	517.80	-0.20
2552	515.30	515.64	0.34
2553	514.90	515.39	0.49
2636	513.00	513.60	0.60
2648	521.40	521.32	-0.08
2649	522.40	522.31	-0.09
2702	512.30	513.19	0.89
2821	521.70	521.76	0.06
2880	515.30	514.96	-0.34
2881	515.30	515.05	-0.25
2897	515.50	515.16	-0.34
2898	514.90	514.33	-0.57
2899	513.20	513.34	0.14
2900	513.90	513.78	-0.12
2949	520.80	520.90	0.10

AVG RES ID = 0.07 FEET
RMS ERROR = 0.31 FEET

TABLE 3-3

PERFORMANCE MEASURES FOR THE SOUTH FIELD PHASE II MODULE DESIGN

	South Plume Module				South Field Module			
	Gallons Pumped	Module Concentration	Module Mass		Gallons Pumped	Module Concentration	Module Mass	
Year	gpm	µg/L	Annual (pounds)	Cumulative (pounds)	gpm	µg/L	Annual (pounds)	Cumulative (pounds)
2002	1,500	40.2	278.7	278.7	3,365	59.3	967.4	967.4
2003	1,500	36.0	250.5	529.2	3,365	49.0	794.1	1761.4
2004	1,500	32.0	223.5	752.7	3,365	40.2	654.9	2416.3
2005	1,500	28.1	197.4	950.1	3,365	32.7	535.5	2951.8
2006	1,500	24.3	172.2	1122.3	3,365	26.2	432.2	3384.0
2007	0	0.0	0.0	1122.3	1,700	20.8	177.6	3561.5
2008	0	0.0	0.0	1122.3	1,700	15.7	135.3	3696.9
2009	0	0.0	0.0	1122.3	1,700	13.9	109.5	3806.3
2010	0	0.0	0.0	1122.3	1,700	12.4	97.1	3903.5
2011	0	0.0	0.0	1122.3	1,700	11.2	87.2	3990.7

v:\5fgp1\dgn\SOUTHFIELD\sfmod006.dgn

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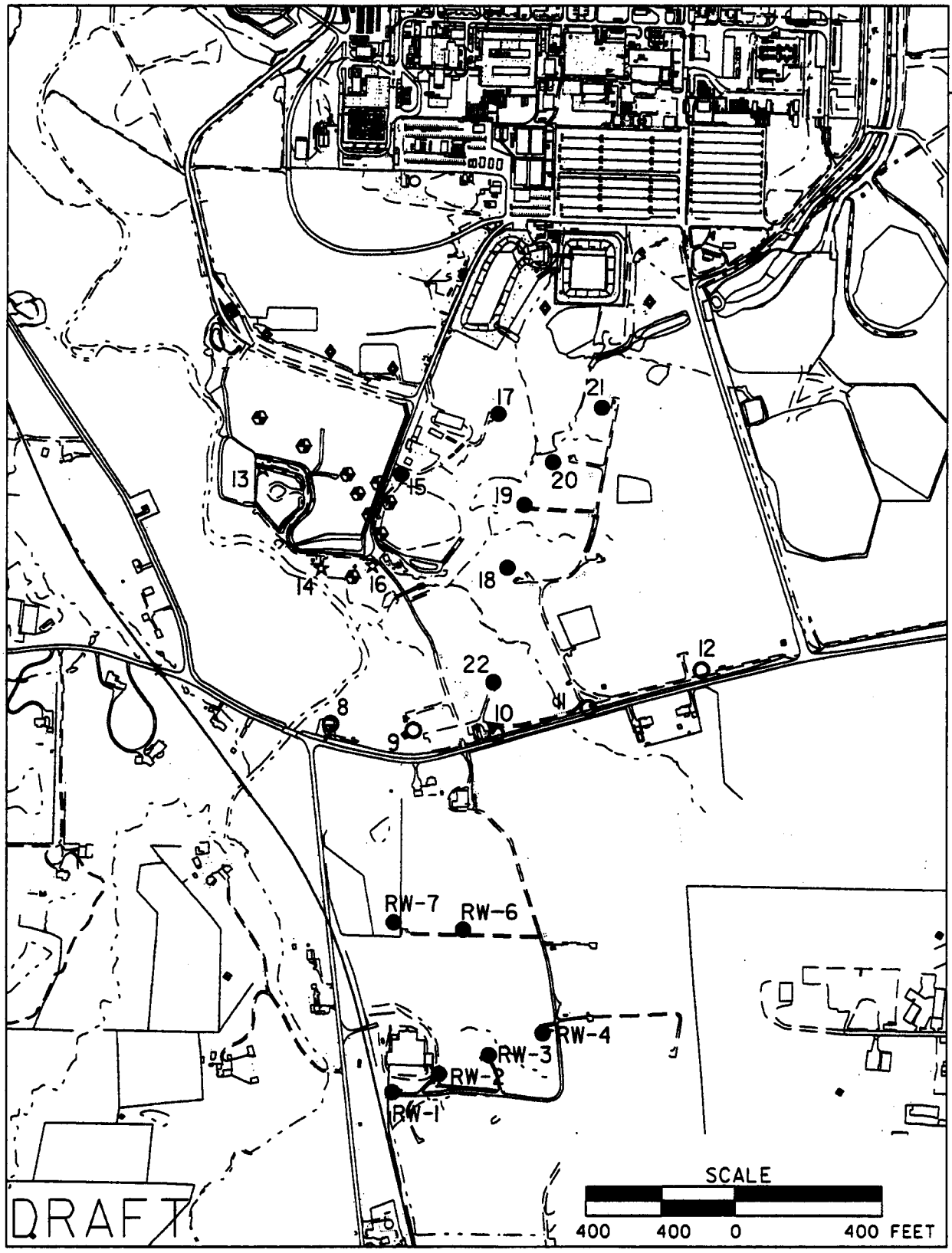
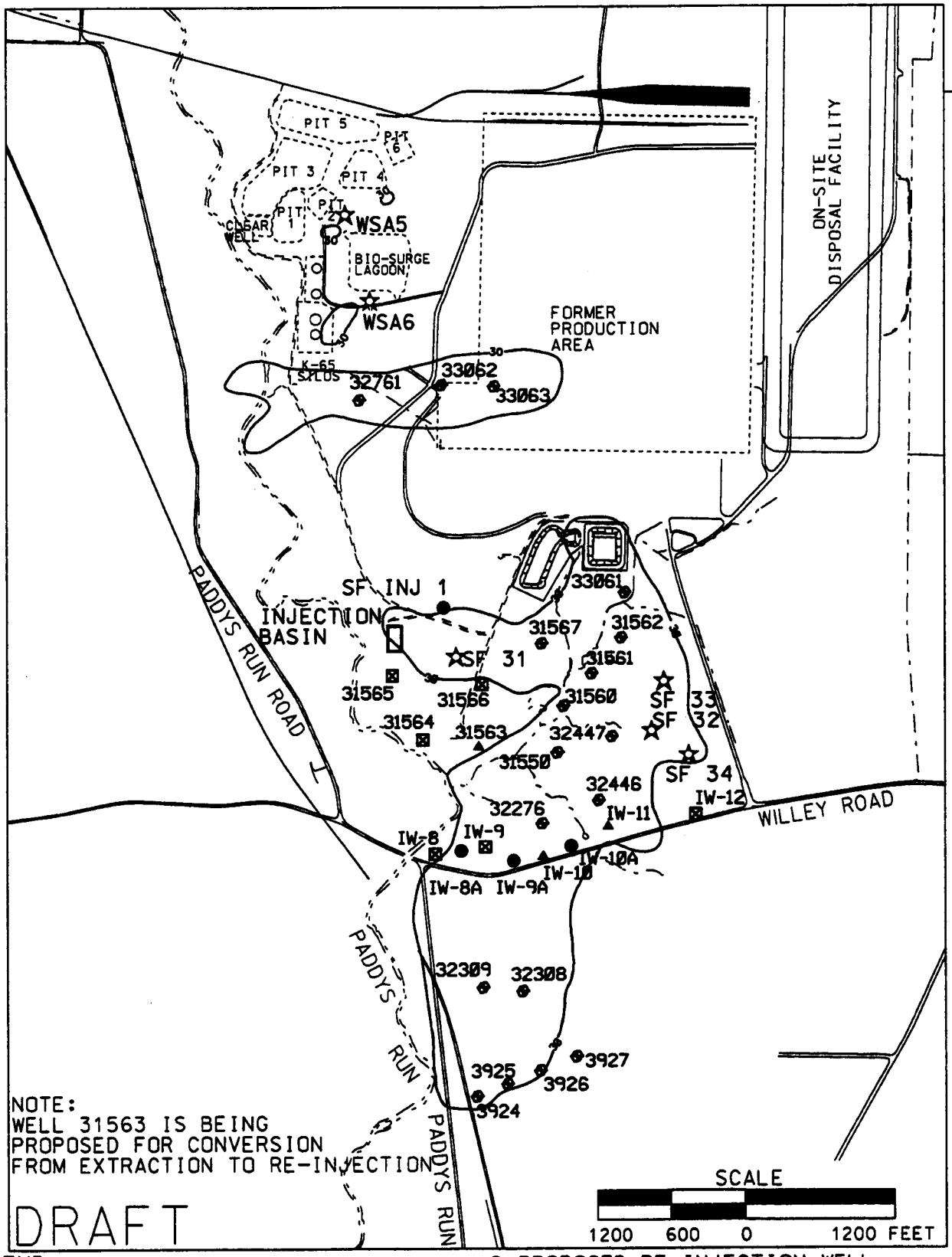
13-MAY-2002



LEGEND:

- FEMP BOUNDARY
- PHASE I RE-INJECTION WELL
- PHASE I EXTRACTION WELL
- PHASE I EXTRACTION/PHASE II RE-INJECTION WELL
- PHASE II RE-INJECTION WELL
- PHASE II EXTRACTION WELL

FIGURE 3-1. SOUTH FIELD DESIGN FROM BASELINE REMEDIAL STRATEGY REPORT



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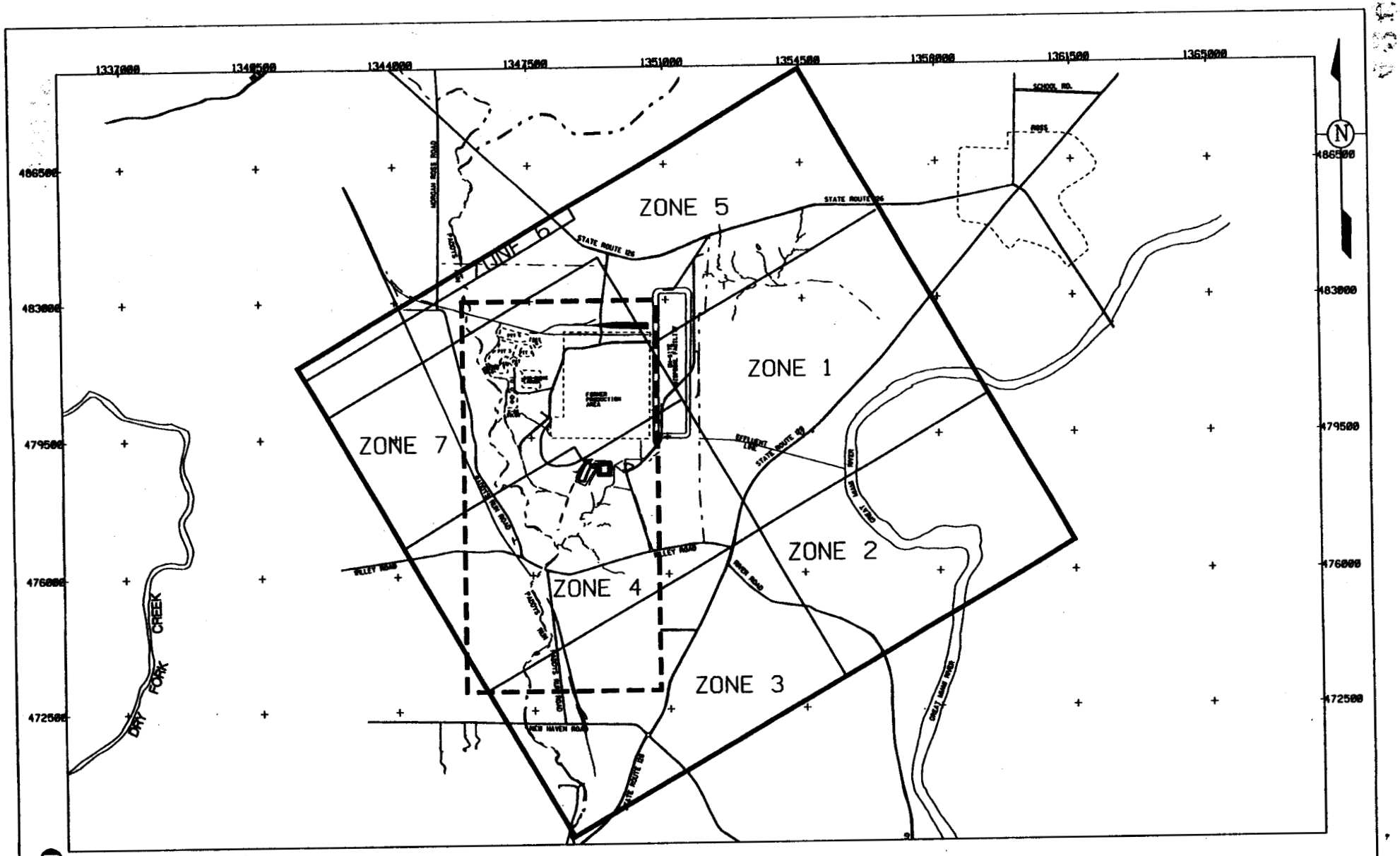
13-MAY-2002

FIGURE 3-2. SOUTH FIELD REVISED PHASE II DESIGN



LEGEND:

- FEMP BOUNDARY
- LARGE MODEL BOUNDARY
- ZOOM MODEL BOUNDARY
- MODELED CONDUCTIVITY ZONES

SCALE

3500 1750 0 3500 FEET

DRAFT

v:#5fgp1#dgn#SOUTHFIELD#sfext001.dgn
STATE PLANAR COORDINATE SYSTEM 1927

13-MAY-2002

FIGURE 3-3. VAM 3D LARGE MODEL AND ZOOM MODEL BOUNDARIES

000047

4269

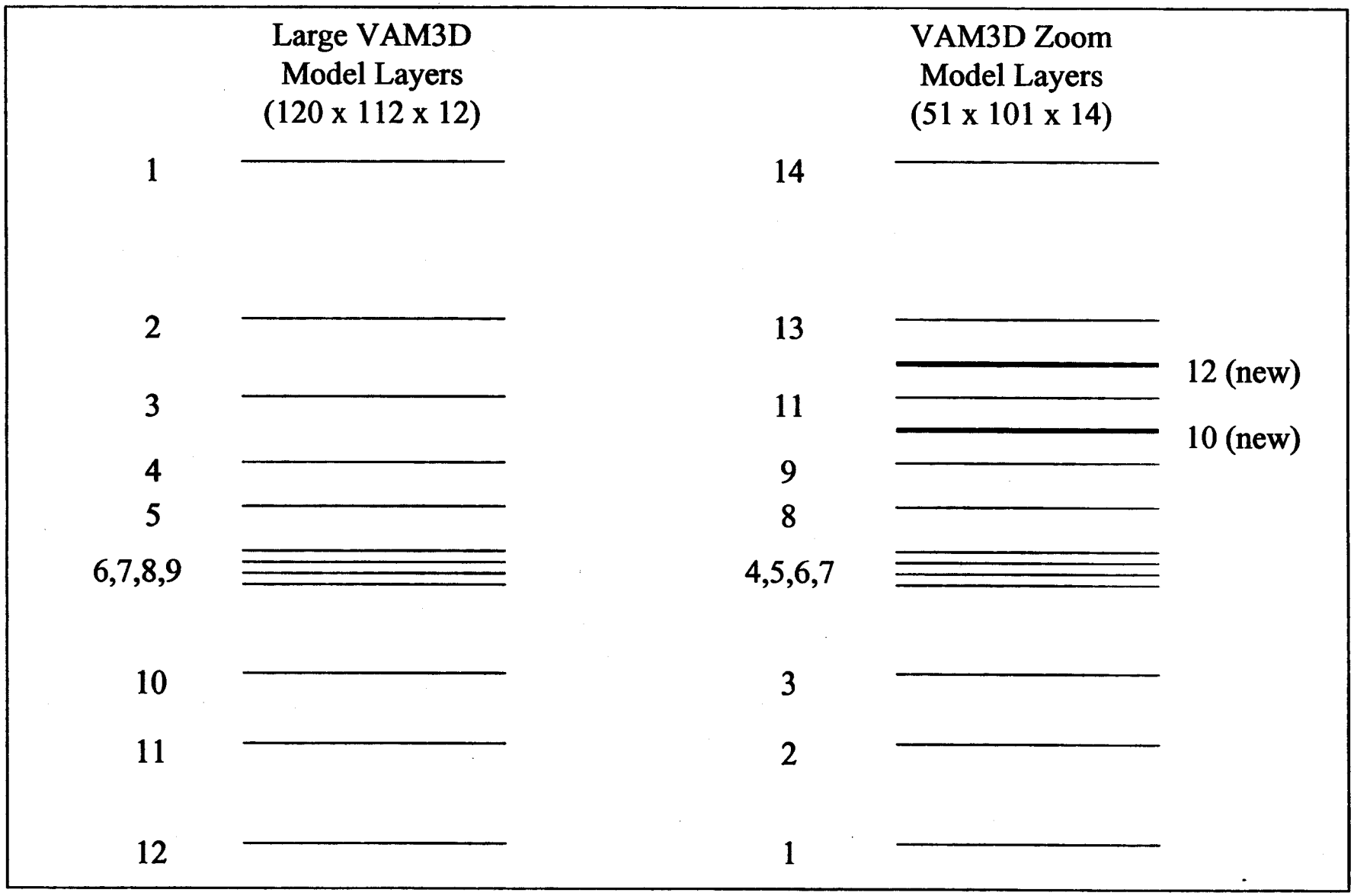


Figure 3-4. Comparison of VAM3D Large Model and Zoom Model Layers

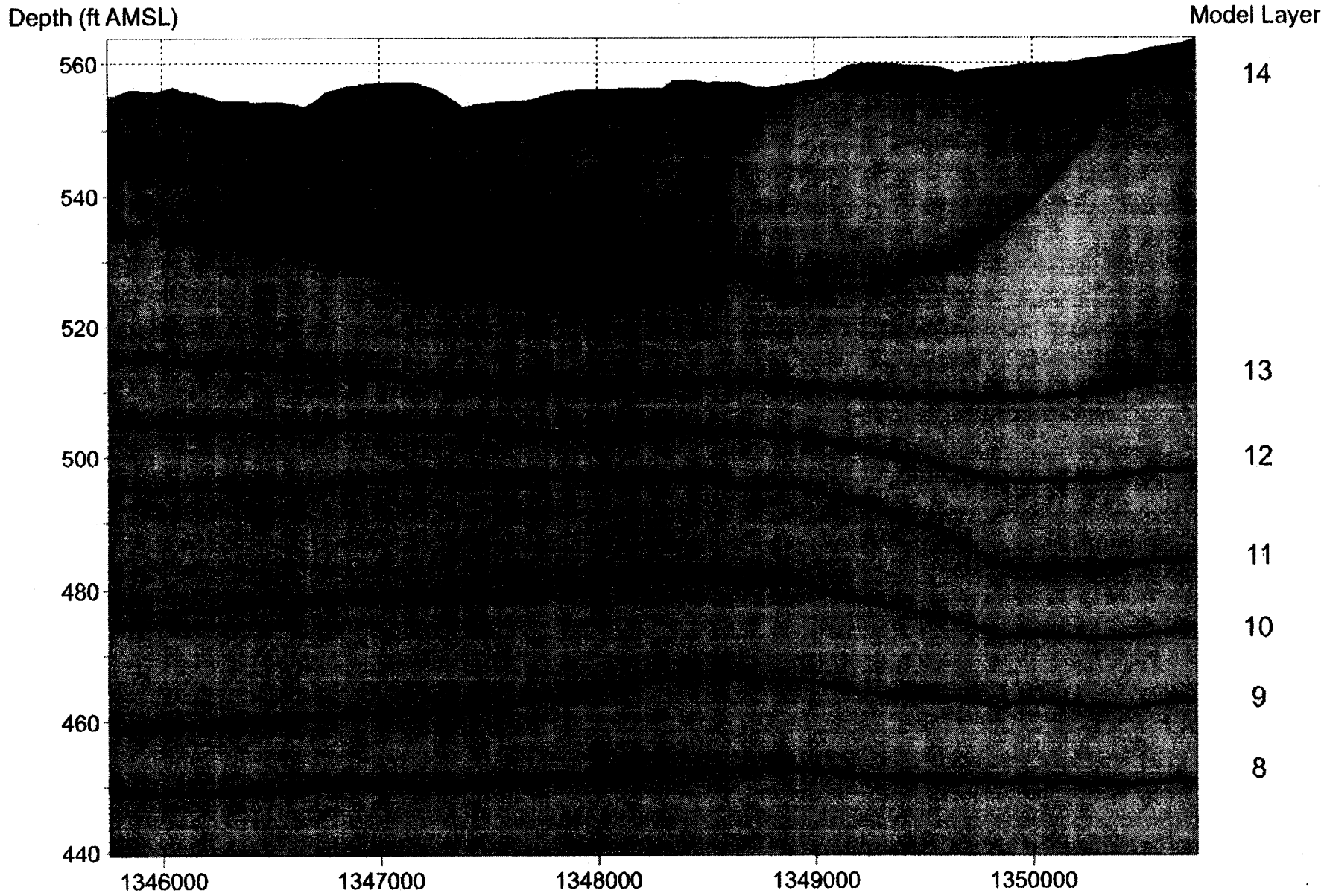
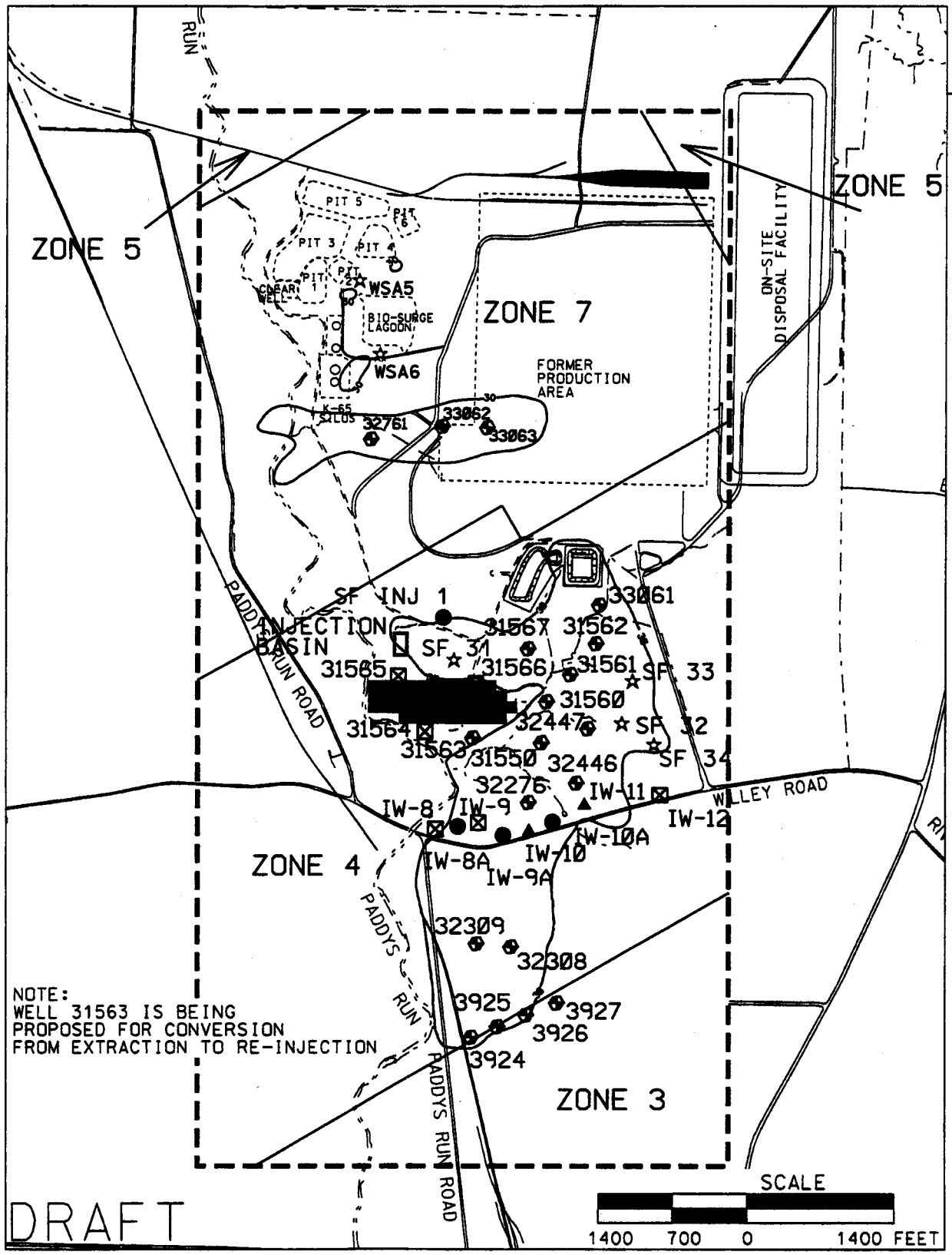


Figure 3-5. Zoom Model Layers - Looking North
Vertical Exaggeration = 30x

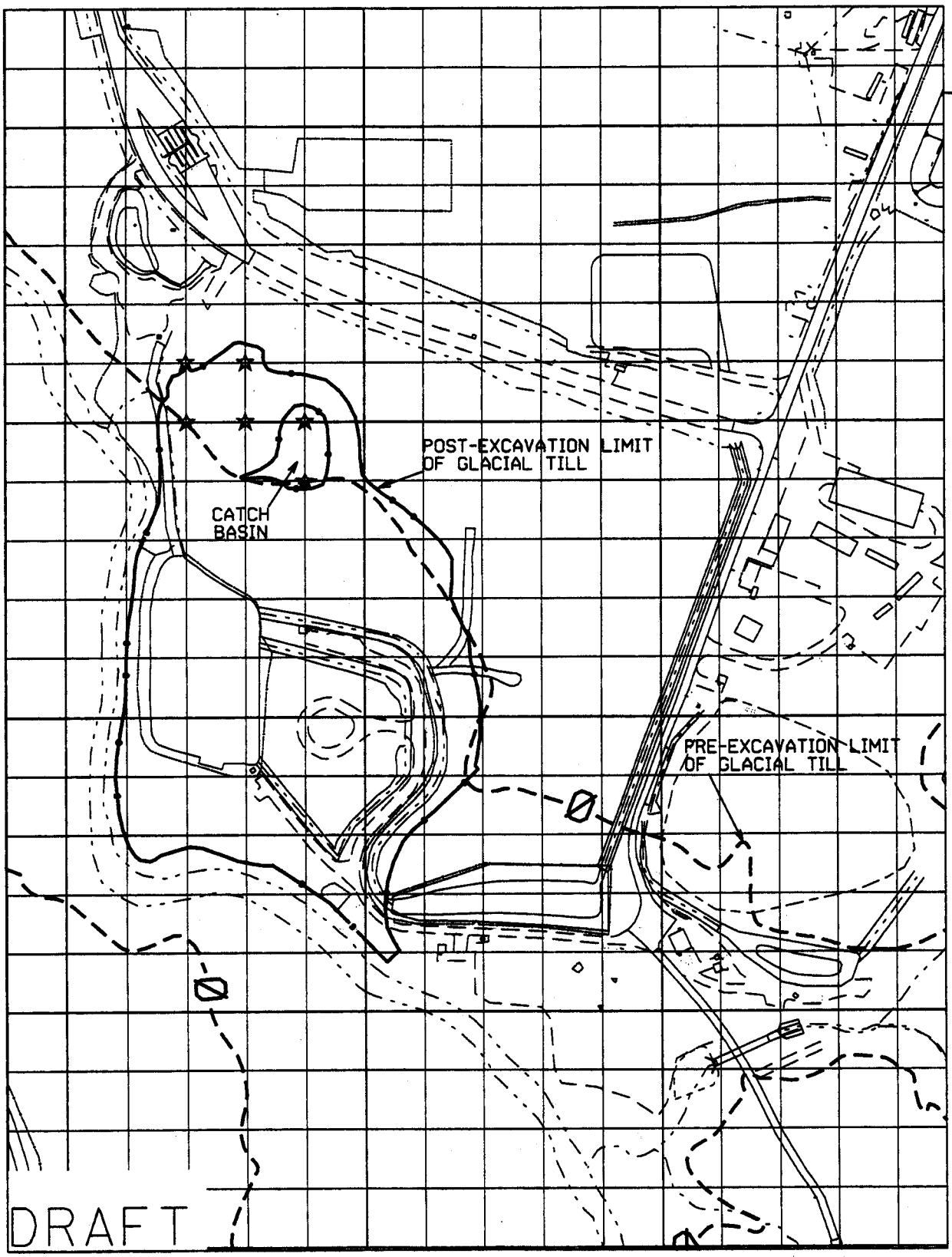


LEGEND:

- FEMP BOUNDARY
- ZOOM MODEL BOUNDARY
- MODELED CONDUCTIVITY ZONES
- LOW CONDUCTIVITY ZONE
- EXTRACTION WELL LOCATION
- PROPOSED RE-INJECTION WELL
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION
- TOTAL URANIUM CONTOUR IN µg/L MODIFIED FROM FOURTH QUARTER 2001

FIGURE 3-6. ZOOM MODEL HYDRAULIC CONDUCTIVITY ZONES

y:\5fdb1\dgn\SOUTHFIELD\esfex1002.dgn
STATE PLANAR COORDINATE SYSTEM 1983
13-MAY-2002



LEGEND:

☆ ZOOM MODEL NODES WHERE INFILTRATION RATE INCREASED FROM 6" PER YEAR TO 30" PER YEAR

— — — — PRE-EXCAVATION

——— POST-EXCAVATION

SCALE

250 125 0 250 FEET

FIGURE 3-7. ZOOM MODEL NODES WITH INCREASED INFILTRATION

v:\ef\fgp1\dgn\SOUTHFIELD\efext003.dgn

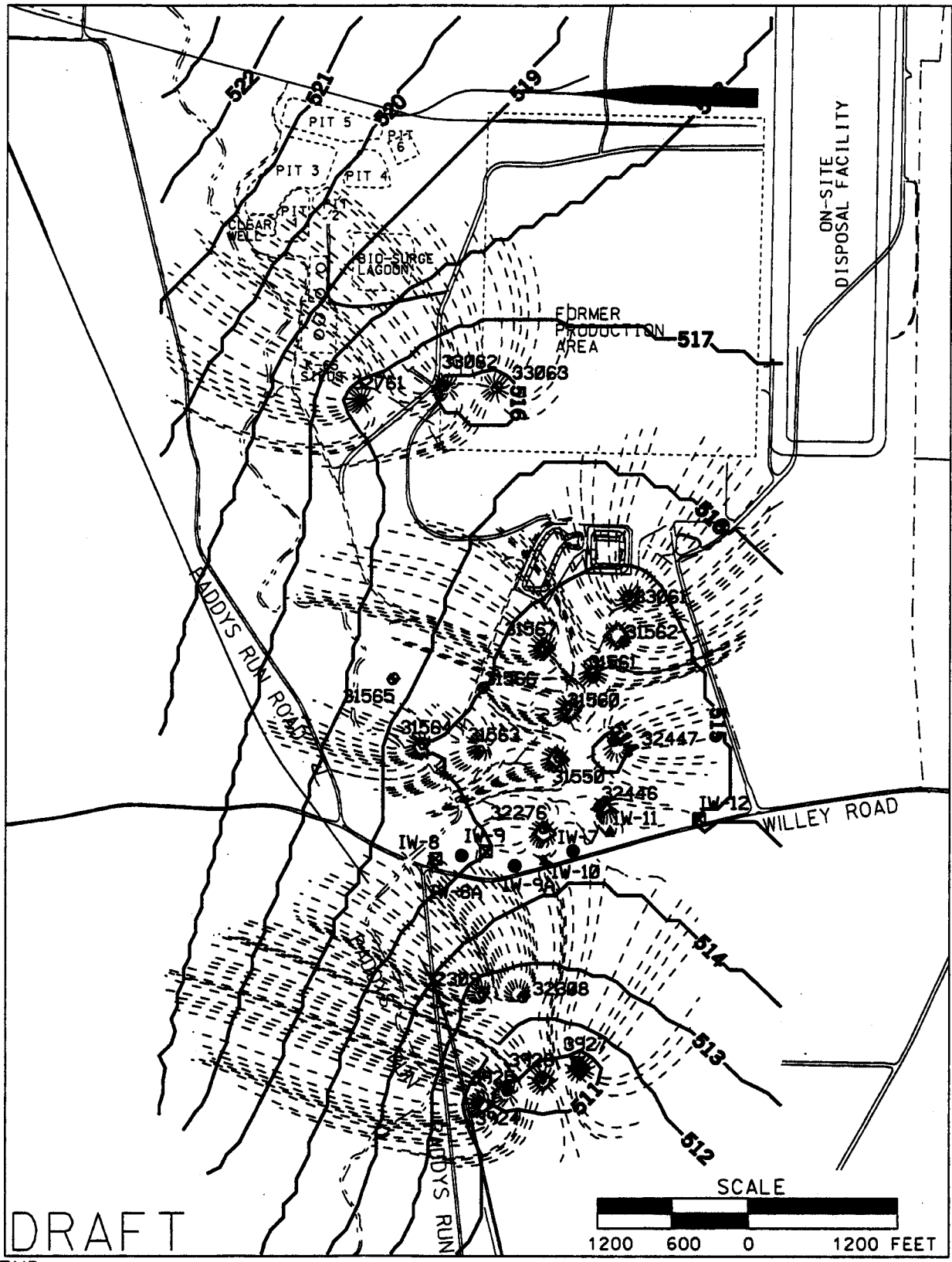
STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002

V:/5FGP1/DGN/SOUTHFIELD/SFEXT016.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

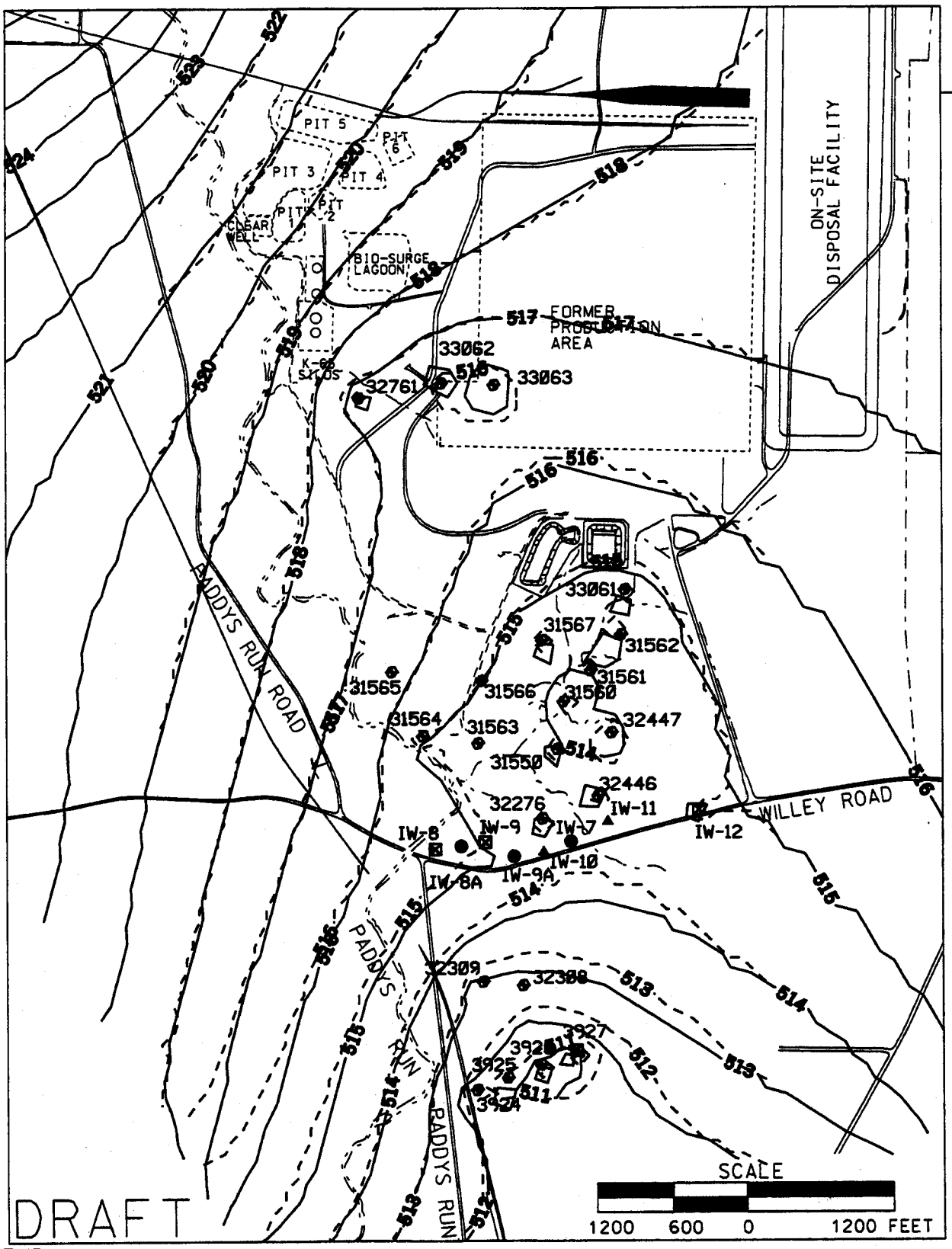
- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- PARTICLE TRACK (6 YEARS)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION

FIGURE 3-8. GROUNDWATER ELEVATIONS WITH NOMINAL BOUNDARY CONDITIONS AND CURRENT PUMPING CONDITIONS

V:/5FGP1/DGN/SOUTHFIELD/SFEXT021.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

- FEMP BOUNDARY
- LARGE MODEL CONTOUR
- ZOOM MODEL CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED ABANDONMENT LOCATION

FIGURE 3-9. COMPARISON OF LARGE MODEL AND ZOOM MODEL GROUNDWATER ELEVATIONS - CURRENT PUMPING CONDITIONS AND NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT004.DGN

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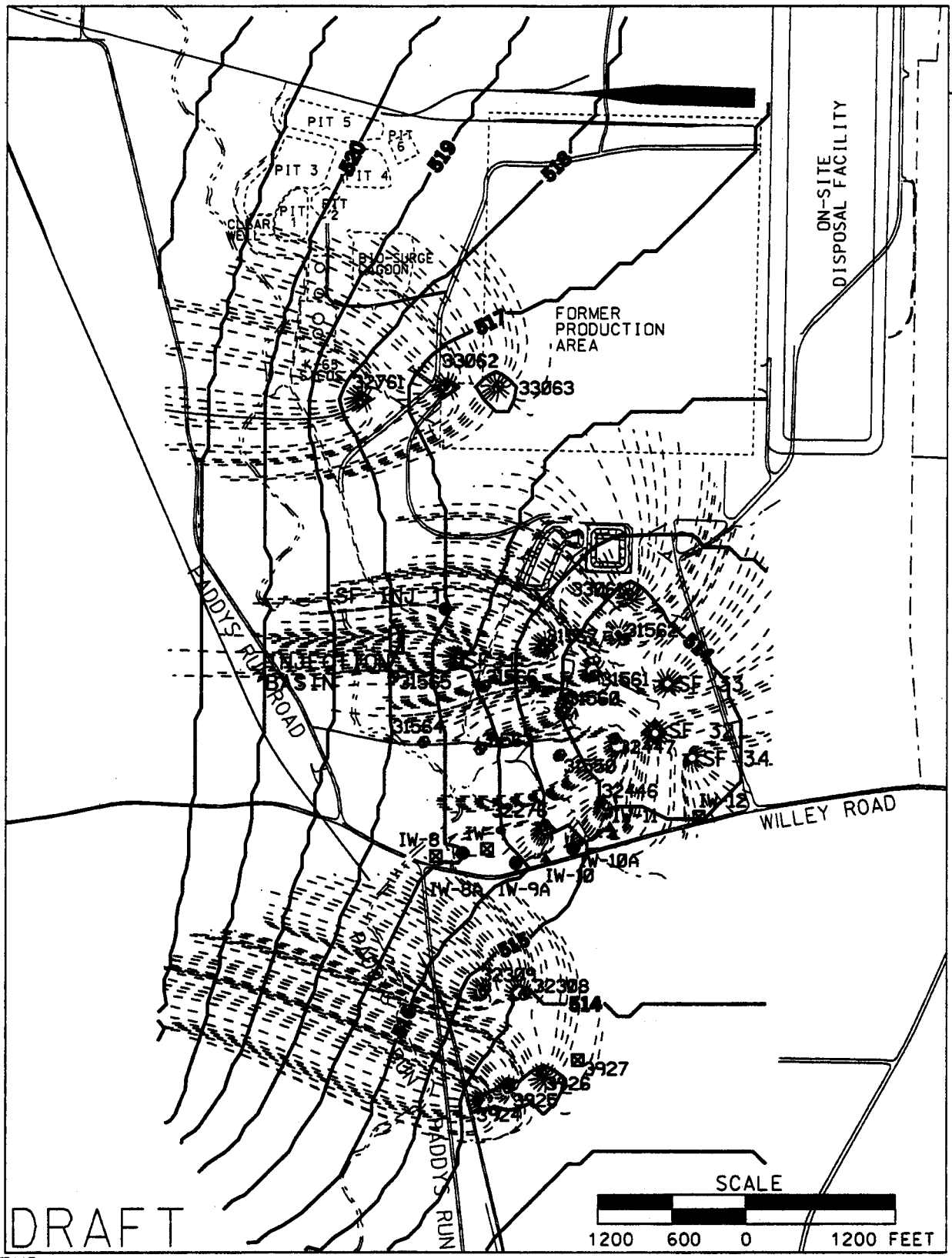
13-MAY-2002



LEGEND:

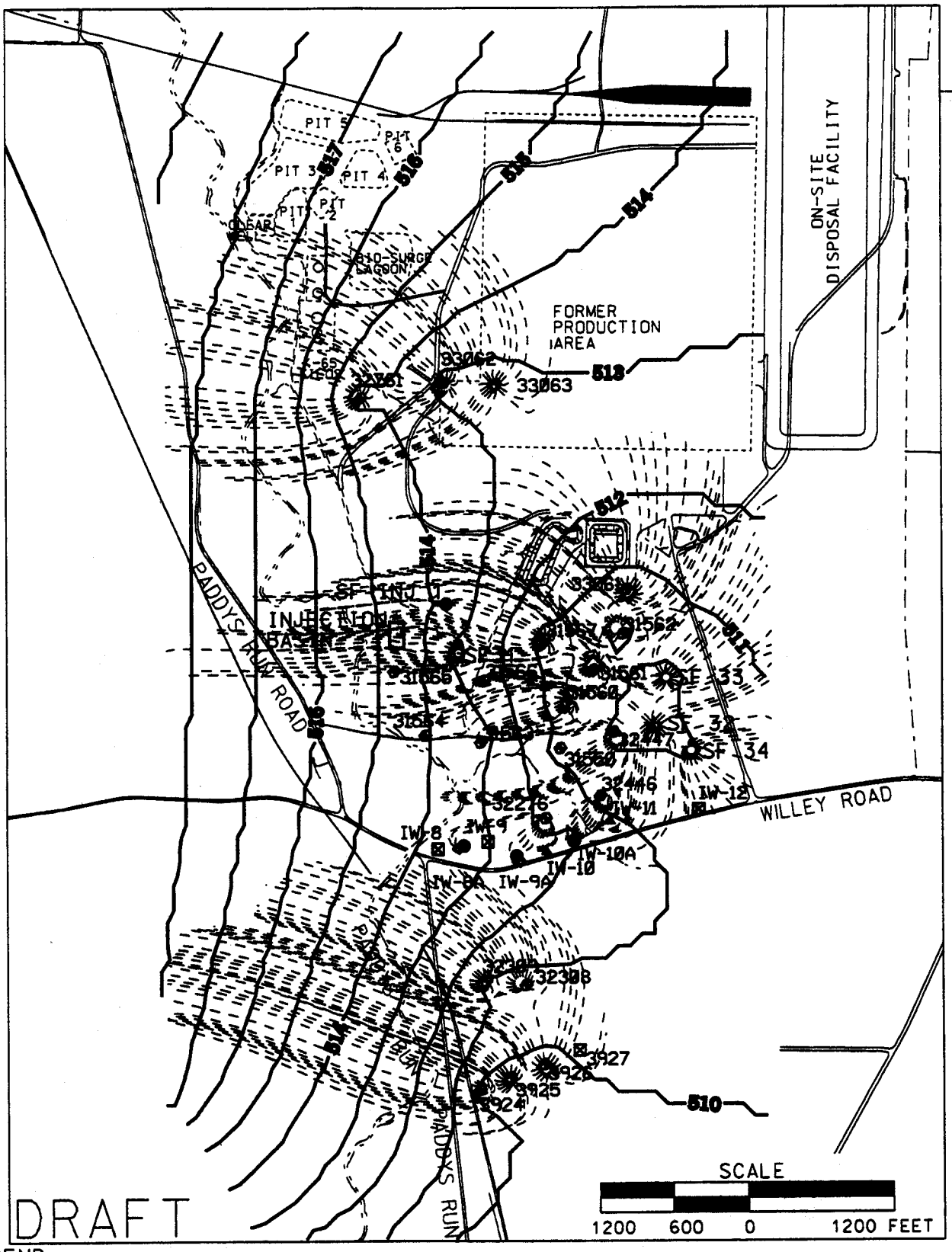
- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- PARTICLE TRACK (6 YEARS)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED ABANDONMENT LOCATION

FIGURE 3-10. PREDICTED GROUNDWATER ELEVATIONS FOR SOUTH FIELD PHASE II DESIGN YEARS 2001 THROUGH 2006 WITH NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT005.DGN

STATE PLANAR COORDINATE SYSTEM 1983

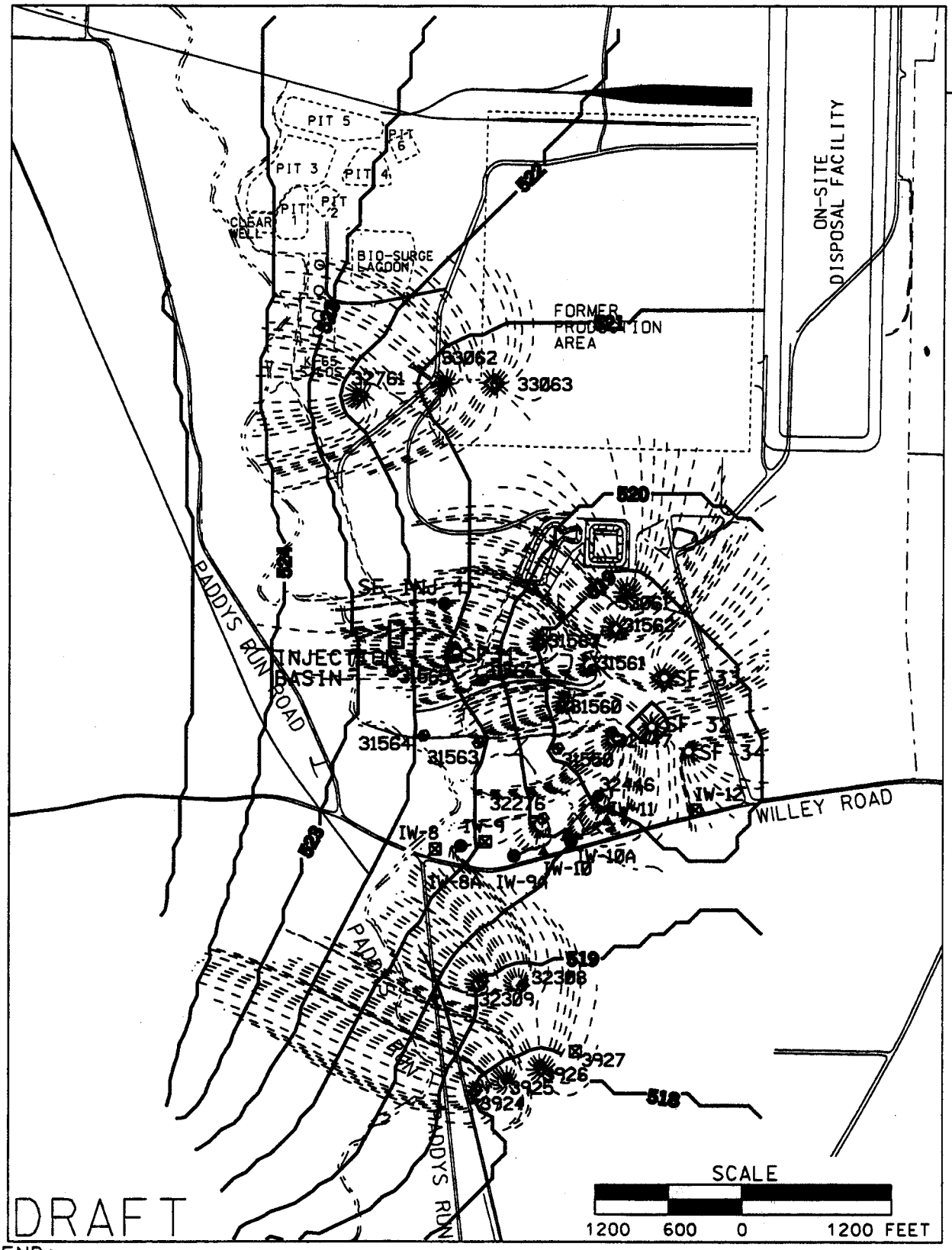
13-MAY-2002



LEGEND:

- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- PARTICLE TRACK (6 YEARS)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-11. PREDICTED GROUNDWATER ELEVATIONS FOR SOUTH FIELD PHASE II DESIGN YEARS 2001 THROUGH 2006 WITH DRY BOUNDARY CONDITIONS



LEGEND:

- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- PARTICLE TRACK (6 YEARS)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

V:/SFGP1/DGN/SOUTHFIELD/SFEXT006.DGN

STATE PLANAR COORDINATE SYSTEM 1983

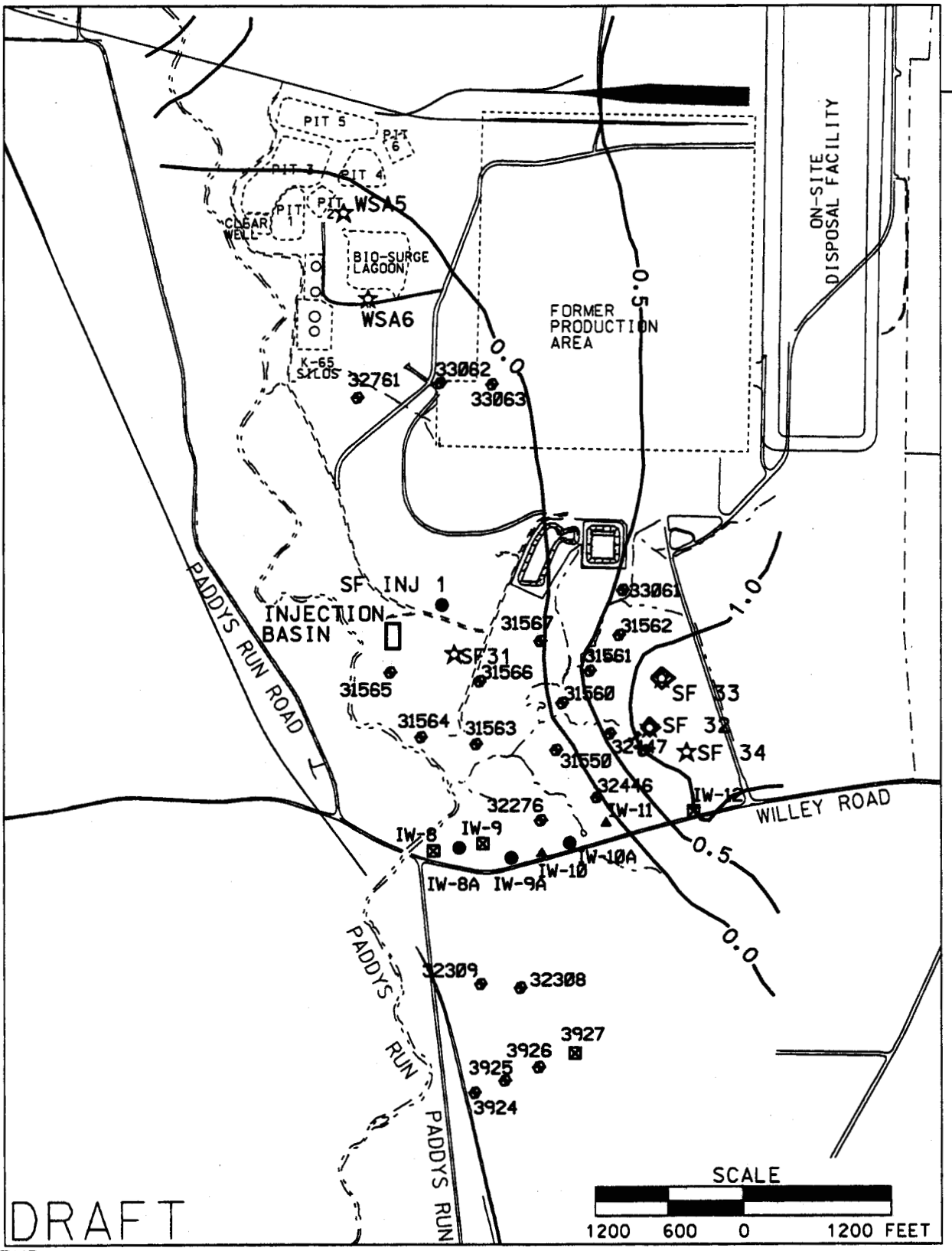
13-MAY-2002

FIGURE 3-12. PREDICTED GROUNDWATER ELEVATIONS FOR SOUTH FIELD PHASE II DESIGN YEARS 2001 THROUGH 2006 WITH WET BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT015.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-13. ADDITIONAL DRAWDOWN BETWEEN CURRENT OPERATIONAL CONDITIONS AND PHASE II DESIGN YEARS 2001 THROUGH 2006 WITH NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT010.DGN

STATE PLANAR COORDINATE SYSTEM 1983

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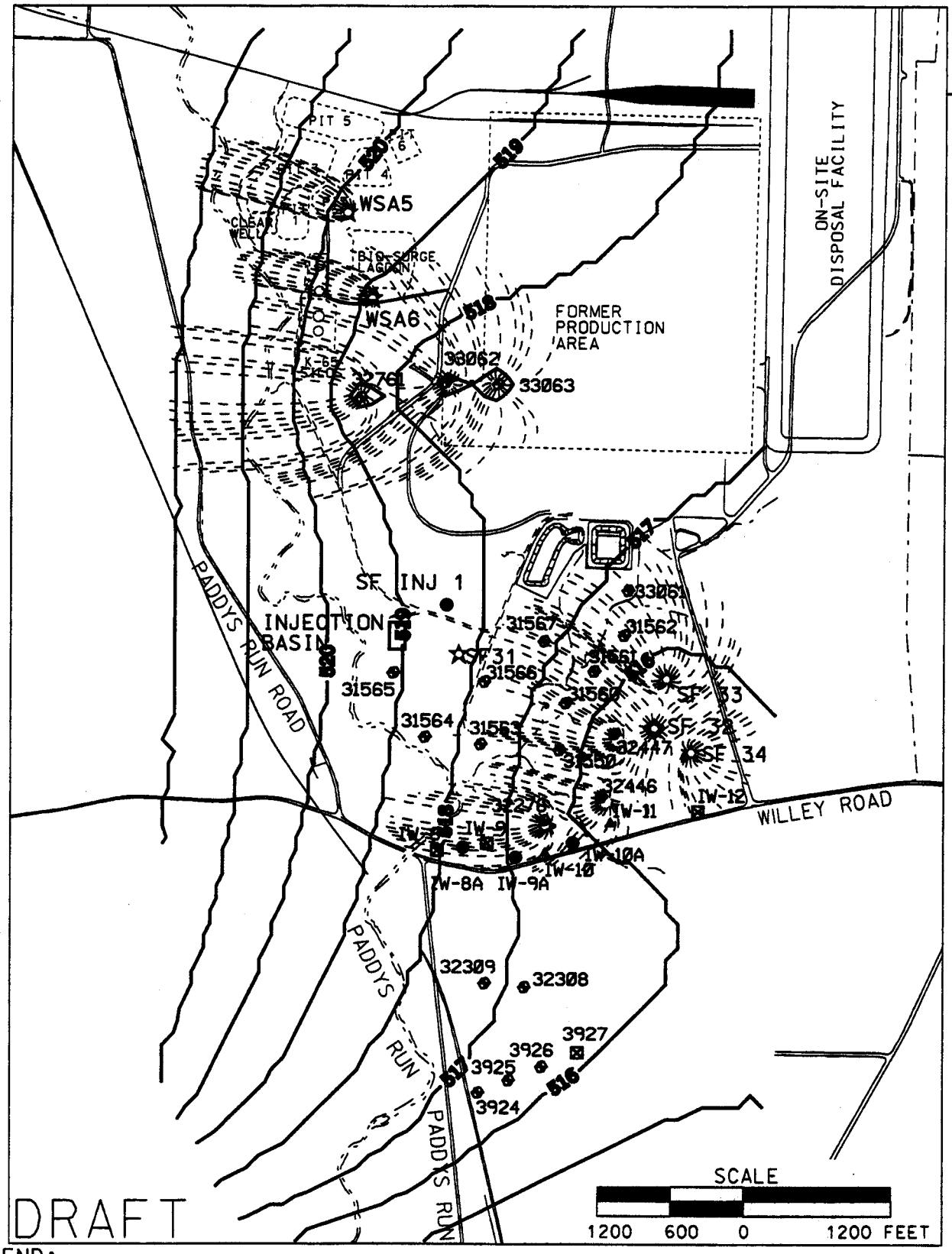


LEGEND:

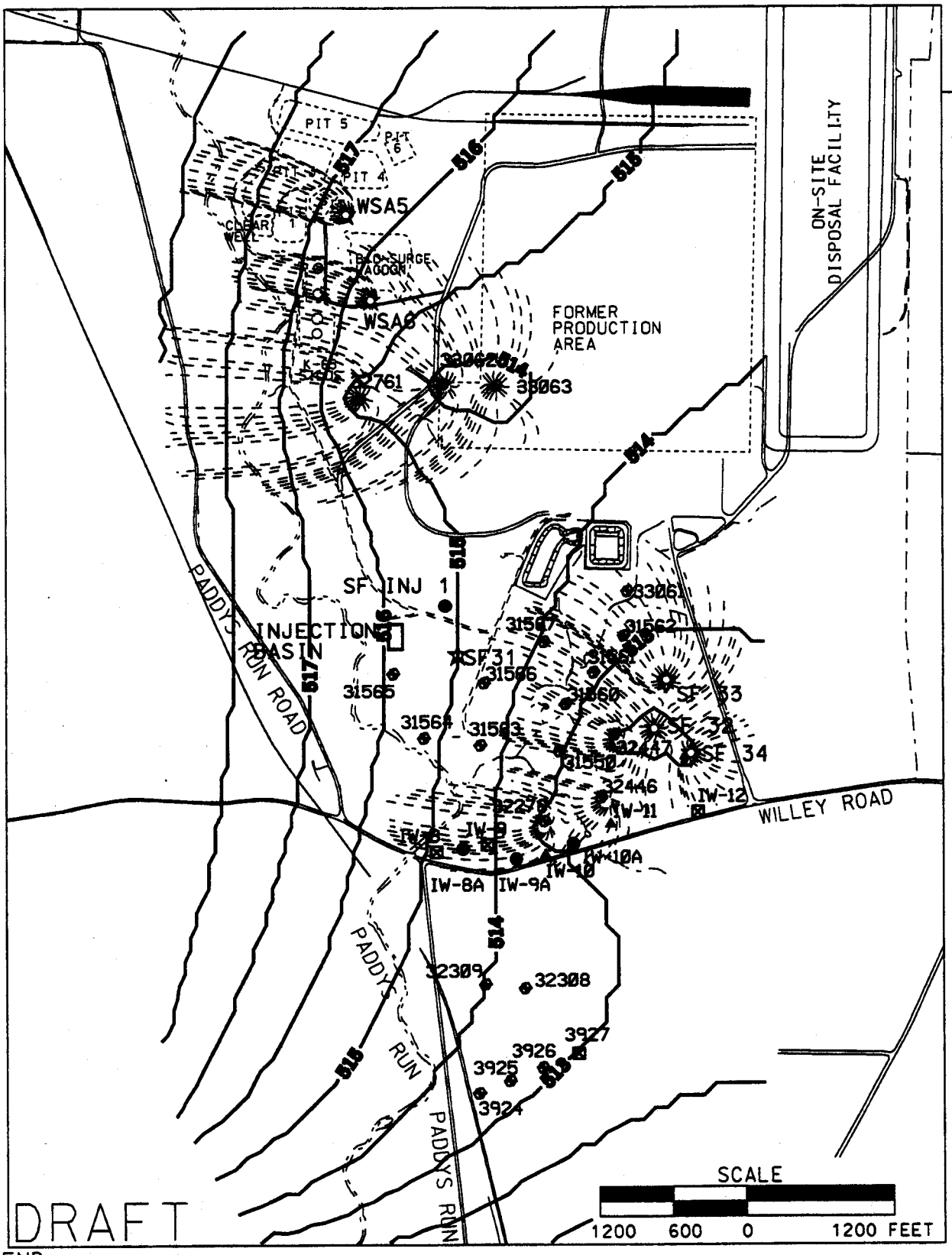
- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- PARTICLE TRACK (5 YEARS)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-14. PREDICTED GROUNDWATER ELEVATIONS FOR SOUTH FIELD PHASE II DESIGN YEARS 2007 THROUGH 2011 WITH NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT011.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

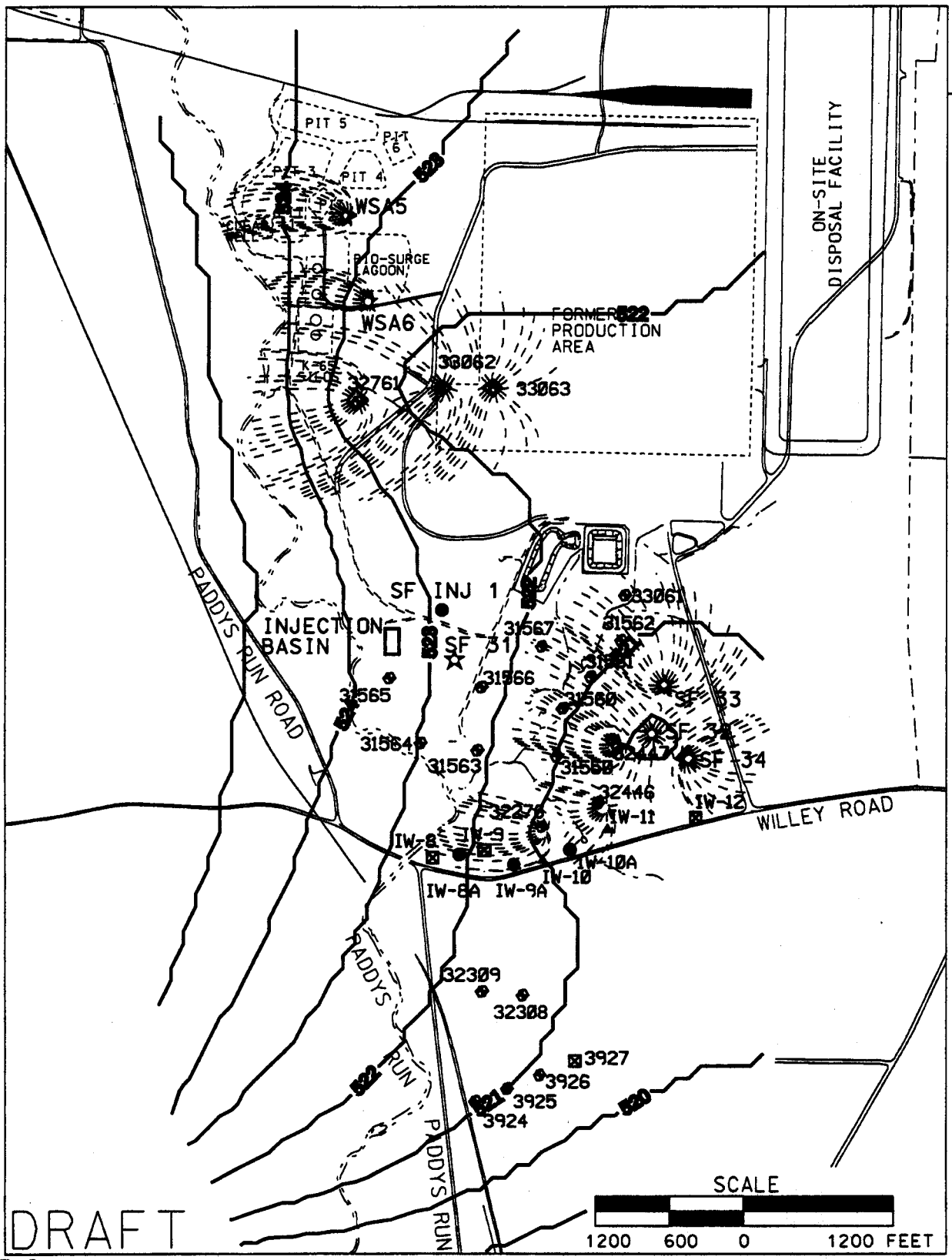
- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- PARTICLE TRACK (5 YEARS)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-15. PREDICTED GROUNDWATER ELEVATIONS FOR SOUTH FIELD PHASE II DESIGN YEARS 2007 THROUGH 2011 WITH DRY BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT012.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

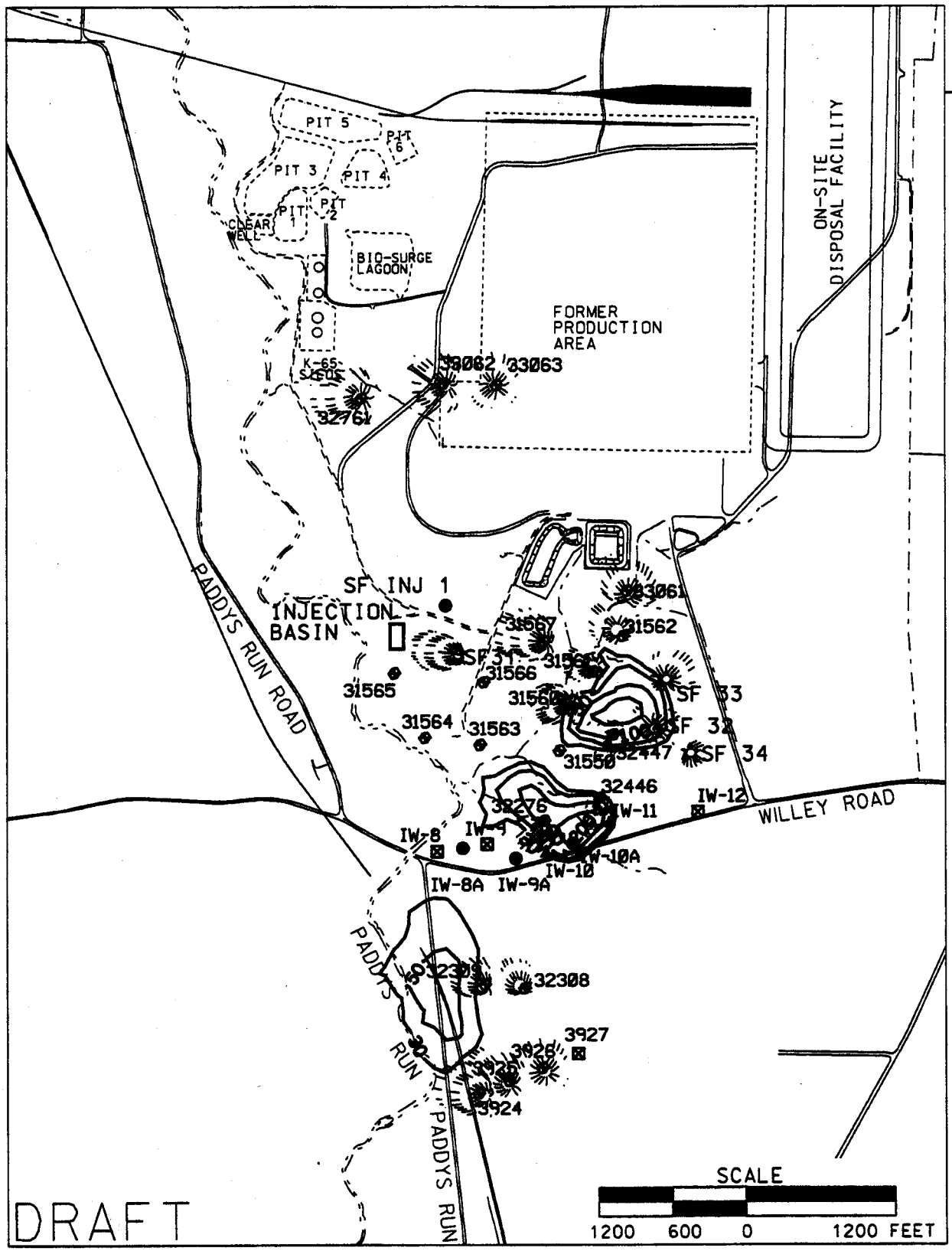
- FEMP BOUNDARY
- GROUNDWATER CONTOUR
- PARTICLE TRACK(5 YEARS)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-16. PREDICTED GROUNDWATER ELEVATIONS FOR SOUTH FIELD PHASE II DESIGN YEARS 2007 THROUGH 2011 WITH WET BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT023.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

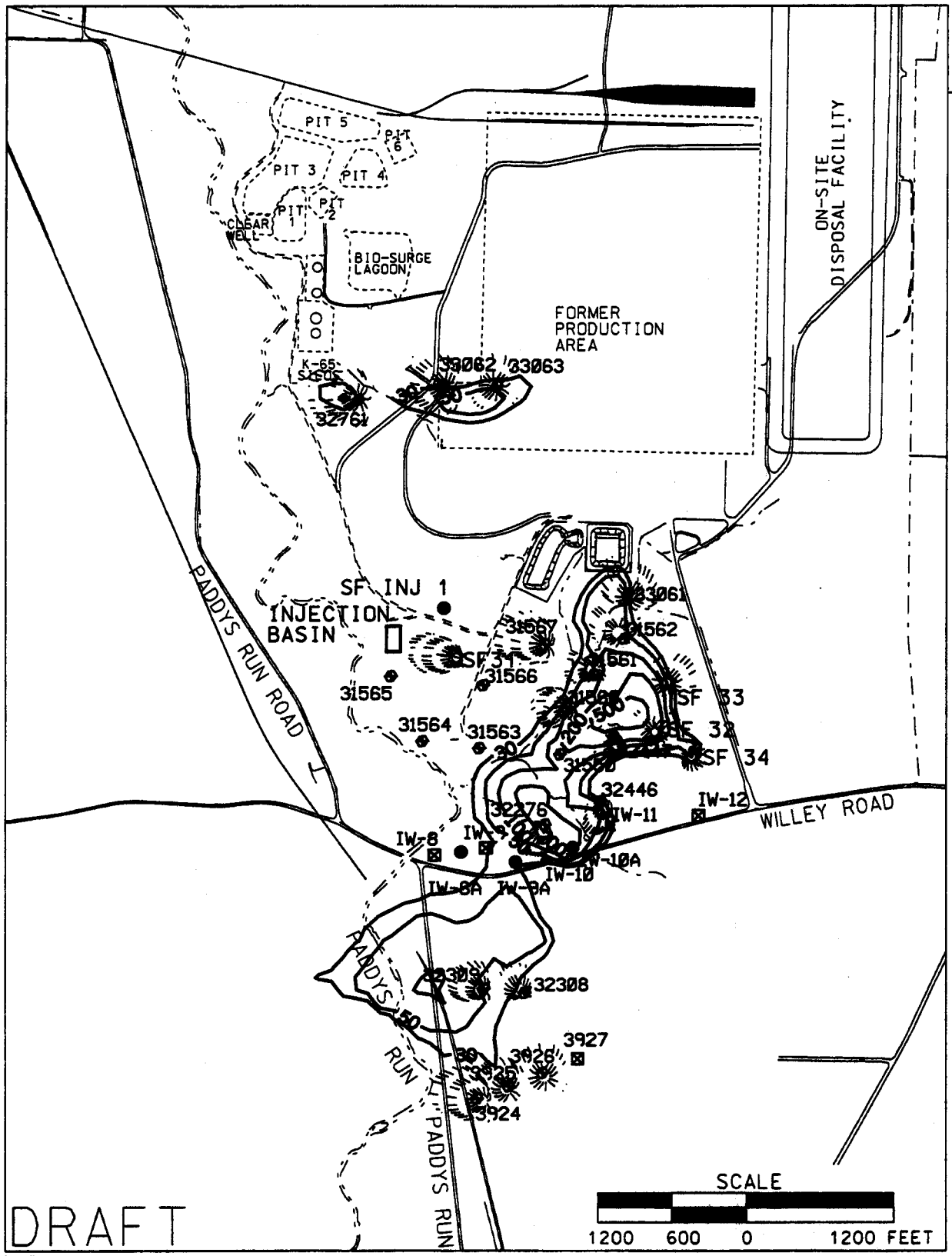
- FEMP BOUNDARY
- URANIUM CONTOUR
- PARTICLE TRACK (6 YEARS RETARDED)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-17. INITIAL CONDITIONS FOR TOTAL URANIUM IN MODEL LAYER 9

V:/SFGP1/DGN/SOUTHFIELD/SFEXT01T.DGN

STATE PLANAR COORDINATE SYSTEM 1983

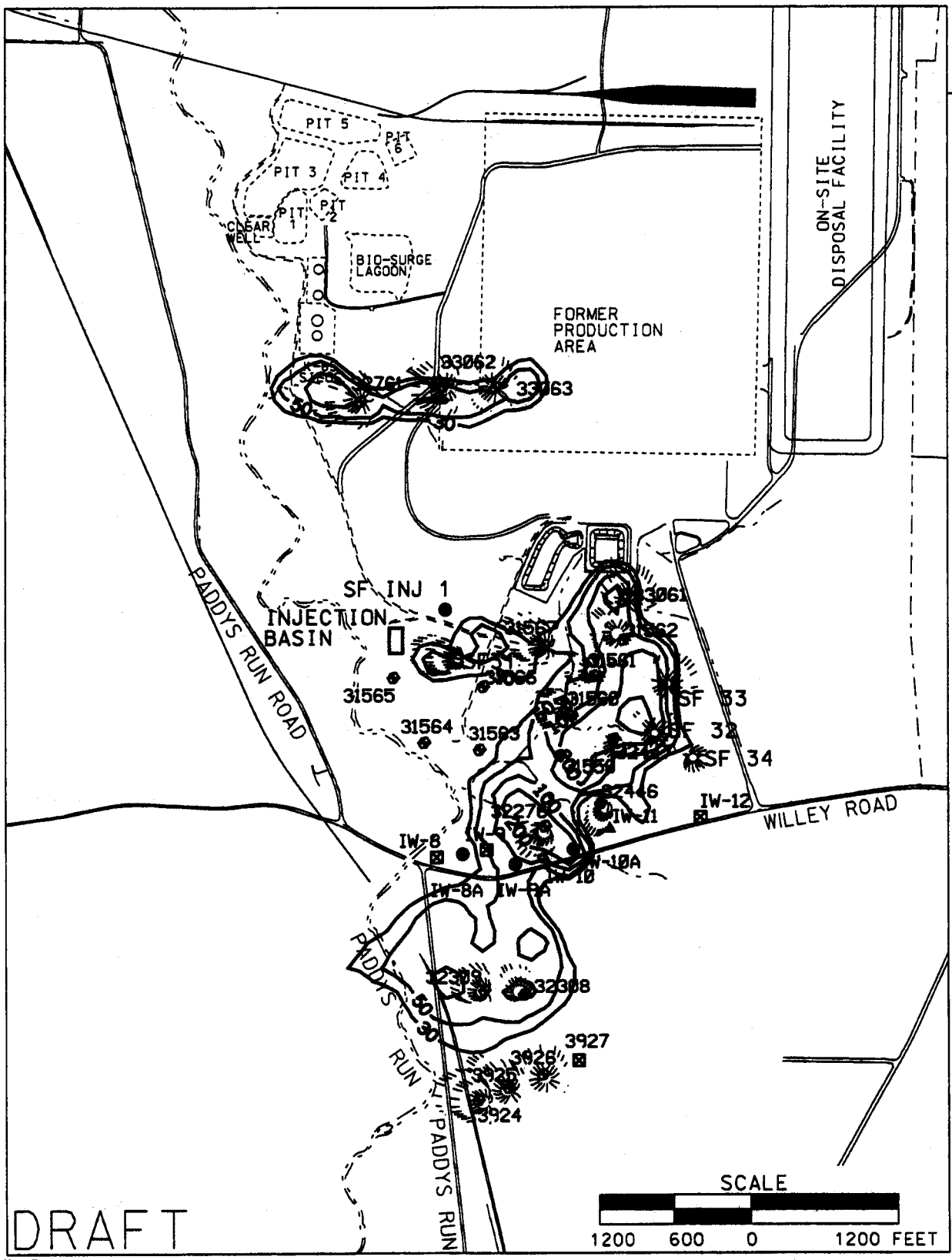
13-MAY-2002



LEGEND:

- FEMP BOUNDARY
- URANIUM CONTOUR
- PARTICLE TRACK (6 YEARS RETARDED)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-18. INITIAL CONDITIONS FOR TOTAL URANIUM IN MODEL LAYER 10



LEGEND:

- FEMP BOUNDARY
- URANIUM CONTOUR
- PARTICLE TRACK (6 YEARS RETARDED)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-19. INITIAL CONDITIONS FOR TOTAL URANIUM IN MODEL LAYER 11

V:/SFGP1/DGN/SOUTHFIELD/SFEXT019.DGN

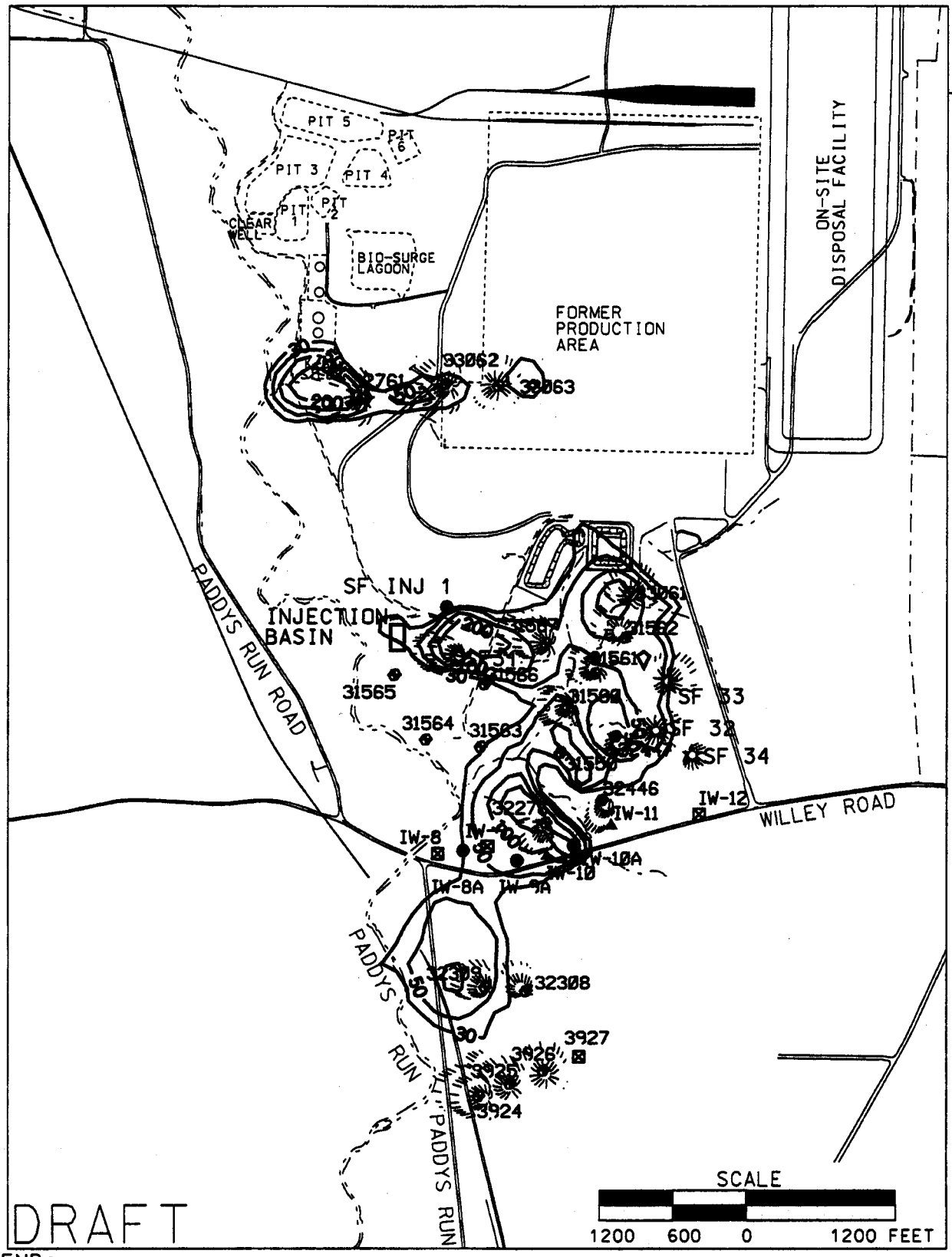
STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002

V:/SFGP1/DGN/SOUTHFIELD/SFEXT020.DGN

STATE PLANAR COORDINATE SYSTEM 1983

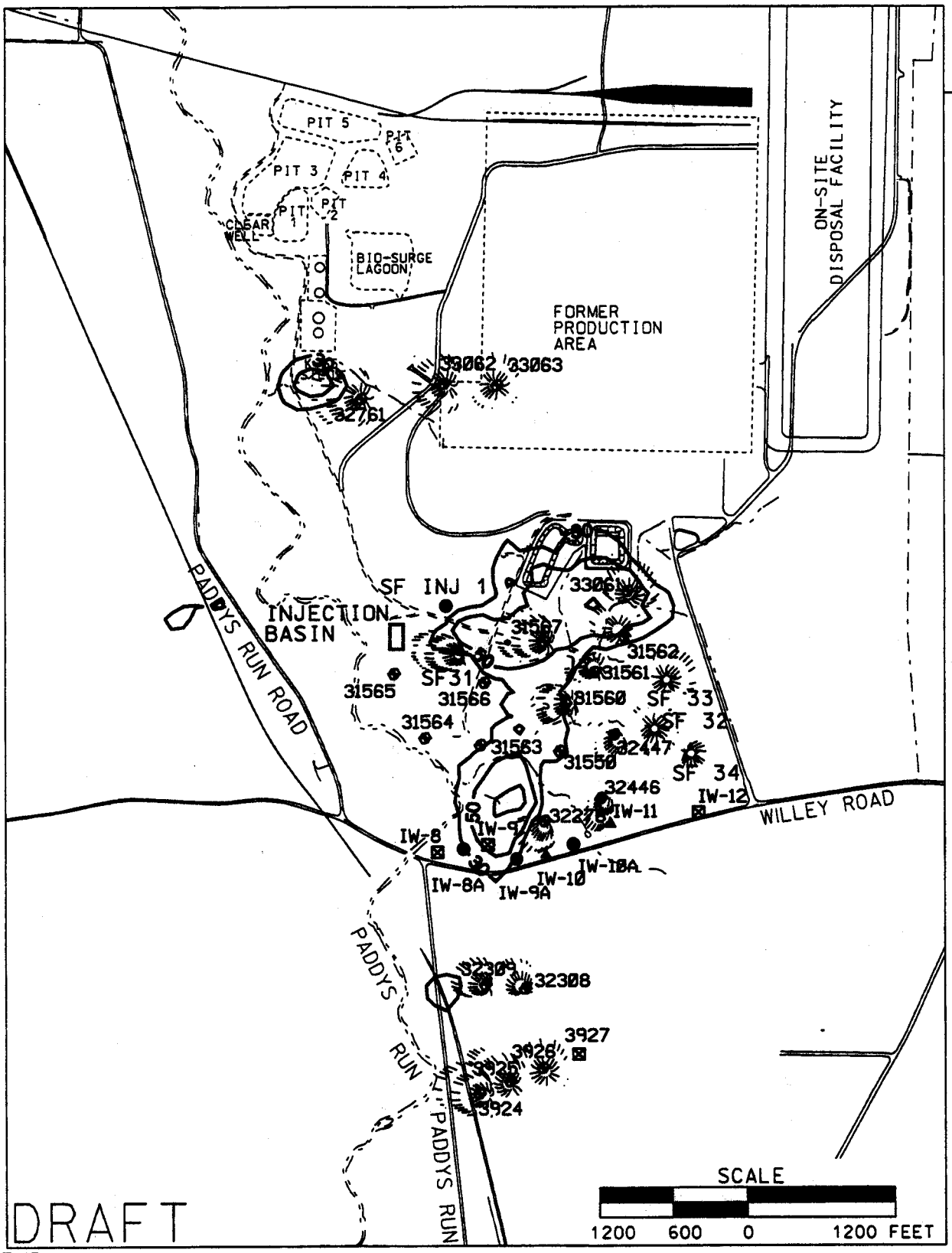
13-MAY-2002



LEGEND:

- FEMP BOUNDARY
- URANIUM CONTOUR
- PARTICLE TRACK (6 YEARS RETARDED)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-20. INITIAL CONDITIONS FOR TOTAL URANIUM IN MODEL LAYER 12



LEGEND:

- FEMP BOUNDARY
- URANIUM CONTOUR
- PARTICLE TRACK (6 YEARS RETARDED)
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

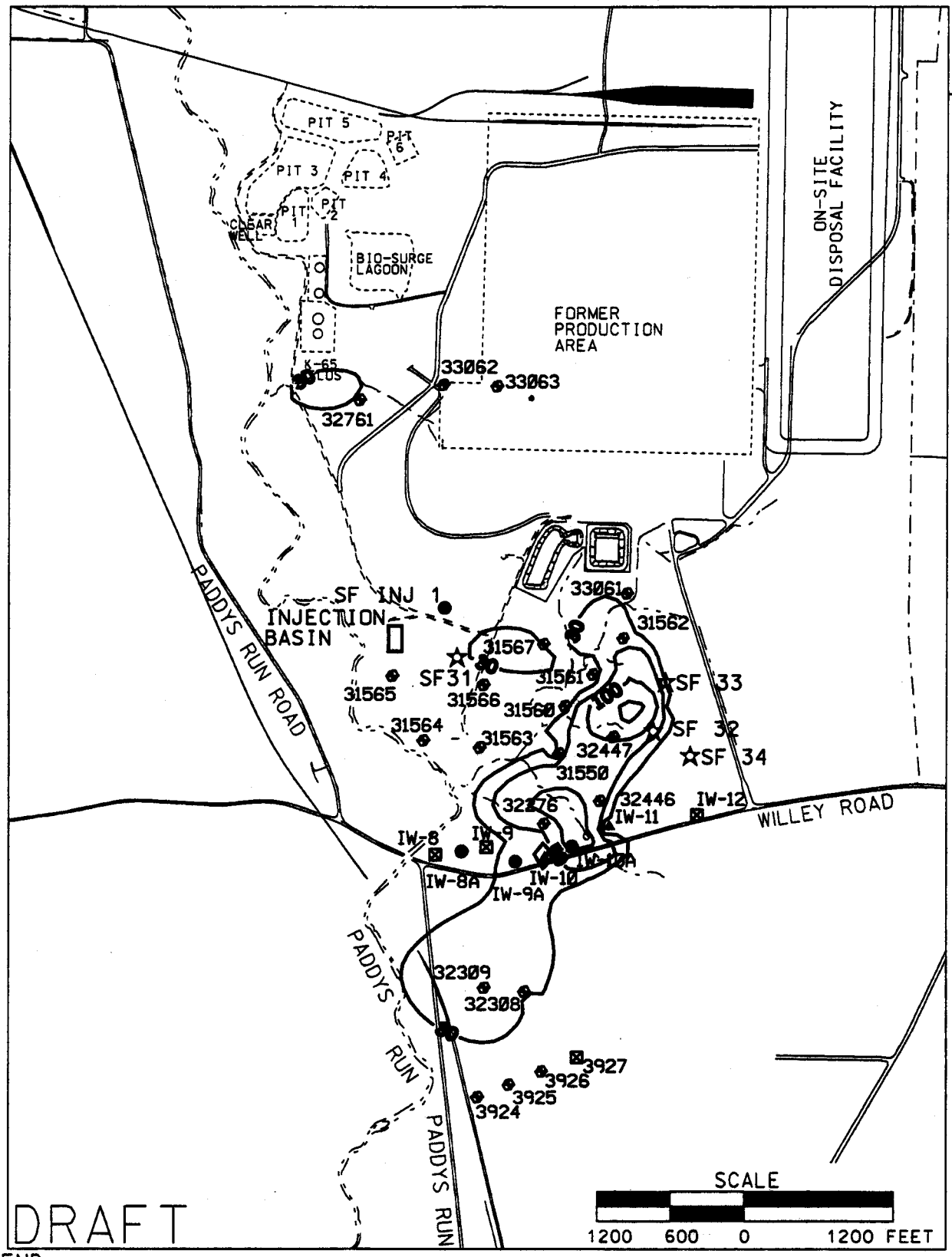
FIGURE 3-21. INITIAL CONDITIONS FOR TOTAL URANIUM PLUME IN MODEL LAYER 13

V:/SFGP1/DGN/SOUTHFIELD/SFEXT026.DGN STATE PLANAR COORDINATE SYSTEM 1983 13-MAY-2002

V:/5FGP1/DGN/SOUTHFIELD/SFEXT007.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

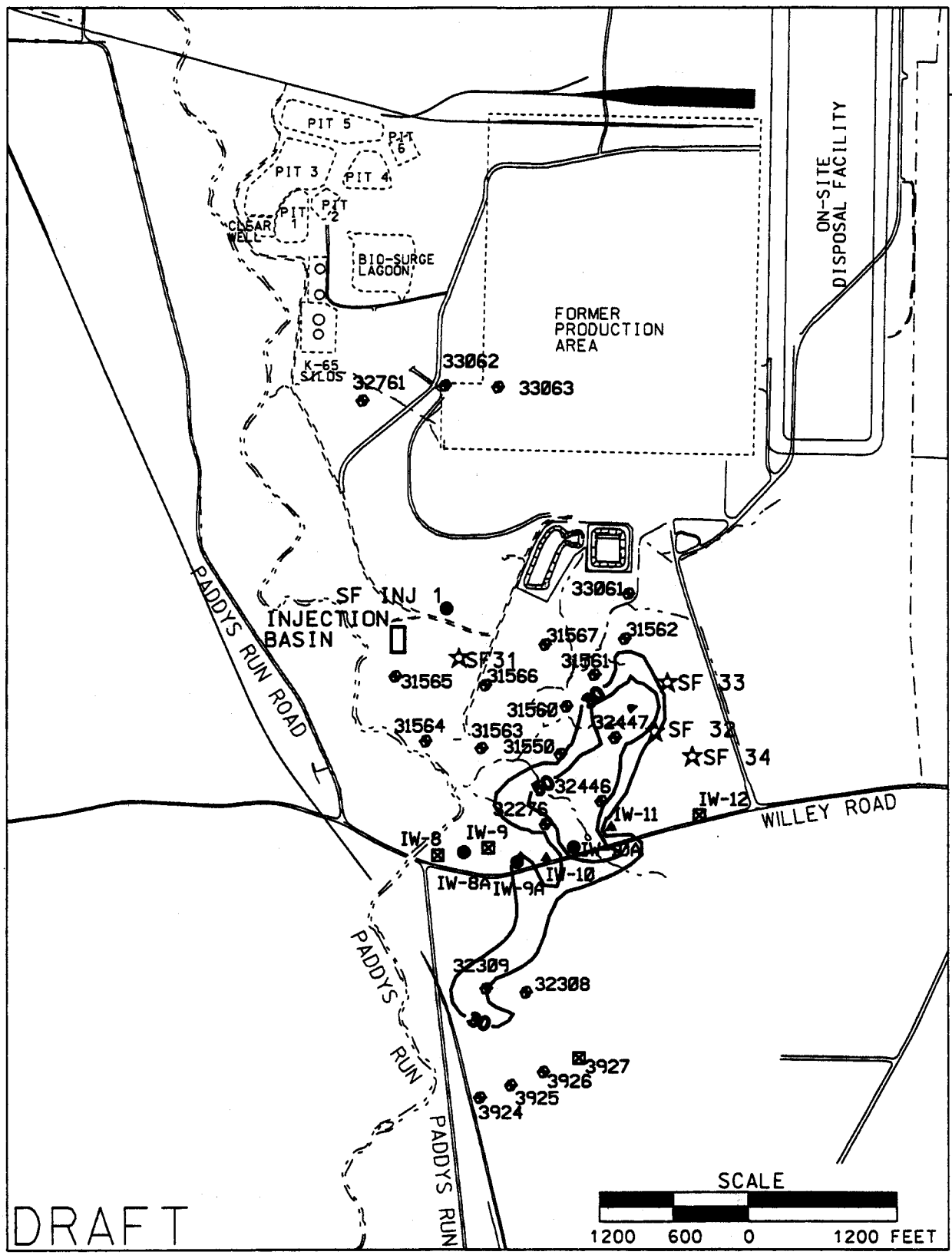
- FEMP BOUNDARY
- URANIUM CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-22. PREDICTED TOTAL URANIUM PLUME IN MODEL LAYER 11 AFTER TWO YEARS OPERATION WITH NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT008.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

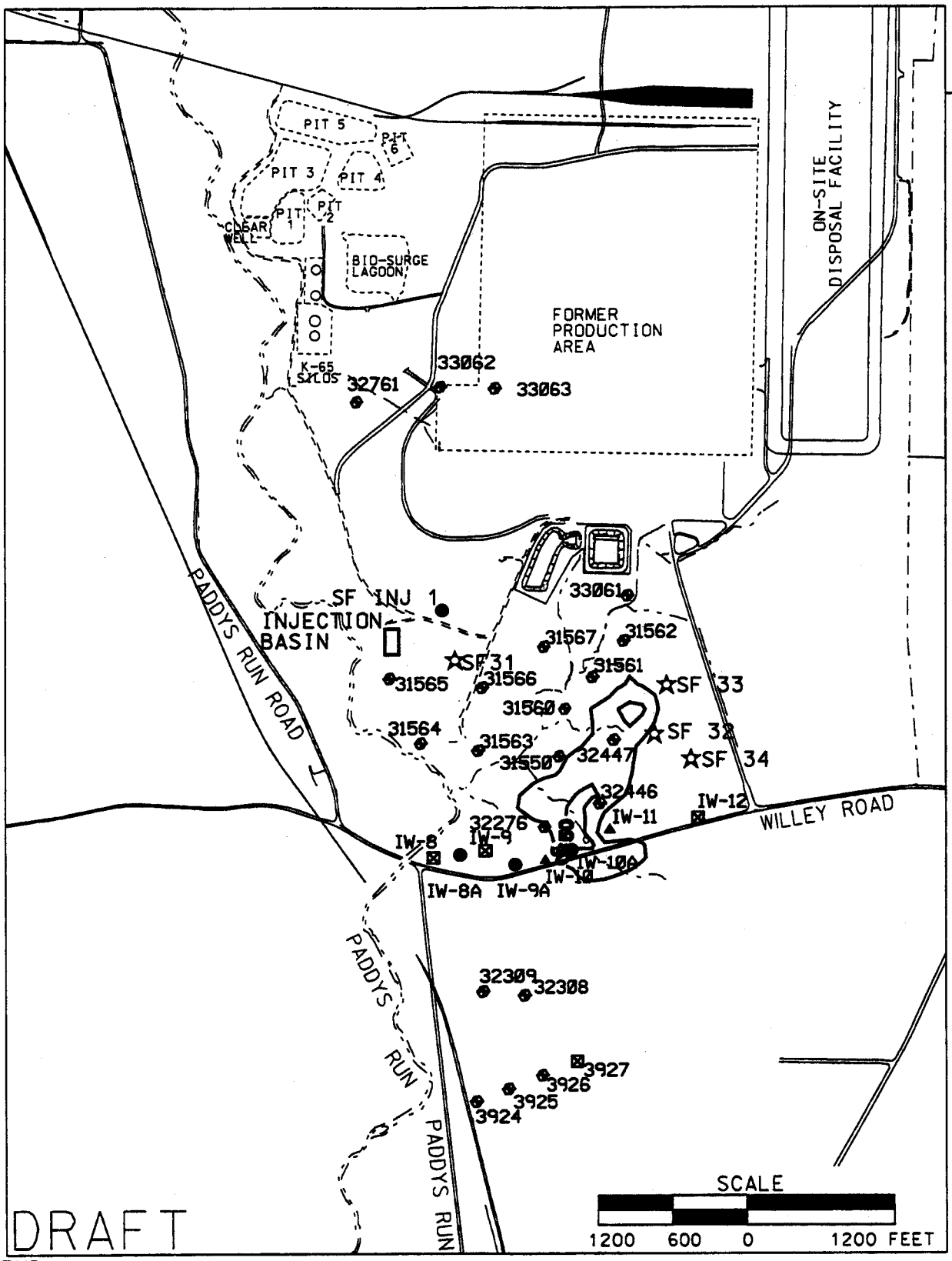
- FEMP BOUNDARY
- URANIUM CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-23. PREDICTED TOTAL URANIUM PLUME IN MODEL LAYER 11 AFTER FOUR YEARS OPERATION WITH NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT009.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

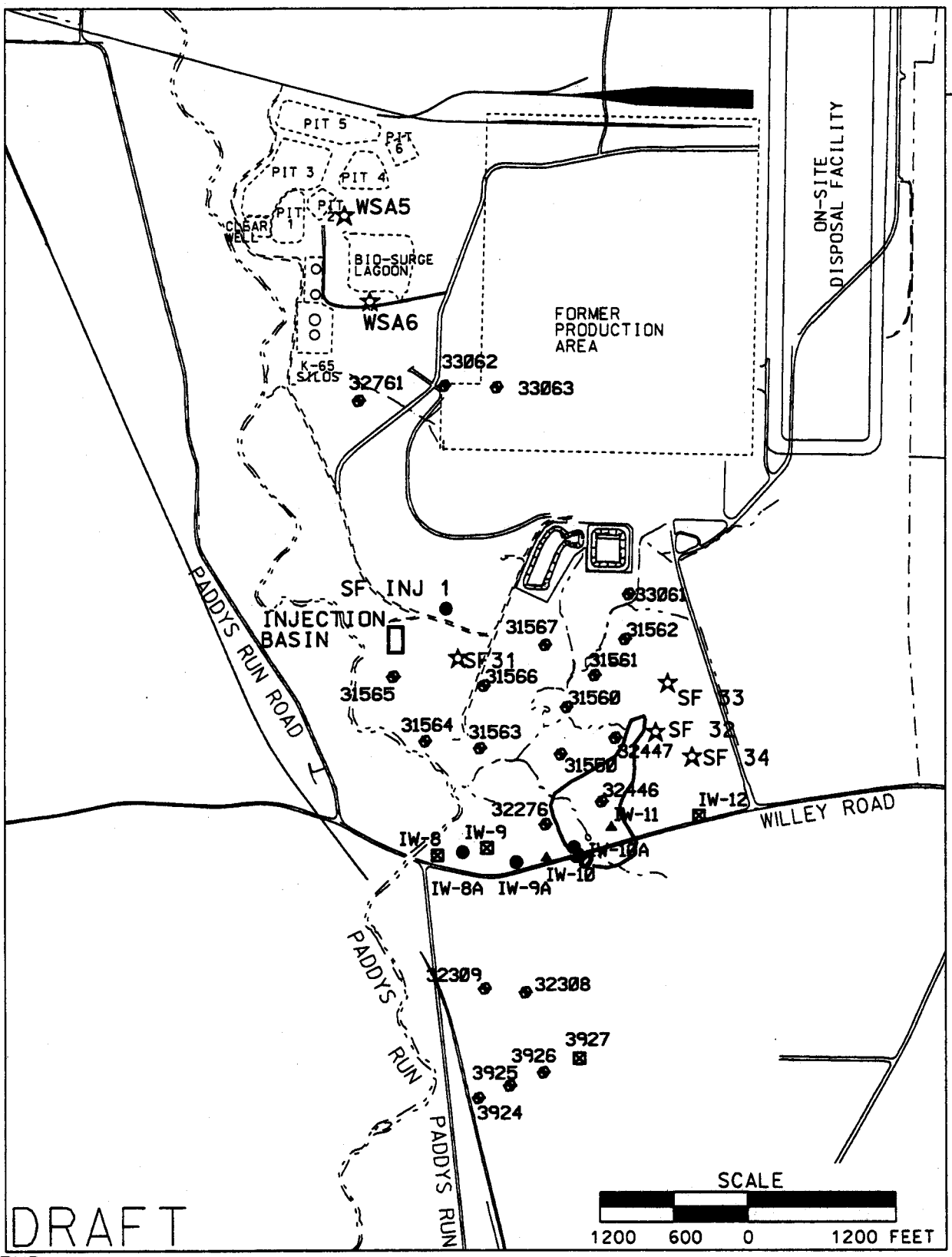
- FEMP BOUNDARY
- URANIUM CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-24. PREDICTED TOTAL URANIUM PLUME IN MODEL LAYER 11 AFTER SIX YEARS OPERATION WITH NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT013.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

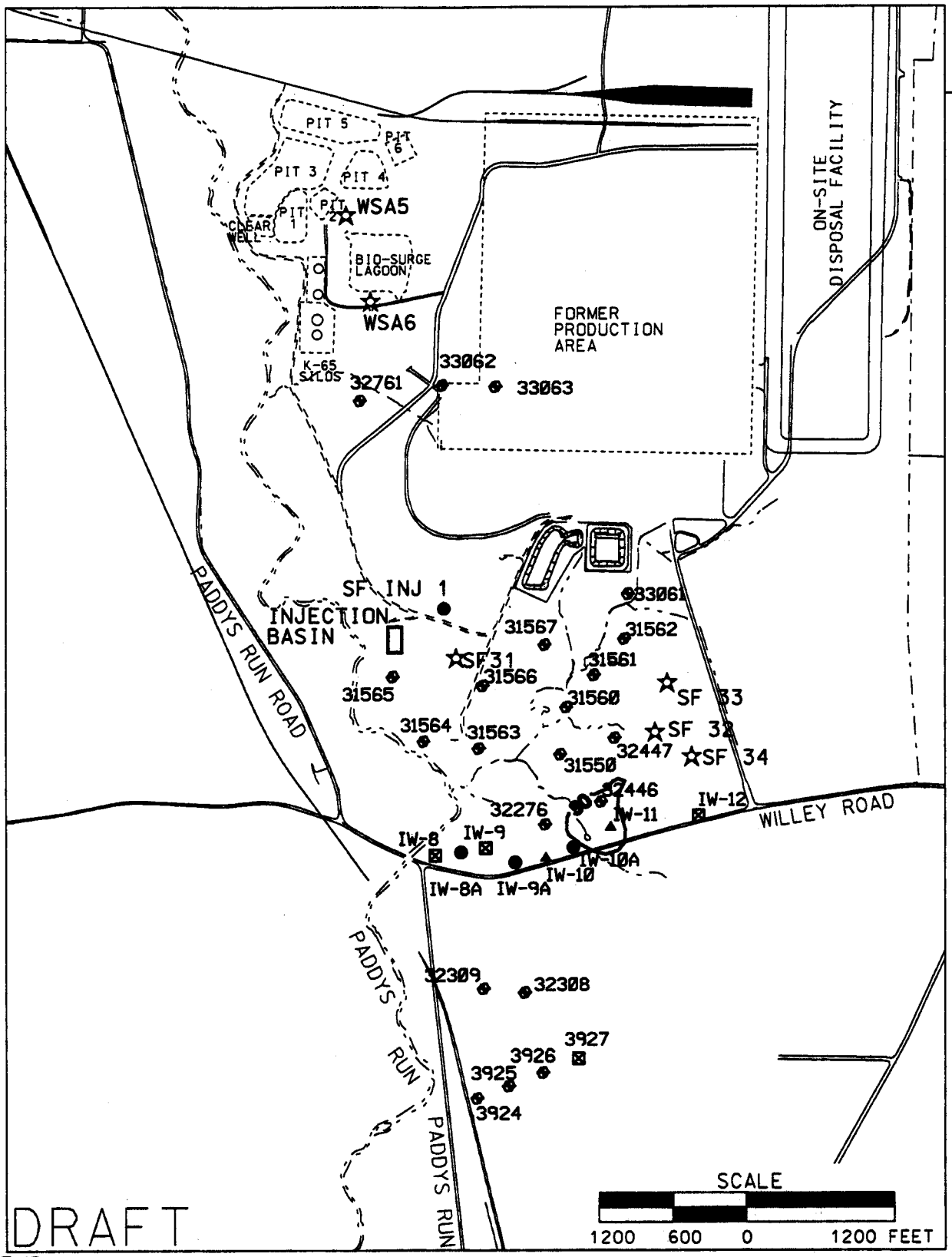
- FEMP BOUNDARY
- URANIUM CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-25. PREDICTED TOTAL URANIUM PLUME IN MODEL LAYER 11 AFTER EIGHT YEARS OPERATION WITH NOMINAL BOUNDARY CONDITIONS

V:/5FGP1/DGN/SOUTHFIELD/SFEXT014.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

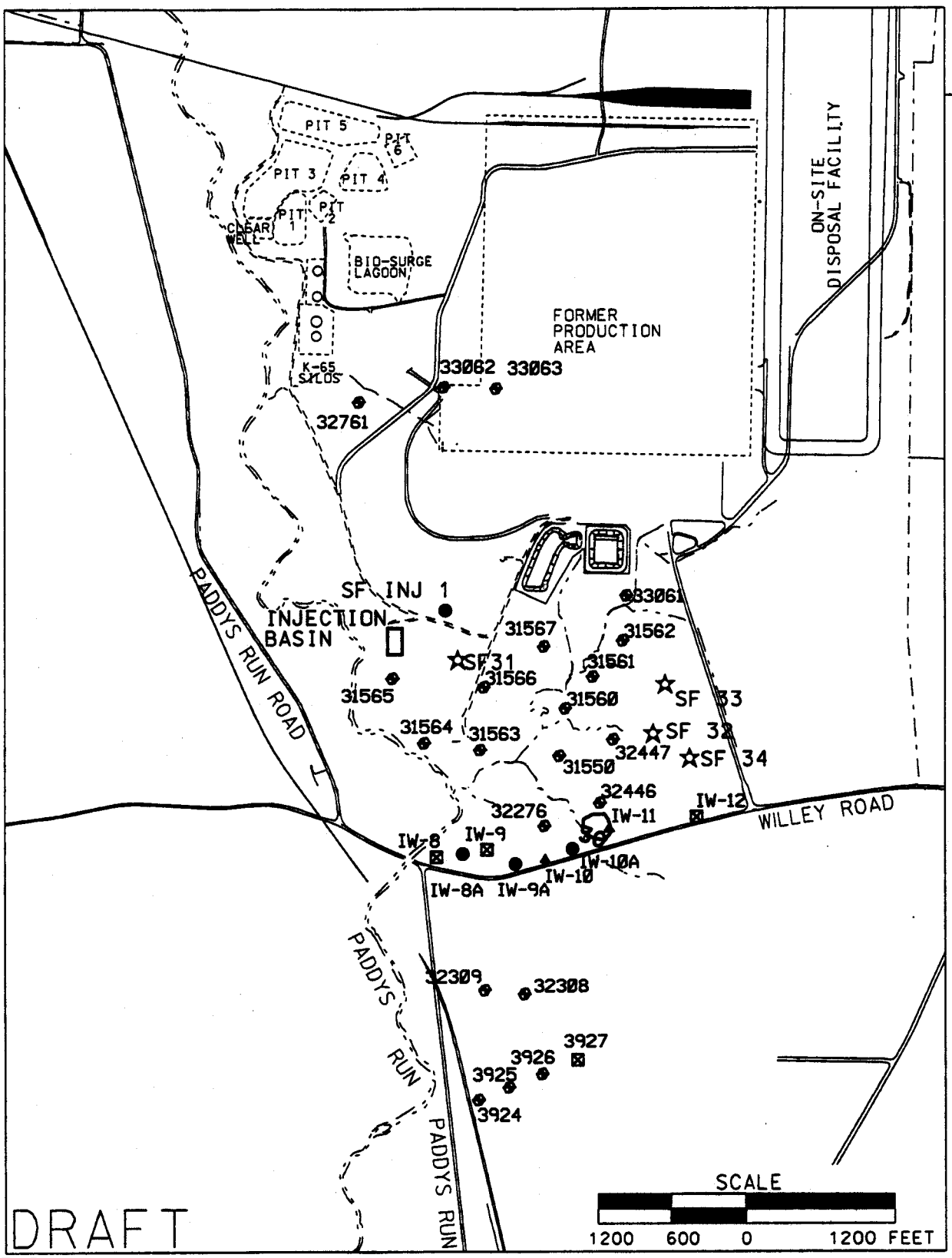
- FEMP BOUNDARY
- URANIUM CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-26. PREDICTED TOTAL URANIUM PLUME IN MODEL LAYER 11 AFTER 10 YEARS OPERATION WITH NOMINAL BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT024.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

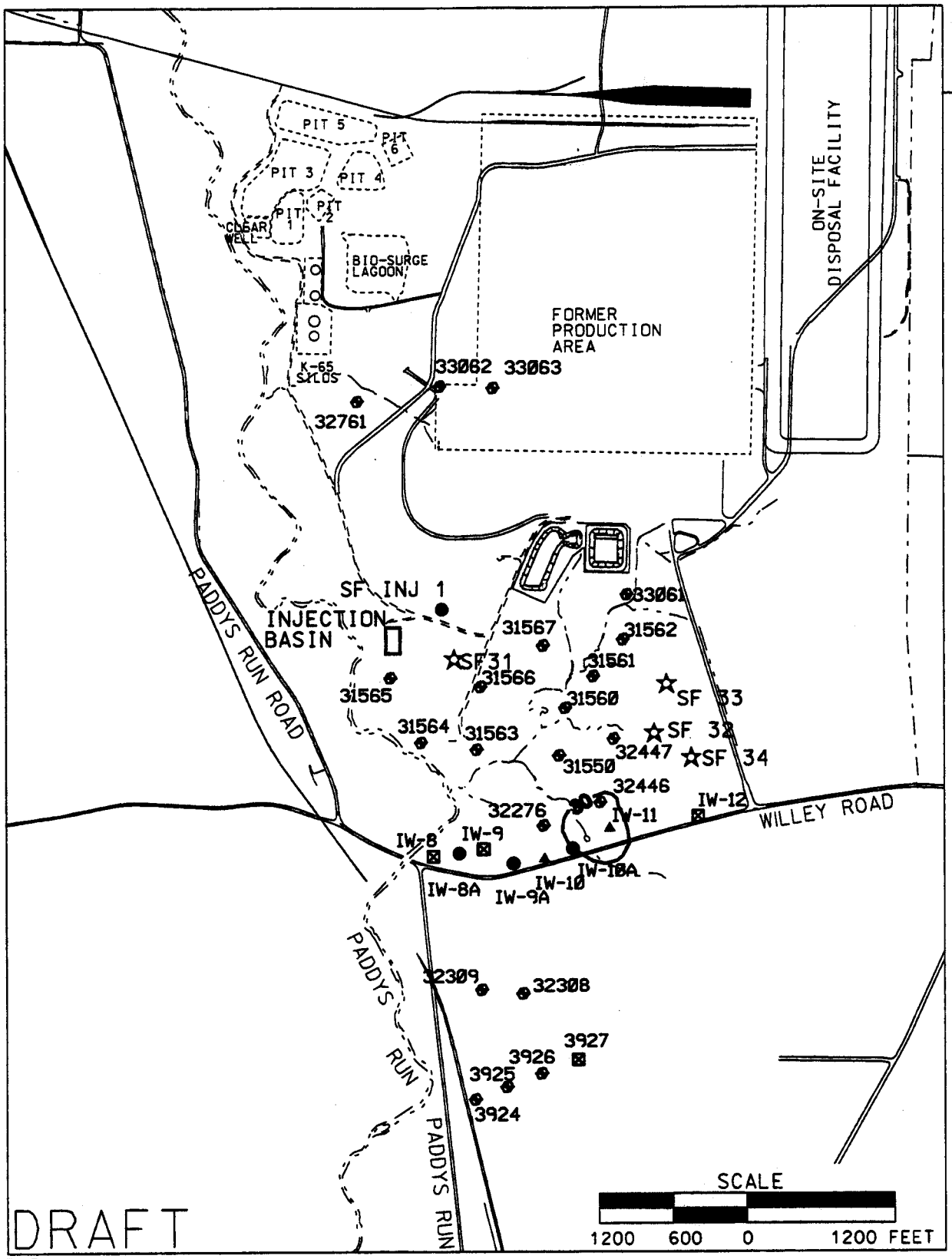
- FEMP BOUNDARY
- URANIUM CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-27. PREDICTED TOTAL URANIUM PLUME IN MODEL LAYER 11 AFTER 10 YEARS OPERATION WITH DRY BOUNDARY CONDITIONS

V:/SFGP1/DGN/SOUTHFIELD/SFEXT025.DGN

STATE PLANAR COORDINATE SYSTEM 1983

13-MAY-2002



LEGEND:

- FEMP BOUNDARY
- URANIUM CONTOUR
- EXTRACTION WELL
- RE-INJECTION WELL
- PROPOSED RE-INJECTION WELL
- PROPOSED PLUGGING AND ABANDONMENT LOCATION
- PROPOSED EXTRACTION WELL
- PROPOSED BASIN RE-INJECTION

FIGURE 3-28. PREDICTED TOTAL URANIUM PLUME IN MODEL LAYER 11 AFTER 10 YEARS OPERATION WITH WET BOUNDARY CONDITIONS

4.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions of this report include:

- A revised South Field Phase II Module Design is required. The revised design consists of four additional extraction wells, one in the SWU area and three along the eastern edge of the uranium plume in the South Field, just west of the FEMP South Access Road. The design also consists of changing South Field Extraction Well 31563 (EW-16) into a re-injection well and adding a re-injection well upgradient of the SWU area to help maintain water levels in the area. Surface water re-injection through existing basins in the SWU area will be used to supplement wellhead re-injection.

- An additional 1.83 acres of uranium contamination in the Great Miami Aquifer had been characterized between the Storm Sewer Outfall Ditch and the FEMP South Access Road.

- Uranium concentrations beneath the SWU are much lower today than they were in previous years. The lower concentrations are attributed to source removal, natural flow of clean groundwater from the west into the area, the continued flushing of clean water through Paddys Run to the west, increased flushing of clean water through deep surface excavations in the Inactive Flyash Pile, and remedial pumping of the extraction wells to the east of this area.

- The water table beneath the former Inactive Flyash Pile was lower in the fourth quarter of 2001 than it was in previous years, raising the concern that uranium contamination may be sorbed onto sediments above the present surface of the saturated zone. Pump-and-treat operations will only remove uranium from the saturated zone. Additional pumping will serve to lower the water table even more with the potential for having even more uranium out of the influence of the pump-and-treat operation.

- Remedy design beneath the former Inactive Flyash Pile will need to address variations in plume thickness. In the middle of the plume, which lies beneath the former Inactive Flyash Pile, the 30 μg/L uranium plume was measured as being approximately 40 feet thick. However, the concentrations are very close to 30 μg/L for approximately 30 of the 40 feet. Along the edges the plume thins to approximately 10 feet.

- Pumping rates beneath the former Inactive Flyash Pile need to consider the effects of partial penetration in light of the plume being approximately 10 feet thick in several areas. Large pumping rates might draw a lot of uncontaminated water from beneath the plume and lower system efficiencies for uranium removal.

- Remedy design should take advantage of natural aquifer flushing through the use of infiltration basins, etc. Such flushing might serve to release some of the uranium sorbed to soils above the present day water table, particularly in/near the former source areas.

- Based on groundwater modeling, pumping and re-injection is expected to continue in the South Field and South Plume areas through 2006. It is anticipated that re-injection at the southern property boundary will no longer be needed, and that pumping in the off-property portion of the South Plume will be complete in 2006. However, it is anticipated that additional pumping will continue in the South Field and in the Waste Storage Area through 2011.

- A Kd of 1.78 liters per kilogram was used for all groundwater modeling transport runs. Additional Kd work is being conducted to determine if 1.78 is the most realistic Kd to use. This additional Kd work will refine the uncertainty in predicted clean up time.

Recommendations are as follows:

- Install and operate components of the South Field Phase II Module presented in Section 3 (i.e., one re-injection well, four extraction wells, one active infiltration basin, and conversion of Extraction Well 31563 [EW-16] to a re-injection well).

- Install additional monitoring wells in optimal locations based on the information collected for the design to better track remedy progress.

- Shut down Extraction Wells 31565 (EW-13) and 31564 (EW-14). These wells are no longer situated in locations that will provide a pumping benefit to the aquifer remedy. Pumping should stop in these wells, and they should be used for monitoring the ongoing decline of uranium concentrations in this area of the aquifer.

- In addition to the re-injection activities already discussed (i.e., wells and active basins) efforts need to be taken all over the South Field to keep the water level as high as possible. Other possibilities that should be explored include infiltration ponds, the installation of check dams along the Storm Sewer Outfall Ditch and perhaps pulse pumping by shutting down some or part of the South Field Module each spring to allow seasonal water level recovery to occur to the degree possible. This pulse pumping may extend the pumping times presented in Section 3.

- After the South Field Phase II Module Design is finalized and approved, an addendum to the 1997 BRSR will be issued adopting the pumping schedules/rates provided in Table 3-1 as the up-to-date plan for aquifer restoration at the FEMP. The addendum would also contain revised performance measures, similar to those identified in Table 3-3, for all areas where groundwater restoration is in progress or planned.

5.0 REFERENCES

HydroGeologic Inc., 2000, "Integration of Data Fusion Modeling (DFM) with VAM3D Contaminant Transport Code, Final, Herndon, VA.

U.S. Dept. of Energy, 2001, "Integrated Environmental Monitoring Plan, Revision 2," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

U.S. Dept. of Energy, 2000a, "Conceptual Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas," Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

U.S. Dept. of Energy, 2000b, "The Great Miami Aquifer VAM3D Flow Model Recalibration Report," Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

U.S. Dept. of Energy, 1997, "Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

U.S. Dept. of Energy, 1996, "Record of Decision for Remedial Actions at Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

U.S. Dept. of Energy, 1995, "Remedial Investigation Report for Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

U.S. Dept. of Energy, 1994, "SWIFT Great Miami Aquifer Model Summary of Improvements Report, Revision B," Draft Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Cincinnati, OH.

APPENDIX A

DIRECT-PUSH SAMPLING RESULTS

APPENDIX A

The following information is provided for each direct-push sample location:

- Easting survey coordinate
- Northing survey coordinate
- Reference surface elevation
- Depth (feet) to the water table
- Work duration (date sampling was conducted)
- The total uranium sampling results for each sampling depth.

TABLE A-1

GEOPROBE 12814

Easting '83: 1347671.44
Northing '83: 477907.64
Reference Elevation: 544.4 feet amsl
Depth to Water Table: 28.5 feet bgs
Work Duration: 10/22/00 – 10/28/00

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 515.9 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	512.9	31.5	3	28.7	31.5
2	505.9	38.5	10	22.9	23.4
3	495.9	48.5	20	9.2	9.6
4	495.9	48.5	20-D	9.0	9.4
5	485.9	58.5	30	8.9	12.2
6	475.9	68.5	40	15.0	15.9
7	465.9	78.5	50	2.9	3.2
8	455.9	88.5	60	4.4	5.9

TABLE A-2

GEOPROBE 12815

Easting '83: 1347647.81
Northing '83: 478086.39
Reference Elevation: 558.0 feet amsl
Depth to Water Table: 43.0 feet bgs
Work Duration: 10/23/00 – 10/26/00

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 515 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	512	46	3	62	64
2	505	53	10	22	23
3	495	63	20	11	13
4	495	63	20-D	11	13
5	485	73	30	13	13
6	475	83	40	8.3	8.5
7	465	93	50	0.7	0.7
8	455	103	60	0.6	0.7

TABLE A-3

GEOPROBE 12816

Easting '83: 1347945.79
Northing '83: 477721.21
Reference Elevation: 558.4 feet amsl
Depth to Water Table: 45.0 feet bgs
Work Duration: 10/26/00 – 11/1/00

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.4 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	510.4	48	3	109	112
2	503.4	55	10	69	70
3	493.4	65	20	24	24
4	493.4	65	20-D	24	23
5	483.4	75	30	15	17
6	473.4	85	40	10	11
7	463.4	95	50	0.9	1.0
8	453.4	105	60	1.4	1.5

TABLE A-4

GEOPROBE 12817

Easting '83: 1349724.51
Northing '83: 478725.48
Reference Elevation: 575.1 feet amsl
Depth to Water Table: 62.0 feet bgs
Work Duration: 11/2/00 – 11/14/00

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.1 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	510.1	65	3	1.0	2.1
2	503.1	72	10	0.6	0.7
3	493.1	82	20	0.6	0.6
4	493.1	82	20-D	0.6	0.6
5	483.1	92	30	0.8	2.2
6	473.1	102	40	0.7	1.5
7	463.1	112	50	0.4	0.5
8	453.1	122	60	0.2	0.2

TABLE A-5

GEOPROBE 12818

Easting '83: 1348109.62
Northing '83: 477099.20
Reference Elevation: 537.9 feet amsl
Depth to Water Table: 25.0 feet bgs
Work Duration: 11/28/00 – 12/4/00

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.9 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	509.9	28	3	20	21
2	502.9	35	10	15	16
3	492.9	45	20	12	13
4	492.9	45	20-D	12	12
5	482.9	55	30	15	15
6	472.9	65	40	11	12
7	462.9	75	50	12	12
8	452.9	85	60	1.8	2.5

TABLE A-6

GEOPROBE 12819

Easting '83: 1348971.77
Northing '83: 478+A12556.75
Reference Elevation: 574.0 feet amsl
Depth to Water Table: 61.0 feet bgs
Work Duration: 12/19/00 – 12/28/00

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	510	64	3	2.0	2.2
2	503	71	10	2.5	2.5
3	493	81	20	1.3	1.3
4	493	81	20-D	1.2	1.3
5	483	91	30	0.8	1.2
6	473	101	40	0.9	1.1
7	463	111	50	0.6	0.7
8	453	121	60	0.4	0.5

TABLE A-7

GEOPROBE 12820

Easting '83: 1349173.46
Northing '83: 478798.48
Reference Elevation: 569.6 feet amsl
Depth to Water Table: 56.5 feet bgs
Work Duration: 12/28/00 – 1/4/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.1 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	510.1	59.5	3	63	67
2	503.1	66.5	10	2.1	2.2
3	493.1	76.5	20	2.9	4.3
4	493.1	76.5	20-D	3.0	2.8
5	483.1	86.5	30	1.1	1.2
6	473.1	96.5	40	0.7	0.8
7	463.1	106.5	50	0.5	0.6
8	453.1	116.5	60	0.1	0.2

TABLE A-8

GEOPROBE 12824

Easting '83: 1348039.19
Northing '83: 477920.70
Reference Elevation: 566.7 feet amsl
Depth to Water Table: 53.0 feet bgs
Work Duration: 1/3/01 – 1/9/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.7 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	510.7	56	3	405	403
2	503.7	63	10	29	30
3	493.7	73	20	19	20
4	493.7	73	20-D	20	20
5	483.7	83	30	32	34
6	473.7	93	40	22	29
7	463.7	103	50	1.9	2.1
8	453.7	113	60	1.1	1.0

TABLE A-9

GEOPROBE 12825

Easting '83: 1347883.87
Northing '83: 478236.33
Reference Elevation: 575.8 feet amsl
Depth to Water Table: 63.0 feet bgs
Work Duration: 1/8/01 – 1/15/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.8 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	509.8	66	3	0.7	0.8
2	502.8	73	10	5.6	6.0
3	492.8	83	20	1.0	1.0
4	492.8	83	20-D	1.0	1.0
5	482.8	93	30	0.4	0.5
6	472.8	103	40	2.9	3.1
7	462.8	113	50	1.8	1.6
8	452.8	123	60	0.5	0.5

TABLE A-10

GEOPROBE 12826

Easting '83: 1348115.93
Northing '83: 477774.73
Reference Elevation: 568.9 feet amsl
Depth to Water Table: 56.0 feet bgs
Work Duration: 1/8/01 – 1/17/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.9 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	509.9	59	3	424	424
2	502.9	66	10	47	47
3	492.9	76	20	30	31
4	492.9	76	20-D	31	31
5	482.9	86	30	15	16
6	472.9	96	40	2.0	2.1
7	462.9	106	50	2.1	2.3
8	452.9	116	60	0.8	0.8

TABLE A-11

GEOPROBE 12827

Easting '83: 1348274.17
Northing '83: 477920.00
Reference Elevation: 568.9 feet amsl
Depth to Water Table: 56.0 feet bgs
Work Duration: 1/18/01 – 1/24/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.9 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	511.9	57	1	176	180
2	502.9	66	10	28	29
3	492.9	76	20	22	22
4	492.9	76	20-D	22	22
5	482.9	86	30	24	26
6	472.9	96	40	16	18
7	462.9	106	50	1.1	1.3
8	452.9	116	60	0.6	0.7

TABLE A-12

GEOPROBE 12828

Easting '83: 1348328.15
Northing '83: 477803.10
Reference Elevation: 575.9 feet amsl
Depth to Water Table: 63.0 feet bgs
Work Duration: 1/29/01 – 2/5/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.9 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	509.9	66	3	223	224
2	502.9	73	10	56	65
3	492.9	83	20	19	19
4	492.9	83	20-D	19	20
5	482.9	93	30	21	22
6	472.9	103	40	1.8	1.9
7	462.9	113	50	1.8	1.9
8	452.9	123	60	1.0	0.8

TABLE A-13

GEOPROBE 12833

Easting '83: 1349411.68
Northing '83: 478335.75
Reference Elevation: 575.0 feet amsl
Depth to Water Table: 62.5 feet bgs
Work Duration: 2/12/01 – 2/15/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.5 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	511.5	63.5	1	312	310
2	502.5	72.5	10	274	280
3	492.5	82.5	20	133	135
4	492.5	82.5	20-D	135	137
5	482.5	92.5	30	44	46
6	472.5	102.5	40	9.7	9.8
7	462.5	112.5	50	1.8	1.6
8	452.5	122.5	60	1.2	1.2

TABLE A-14

GEOPROBE 12834

Easting '83: 1349531.55
Northing '83: 478460.34
Reference Elevation: 576.0 feet amsl
Depth to Water Table: 63.0 feet bgs
Work Duration: 2/20/01 – 2/26/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.0 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	512	64	1	90	91
2	503	73	10	95	97
3	493	83	20	54	55
4	493	83	20-D	56	63
5	483	93	30	25	27
6	473	103	40	2.2	2.6
7	463	113	50	1.5	1.8
8	453	123	60	1.1	1.1

TABLE A-15

GEOPROBE 12835

Easting '83: 1349678.12
Northing '83: 478280.90
Reference Elevation: 570.8 feet amsl
Depth to Water Table: 58.0 feet bgs
Work Duration: 2/26/01 – 3/1/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.8 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	511.8	59	1	61	64
2	502.8	68	10	6.4	6.5
3	492.8	78	20	2.5	2.4
4	492.8	78	20-D	2.4	2.3
5	482.8	88	30	1.4	1.4
6	472.8	98	40	0.8	0.8
7	462.8	108	50	0.8	0.9
8	452.8	118	60	0.4	0.4

TABLE A-16

GEOPROBE 12836

Easting '83: 1349527.37
Northing '83: 478155.77
Reference Elevation: 574.2 feet amsl
Depth to Water Table: 62.0 feet bgs
Work Duration: 3/5/01 – 3/8/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.2 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	511.2	63	1	225	232
2	502.2	72	10	159	161
3	492.2	82	20	90	90
4	492.2	82	20-D	90	91
5	482.2	92	30	30	32
6	472.2	102	40	4.0	4.1
7	462.2	112	50	2.4	2.6
8	452.2	122	60	1.3	1.4

TABLE A-17

GEOPROBE 12837

Easting '83: 1348348.85
Northing '83: 478035.74
Reference Elevation: 578.23 feet amsl
Depth to Water Table: 66.0 feet bgs
Work Duration: 3/5/01 – 3/8/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.23 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	511.2	69	1	463	460
2	502.2	76	10	62	62
3	492.2	86	20	17	17
4	492.2	86	20-D	17	18
5	482.2	96	30	45	44
6	472.2	106	40	30	31
7	462.2	116	50	3.7	3.8
8	452.2	126	60	1.3	1.3

TABLE A-18

GEOPROBE 12838

Easting '83: 1348129.11
Northing '83: 478083.68
Reference Elevation: 577.0 feet amsl
Depth to Water Table: 64.5 feet bgs
Work Duration: 3/8/01 – 3/15/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.5 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	511.5	65.5	1	422	439
2	502.5	74.5	10	24	25
3	492.5	84.5	20	18	19
4	492.5	84.5	20-D	19	19
5	482.5	94.5	30	12	12
6	472.5	104.5	40	4.1	4.3
7	462.5	114.5	50	4.7	5.0
8	452.5	124.5	60	1.0	1.1

TABLE A-19

GEOPROBE 12839

Easting '83: 1348138.31
Northing '83: 477649.75
Reference Elevation: 569.8 feet amsl
Depth to Water Table: 56.0 feet bgs
Work Duration: 3/19/01 – 3/26/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.8 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	512.8	57	1	7.1	7.2
2	503.8	66	10	32	33
3	493.8	76	20	13	13
4	493.8	76	20-D	13	13
5	483.8	86	30	2.1	2.2
6	473.8	96	40	1.2	1.4
7	463.8	106	50	0.8	0.9
8	453.8	116	60	0.7	0.7

TABLE A-20

GEOPROBE 12840

Easting '83: 1348362.89
Northing '83: 477700.44
Reference Elevation: 574.20 feet amsl
Depth to Water Table: 60.0 feet bgs
Work Duration: 3/15/01 – 3/21/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 514.2 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	509.2	65	5	89	90
2	504.2	70	10	35	35
3	494.2	80	20	3.8	4.0
4	494.2	80	20-D	3.9	4.1
5	484.2	90	30	0.7	0.8
6	474.2	100	40	0.5	0.7
7	464.2	110	50	0.5	0.5
8	454.2	120	60	0.5	0.5

TABLE A-21

GEOPROBE 12841

Easting '83: 1347879.23
Northing '83: 477609.96
Reference Elevation: 544.9 feet amsl
Depth to Water Table: 30.5 feet bgs
Work Duration: 3/27/01 – 3/29/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 514.4 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	513.4	31.5	1	3.4	3.7
2	504.4	40.5	10	11	12
3	494.4	50.5	20	12	12
4	494.4	50.5	20-D	11	12
5	484.4	60.5	30	11	11
6	474.4	70.5	40	7.5	7.8
7	464.4	80.5	50	1.6	1.7
8	454.4	90.5	60	1.5	1.7

TABLE A-22

GEOPROBE 12842

Easting '83: 1348644.25
Northing '83: 477701.42
Reference Elevation: 575.6 feet amsl
Depth to Water Table: 62.5 feet bgs
Work Duration: 3/22/01 – 3/29/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.1 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	510.1	65.5	3	136	139
2	503.1	72.5	10	57	58
3	493.1	82.5	20	4.4	4.4
4	493.1	82.5	20-D	4.6	4.6
5	483.1	92.5	30	1.1	1.1
6	473.1	102.5	40	1.7	1.8
7	463.1	112.5	50	1.1	1.2
8	453.1	122.5	60	1.8	1.9

TABLE A-23

GEOPROBE 12843

Easting '83: 1349534.20
Northing '83: 478320.20
Reference Elevation: 575.1 feet amsl
Depth to Water Table: 64.0 feet bgs
Work Duration: 4/2/01 – 4/5/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 511.1 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	508.1	67	3	240	241
2	501.1	74	10	116	111
3	491.1	84	20	56	59
4	491.1	84	20-D	57	57
5	481.1	94	30	7.0	7.2
6	471.1	104	40	1.9	2.0
7	461.1	114	50	1.9	2.2
8	451.1	124	60	0.8	0.9

TABLE A-24

GEOPROBE 12844

Easting '83: 1348862.32
Northing '83: 478081.06
Reference Elevation: 573.59 feet amsl
Depth to Water Table: 60.0 feet bgs
Work Duration: 4/24/01 – 5/1/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.6 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	512.6	61	1	56	55
2	503.6	70	10	11	12
3	493.6	80	20	4.3	4.5
4	493.6	80	20-D	4.2	4.2
5	483.6	90	30	2.4	2.4
6	473.6	100	40	1.4	1.5
7	463.6	110	50	0.8	0.8
8	453.6	120	60	0.5	0.5

TABLE A-25

GEOPROBE 12845

Easting '83: 1348803.74
Northing '83: 477713.24
Reference Elevation: 574.85 feet amsl
Depth to Water Table: 61.5 feet bgs
Work Duration: 4/24/01 – 5/7/01

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.4 feet amsl)	Total Uranium Conc. (0.45 micron filtered) (µg/L)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	512.4	62.5	1	107	109
2	503.4	71.5	10	6.9	7.3
3	493.4	81.5	20	2.2	2.0
4	493.4	81.5	20-D	2.6	2.1
5	483.4	91.5	30	3.4	3.8
6	473.4	101.5	40	2.5	2.7
7	463.4	111.5	50	2.1	2.7
8	453.4	121.5	60	1.6	1.6

TABLE A-26

GEOPROBE 13241

Easting '83: 1350070.84
Northing '83: 477048.77
Reference Elevation: 581.0 feet amsl
Depth to Water Table: 65.0 feet bgs
Work Duration: 1/22/02 – 1/23/02

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 516 feet amsl)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	515	66	1	3.6
2	506	75	10	8.7
3	496	85	20	33
4	496	85	20-D	33
5	486	95	30	120
6	476	105	40	14
7	466	115	50	4.8
8	456	125	60	1.4
9	446	135	70	2.5

TABLE A-27

GEOPROBE 13247

Easting '83: 1350281.339
Northing '83: 476939.546
Reference Elevation: 583.7 feet amsl
Depth to Water Table: 69.0 feet bgs
Work Duration: 1/29/02 – 1/30/02

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 514.7 feet amsl)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	513.7	70	1	1.9
2	504.7	79	10	1.8
3	494.7	89	20	2.0
4	494.7	89	20-D	1.5
5	484.7	99	30	2.0
6	474.7	109	40	1.0
7	464.7	119	50	1.6
8	454.7	129	60	0.7
9	444.7	139	70	0.4

TABLE A-28

GEOPROBE 13248

Easting '83: 1350096.574
Northing '83: 477312.792
Reference Elevation: 581.6 feet amsl
Depth to Water Table: 67.0 feet bgs
Work Duration: 2/6/02 – 2/7/02

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 514.6 feet amsl)	Total Uranium Conc. (5 micron filtered) (µg/L)
1	513.6	68	1	7.5
2	504.6	77	10	1.7
3	494.6	87	20	1.8
4	494.6	87	20-D	1.5
5	484.6	97	30	0.9
6	474.6	107	40	3.2
7	464.6	117	50	1.0
8	454.6	127	60	0.5
9	444.6	137	70	0.5