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ADDENDUM TO THE
WASTE STORAGE AREA (PHASE II) DESIGN REPORT

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ADDENDUM TO THE WASTE STORAGE AREA (PHASE II) DESIGN REPORT

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1.0 INTRODUCTION

This addendum to the Waste Storage Area (Phase II) Design Report, Revision A, Draft Final, (DOE 2005) provides the following information:

- Manganese speciation in Great Miami Aquifer groundwater and compiled Kd Values for manganese, molybdenum, nickel, nitrate/nitrite, carbon disulfide and trichloroethylene (Section 2)
- Direct-push sampling results from four new locations in the Waste Storage Area, and a new manganese plume interpretation (Section 3)
- New groundwater modeling results for the remediation of the manganese plume in the Waste Storage Area (Section 4).

As reported in the Waste Storage Area (Phase II) Design Report, the footprint of the maximum manganese plume in the Waste Storage Area is larger than the footprint of the uranium plume that is being targeted in the Waste Storage Area for remediation. The highest manganese concentrations (4.08 milligrams per liter [mg/L] and 6.14 mg/L measured at Monitoring Wells 2648 and 2010, respectively) are both located outside of the uranium plume footprint. Groundwater modeling presented in the Phase II Design (using a Kd of 10 liters per kilogram [L/kg]) indicates that the manganese plume would not be remediated along with the uranium plume but would instead remain almost stationary.

This addendum addresses a recommendation made in the Waste Storage Area (Phase II) Design Report to conduct additional direct-push sampling between Monitoring Well 2648 and Monitoring Well 2010 to determine if the high manganese concentrations measured in those wells are a result of bio-fouling. This addendum also addresses comments received from the U.S. EPA and Ohio EPA on the Waste Storage Area (Phase II) Design Report concerning; manganese speciation, Kd values, and modeling results for remediation of the manganese plume.

2.0 MANGANESE SPECIATION AND COMPILED KD VALUES

The geochemical code EQ3NR was used to calculate the manganese speciation in groundwater collected from Direct Push Location 13342 (Mn = 1.1 mg/L, September 2005). Results are as follows: Mn^{2+} 84.6%, $MnCO_3$ (aq) 9.65%, $MnSO_4$ (aq) 3.07%, and $MnHCO_3^+$ 2.64%. The manganese (II) ion is very mobile in carbonate groundwater, because Ca^{2+} ions compete for sorption sites on the sediment (Merdy, et al. 2002). Moreover, manganese will not be removed from the aquifer by precipitation of MnO_2, due to oxidation of manganese (II) to manganese (IV). Based on the observed concentrations for Mn (II) in the GMA, redox conditions in the Great Miami Aquifer are below 500 millivolts (mV) at the near-neutral pH. As MnO_2 has a very low solubility product, the observed concentrations for Mn (II)

would not be possible if redox conditions were above 500 mV. The long-term stability of the carbonate geochemical system is ensured by the large percentage of carbonate minerals (calcite + dolomite >50%) in the aquifer sediments.

Partition coefficients for manganese, molybdenum, nickel, nitrate, carbon disulfide and trichloroethylene, are as follows:

COMPILED K_d VALUES

Specie	K_d (L/kg)	Carbonate System	Reference
Mn^{2+}	0.4 to 1.3	Yes	Bryan, et al. 2004
MoO_4^{2-}	0.2 to 1.0	No, but pH = 7	Goldberg, et al. 2002
Ni^{2+}	48 to 368	Yes	Cantrell, et al. 2003
NO_3^-	0.65 to 1.1	Yes	Mikolajkow 2003
Carbon disulfide	0.46 to 0.54	NA*	ADEC 2004 NYSDEC 2005
Trichloroethylene	0.87 to 1.5	NA*	U.S. EPA 2005

*Not applicable, as sorption of organic compounds is dependent on organic carbon in the sediment. K_d calculated ($K_d = K_{oc} * f_{oc}$) from reported water/organic-carbon partition coefficient (K_{oc}), assuming fraction of organic carbon (f_{oc}) is 0.01 in the Great Miami Aquifer.

The Kd values reflect aqueous conditions similar to those in the Great Miami Aquifer (i.e., carbonate groundwater at near neutral pH), with the exception of carbon disulfide and trichloroethylene. Adsorption of organic constituents is primarily a function of the fraction of organic carbon in the sediment.

Sorption studies by Sandia National Laboratory (Bryan, et al. 2004), using Great Miami Aquifer sediment and groundwater, indicate that Mn Kd values range from 0.4 to 1.3 L/kg. Although the Sandia National Laboratory sorption studies focused on uranium and did not report results for manganese, manganese Kd values can be extracted from the data because major and minor cations were tracked along with the uranium concentrations.

Excluding nickel, the Kd values are all less than the Kd value used to model uranium (3.0 L/Kg). This indicates that the contaminants will be captured during the remediation of the uranium plume. For nickel, Kd values are much greater than uranium, and persistent contamination is possible as nickel slowly desorbs from the sediment. However, nickel contamination is limited to a single location and it may not persist at Well 2649, because it is located within 500 feet of active recharge along Paddys Run. Nickel will be monitored at Well 2649 during remediation of the uranium plume, and further action may be warranted if the nickel contamination persists.

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3.0 DIRECT-PUSH SAMPLING RESULTS

Direct-push sampling was conducted at four additional locations (13342, 13343, 13344, and 13345). Locations are illustrated in Figure 1. Location 13342 is next to Monitoring Well 2010. Location 13343 is next to Monitoring Well 2648. Locations 13344 and 13345 were selected to determine where the eastern edge of the manganese plume is located.

Each location was sampled for the following list of constituents: uranium, technetium-99, nitrate/nitrite, manganese, molybdenum, and nickel. Preliminary sampling results are provided in Tables 1 through 4. Final remediation level (FRL) exceedances are shaded in the tables. There were no new FRL exceedances measured for uranium, so the uranium plume map from the Waste Storage Area Phase II Report was not revised. FRL exceedances were measured for technetium-99, nitrate/nitrite, and manganese. These exceedances are discussed below.

3.1 Technetium-99

The groundwater FRL for technetium-99 is 94 picoCuries per liter (pCi/L). An FRL exceedance for technetium-99 was measured at Location 13343 (163 pCi/L, at a depth of 10 feet below the water table). Sampling results for Location 13343 are provided in Table 2. This location is right next to Monitoring Well 2648. Exceedances for technetium-99 have been measured at Monitoring Well 2648 in the past. The last groundwater FRL exceedance for technetium-99 at Monitoring Well 2648 was 111 pCi/L (January 13, 2003). Monitoring Well 2648 is within the footprint of the uranium plume that is being targeted for remediation.

3.2 Nitrate/Nitrite

The groundwater FRL for nitrate/nitrite is 11 mg/L. FRL exceedances for nitrate/nitrite were measured at Location 13343 (15.5 mg/L, 19.0 mg/L, and 19.5 mg/L) at depths of 10 and 20 feet below the water table. Sampling results for Location 13343 are provided in Table 2. This location is right next to Monitoring Well 2648. Monitoring Well 2648 is within the footprint of the uranium plume that is being targeted for remediation.

3.3 Manganese

The groundwater FRL for manganese is 0.90 mg/L. FRL exceedances for manganese were measured at Locations 13342, 13343, and 13344. However, the FRL exceedances measured in these new locations were considerably lower than the exceedances measured in Monitoring Wells 2648 and 2010. No FRL exceedances for manganese were measured at Location 13345. Location 13345 bounds the eastern extent of the manganese plume. A new maximum manganese plume map for the Waste Storage Area is provided in Figure 2.

Results for Location 13342 are presented in Table 1. Location 13342 is next to Monitoring Well 2010. One FRL exceedance for manganese (1.10 mg/L) was measured at 60 feet below the water able. This concentration is considerably lower than the manganese concentration reported for Monitoring Well 2010 (6.14 mg/L) in the Waste Storage Area (Phase II) Design Report. Monitoring Well 2010 is screened at the water table. No FRL exceedance was detected at Location 13342 within 50 feet of the water able. The difference in measured concentrations between Monitoring Well 2010 and Location 13342 implies that bio-fouling is occurring at Monitoring Well 2010 and concentrating manganese around the well screen.

Results from direct-push Location 13343 are presented in Table 2. Location 13343 is next to Monitoring Well 2648. One FRL exceedance for manganese (0.973 mg/L) was measured at 40 feet below the water table. This concentration is considerably lower than the manganese concentration reported for Monitoring Well 2648 (4.08 mg/L) in the Waste Storage Area (Phase II) Design Report. Monitoring Well 2648 is screened at the water table. No FRL exceedance was detected at Location 13343 within 30 feet of the water table. Again, the difference in concentrations between Monitoring Well 2648 and Location 13343 implies that bio-fouling is occurring at Monitoring Well 2648 and concentrating manganese around the well screen.

Results from direct-push Location 13344 are presented in Table 3. Location 13344 is east of Monitoring Well 2010. Two FRL exceedances for manganese were measured at Location 13344 (0.943 mg/L at 10 feet below the water table and 2.320 mg/L at 60 feet below the water table.

Three of the four FRL exceedances for manganese measured at the four new sampling locations occur at the deepest sampled depth interval. This could be due to naturally occurring geologic conditions in the aquifer, as there does not appear to be any exceedances occurring at the water table or just beneath the water able, which would be expected if the plume were sourced from one of the former waste pits. Regardless of the cause, the deep exceedances were considered in producing a new maximum manganese plume map for the Waste Storage Area. The new map is shown in Figure 2. The main difference between this new manganese map and the map presented in the Waste Storage Area (Phase II) Design Report is that the higher concentrations, for the most part, are situated near the silos area in the new map. The higher manganese concentrations are located in an area that will be strongly influenced by the new extraction well being installed in the silos area.

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4.0 NEW MODELING FOR MANGANESE REMEDIATION

The groundwater model was used to predict how well the Waste Storage Area (Phase II) Design would remediate the newly characterized manganese plume, using a Kd value of 1.3 L/kg instead of the 10 L/kg value previously used.

4.1 Modeled Target Pumping Rates

Target pumping rates remained at the rates defined in Table 3-1 of the Waste Storage Area (Phase II) Design Report. The target pumping rates range from 100 gallons per minute (gpm) to 500 gpm. The additional extraction well modeled in the WSA near the silos is identified in Table 3-1 as WSA-5. It has a target-pumping rate of 300 gpm. This pumping rate was selected because it provided a clean-up end date for the uranium plume that is consistent with the WSA Phase I module, as shown in Figure 3-18 of the WSA Phase II Design Report. Because the modeled prediction for cleanup of the uranium plume was deemed satisfactory using these pumping rates, additional modeling runs with different pumping rates were not conducted for the Phase II Design.

4.2 Transport Modeling Assumptions for Manganese

Initial conditions for manganese were developed from hand-drawn contours of concentration data collected in the Waste Storage Area. Hand-drawn contours of manganese concentrations were digitized, and then converted by hand into model grid node values for each effected model layer. Initial conditions for manganese in model layers 12, 11, 10, 9, 8, and 7 are shown in Figures 3 through 8, respectively. No manganese source terms were used for the model runs because all of the source terms in the WSA have been removed, or are in the process of being removed.

4.3 Transport Modeling Results for Manganese

Modeled manganese concentrations in Layer 12 for the year 2007 are shown in Figure 9. These modeling results support that the manganese plume will be remediated given the current well field design that consists of one additional extraction well in the silos area.

5.0 CONCLUSIONS

- Manganese concentrations measured at direct-push sampling locations next to Monitoring Wells 2648 and 2010 were considerably lower than the concentrations last measured at Monitoring Wells 2648 and 2010. This implies that bio-fouling is occurring around the well screens in the monitoring wells and concentrating manganese there.

- The footprint of the newly mapped manganese plume is larger than the uranium plume being targeted for remediation, but the manganese concentrations are not as high as previously mapped.

- The highest manganese concentrations are situated near the silos area not near Monitoring Wells 2648 and 2010.

- Sorption studies by Sandia National Laboratory indicate that the manganese Kd ranges from 0.4 to 1.3 L/kg. Much lower than the Kd of 10 L/Kg used to model manganese cleanup for the Waste Storage Area (Phase II) Design Report.

- Modeling cleanup of the new manganese plume interpretation, at a Kd of 1.3 L/kg, indicates that below-FRL concentrations for manganese will be achieved in 2007.

- The Waste Storage Area (Phase II) Design is sufficient to remediate the manganese plume in the Waste Storage Area.

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TABLE 1
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13342

Easting '83: 1348178
Northing '83: 481495.2
Reference Elevation: 579.375 feet amsl
Depth to Water Table: 61 feet bgs (518.375 feet amsl)
Work Completed: September 8, 2005

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	514.375	65	4	3.3	U	0.179	0.855	0.0107	0.0103
2	510.375	69	8	13.1	U	0.0974	0.781	0.0088	0.0093
3	498.375	81	20	17.2	U	2.59	0.856	0.0094	0.0098
4	498.375	81	20-D	15.5	U	3.2	0.897	0.0126	0.0147
5	488.375	91	30	19.7	U	3.26	0.73	0.0095	0.0085
6	478.375	101	40	5.0	26.7	0.0657	0.233	0.0138	0.0123
7	468.375	111	50	<1	24.4	0.0402	0.479	0.0156	0.0151
8	458.375	121	60	1.8	U	0.0875	1.100	0.0216	0.0248

TABLE 2
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13343

Easting '83: 1347668
Northing '83: 481487.2
Reference Elevation: 579.83 feet amsl
Depth to Water Table: 61 feet bgs (518.83 feet amsl)
Work Completed: September 1

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	517.83	62	1	8.9	U	U	0.889	0.0114	0.0146
2	508.83	71	10	12.5	163	15.5	0.725	0.0104	0.0166
3	498.83	81	20	3.9	54.1	19.0	0.677	0.012	0.0131
4	498.83	81	20-D	4.0	50.1	19.5	0.678	0.0107	0.0135
5	488.83	91	30	4.8	U	0.123	0.693	0.0086	0.0083
6	478.83	101	40	3.1	U	2.640	0.973	0.0429	0.0247

TABLE 3
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13344

Easting '83: 1348415.924
Northing '83: 481444.449
Reference Elevation: 582.623 feet amsl
Depth to Water Table: 66 feet bgs (516.623 feet amsl)
Work Completed: September 21, 2005

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	513.623	69	3	1.3	U	U	0.656	0.0061	0.0048
2	506.623	76	10	12.7	U	U	0.943	0.0063	0.003
3	496.623	86	20	5.5	U	U	0.672	0.0053	0.0046
4	496.623	86	20-D	5.5	U	U	0.679	0.0052	0.0045
5	486.623	96	30	5.1	U	U	0.508	0.0224	0.0108
6	476.623	106	40	< 1	U	U	0.206	0.015	0.0068
7	466.623	116	50	< 1	U	U	0.21	0.0087	0.0062
8	456.623	126	60	6.5	U	U	2.320	0.0229	0.0232

TABLE 4
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13345

Easting '83: 1348673.041
Northing '83: 481434.184
Reference Elevation: 583.95 feet amsl
Depth to Water Table: 67 feet bgs (feet amsl)
Work Completed: October 13, 2005

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	515.95	68	1	<1	U	0.0445	0.305	0.0065	0.0058
2	506.95	77	10	2.1	U	U	0.481	0.0073	0.0067
3	496.95	87	20	< 1	4.17	U	0.269	0.007	0.0067
4	496.95	87	20-D	< 1	3.26	U	0.265	0.0055	0.0068
5	486.95	97	30	< 1	3.34	U	0.252	0.0081	0.0092
6	476.95	107	40	< 1	2.88	0.812	0.203	0.0081	0.0072
7	466.95	117	50	< 1	3.56	0.132	0.216	0.0095	0.0093
8	456.95	127	60	< 1	5.10	0.109	0.685	0.0078	0.0105

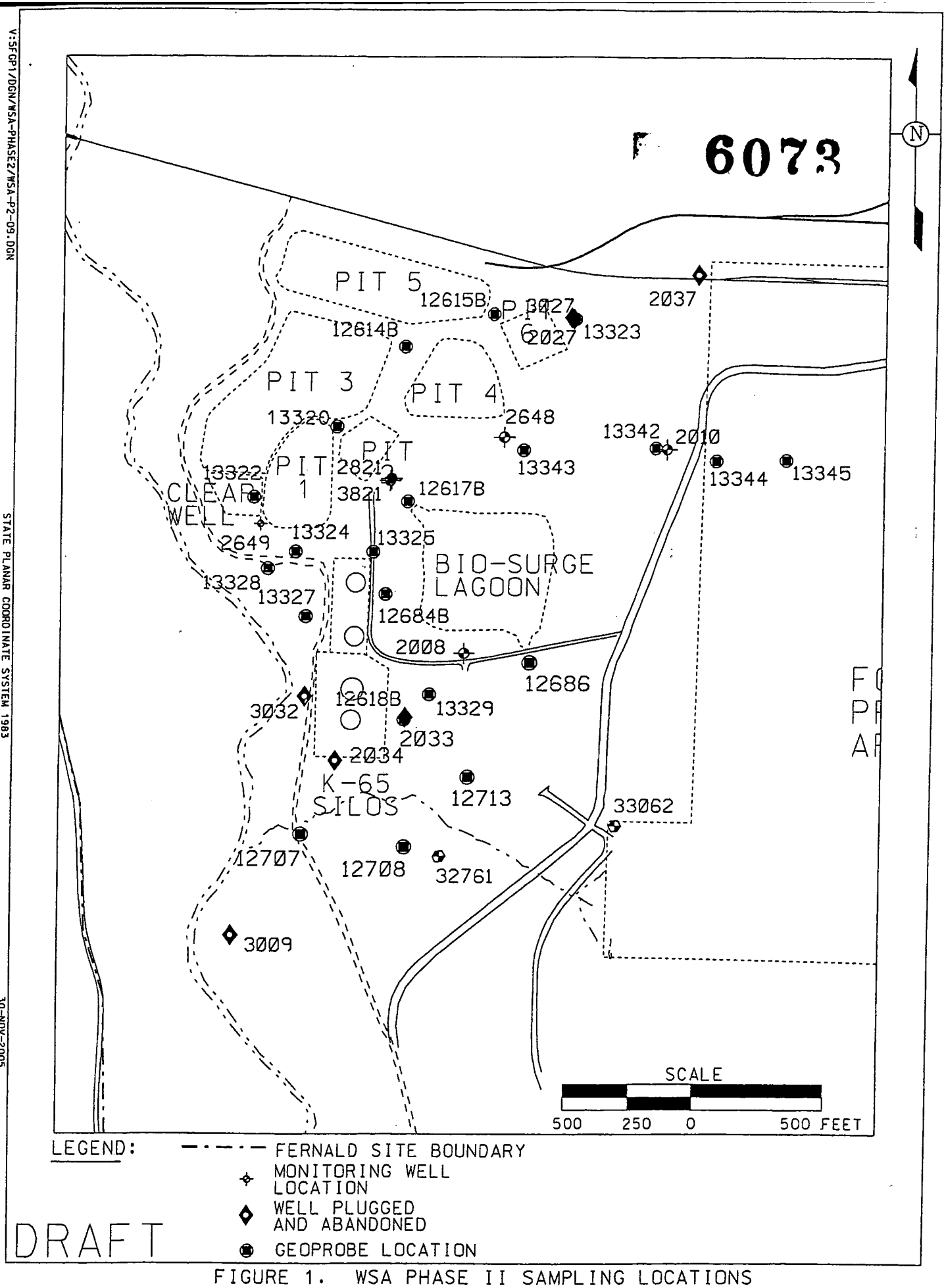

FIGURE 1. WSA PHASE II SAMPLING LOCATIONS

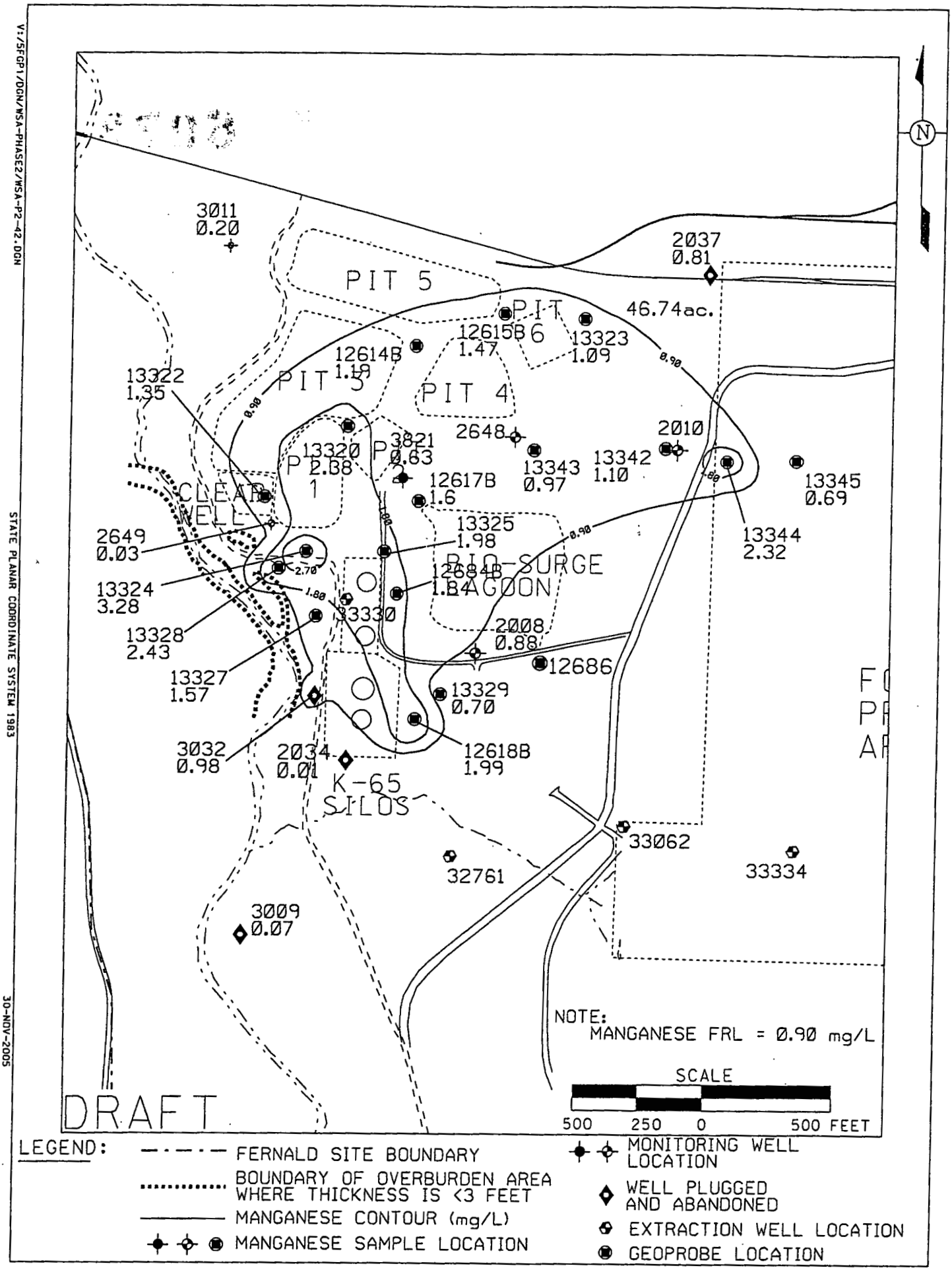

FIGURE 2. MAXIMUM MANGANESE PLUME IN THE WASTE STORAGE AREA

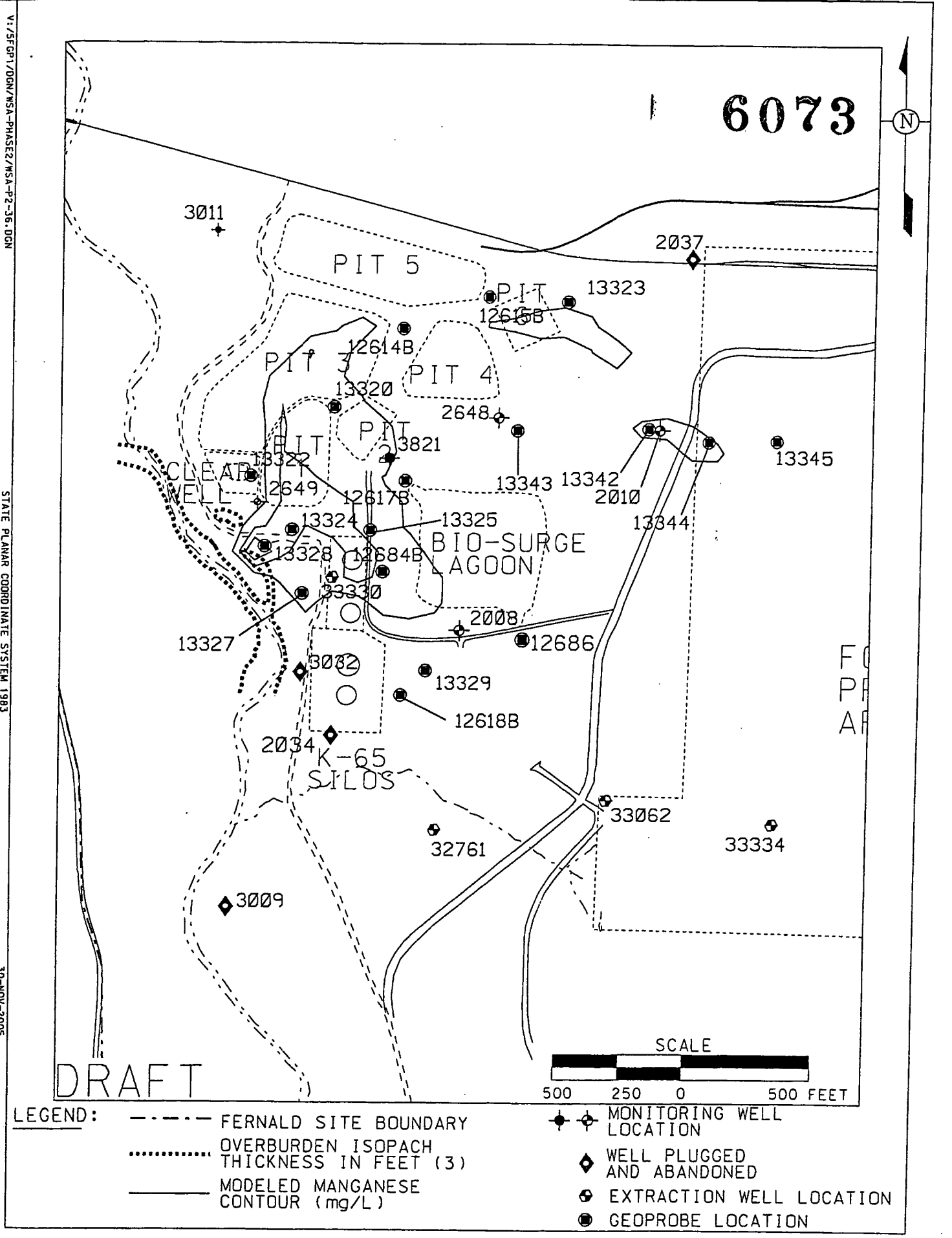

FIGURE 3. LAYER 12 INITIAL CONDITIONS

V:/SFGP1/DGN/WSA-PHASE2/WSA-P2-36.DGN

STATE PLANAR COORDINATE SYSTEM 1983

30-NOV-2005

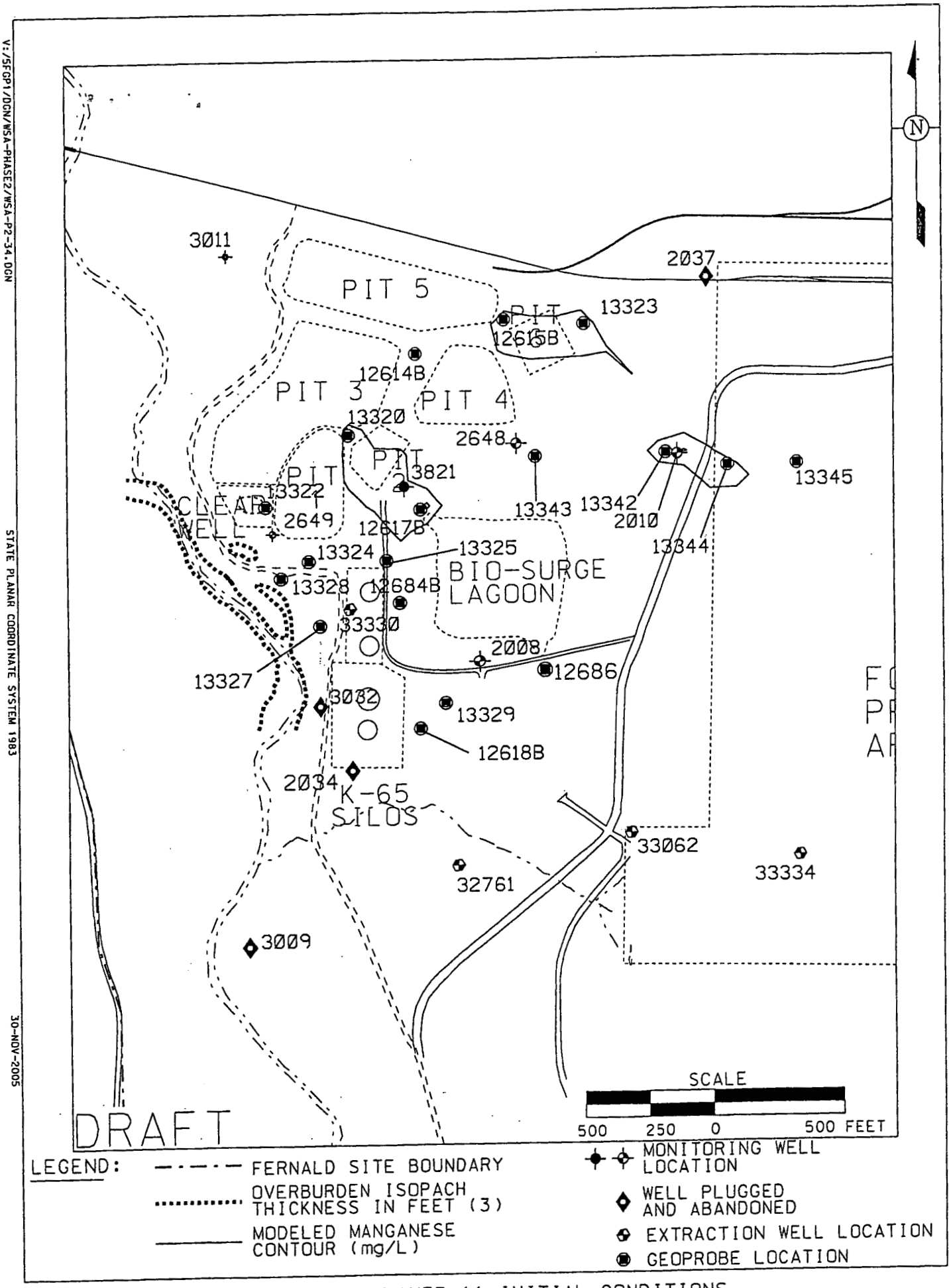

FIGURE 4. LAYER 11 INITIAL CONDITIONS

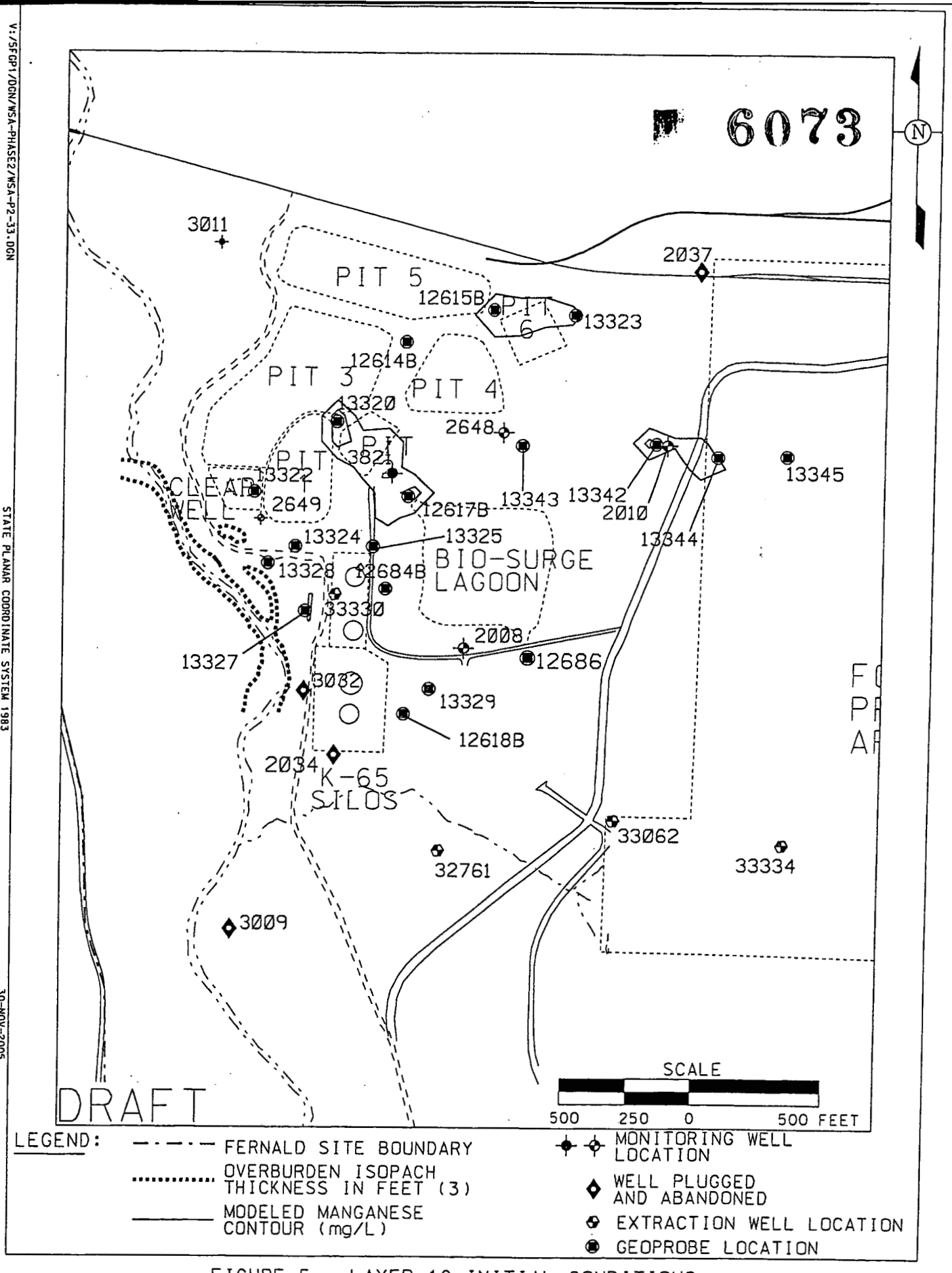

FIGURE 5. LAYER 10 INITIAL CONDITIONS

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STATE PLANAR COORDINATE SYSTEM 1983

30-NOV-2005

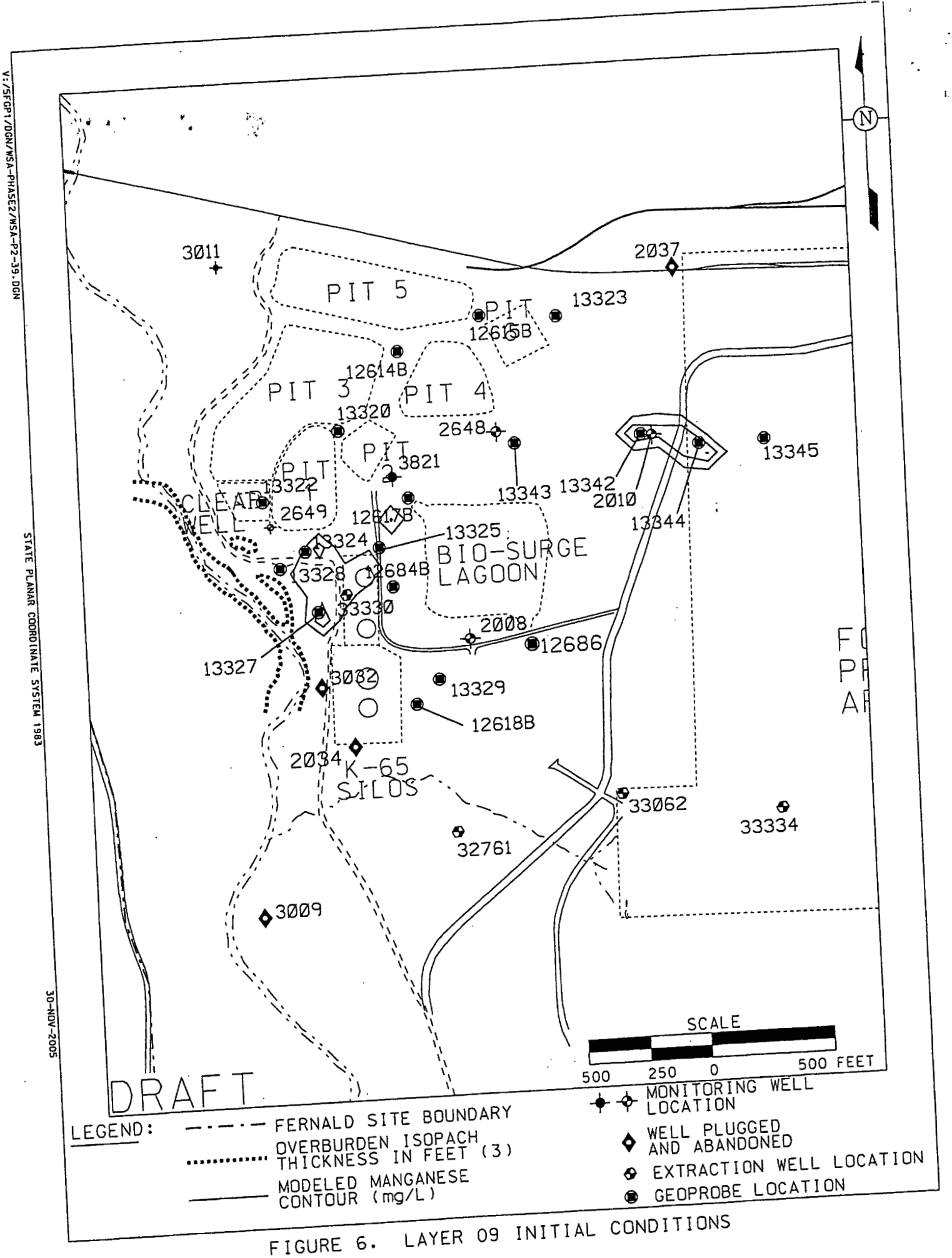

FIGURE 6. LAYER 09 INITIAL CONDITIONS

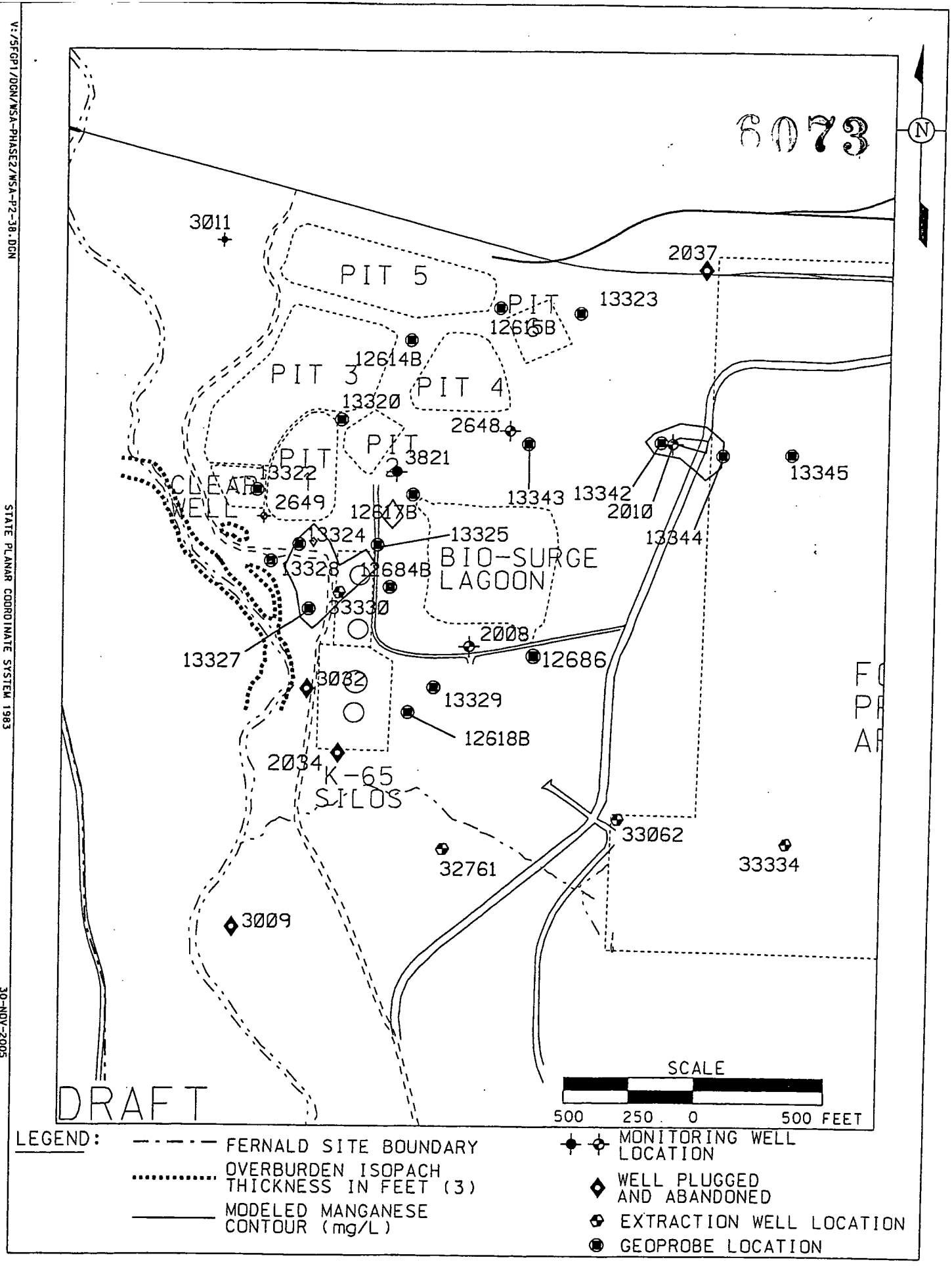

FIGURE 7. LAYER 08 INITIAL CONDITIONS

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STATE PLANAR COORDINATE SYSTEM 1983

30-NOV-2005

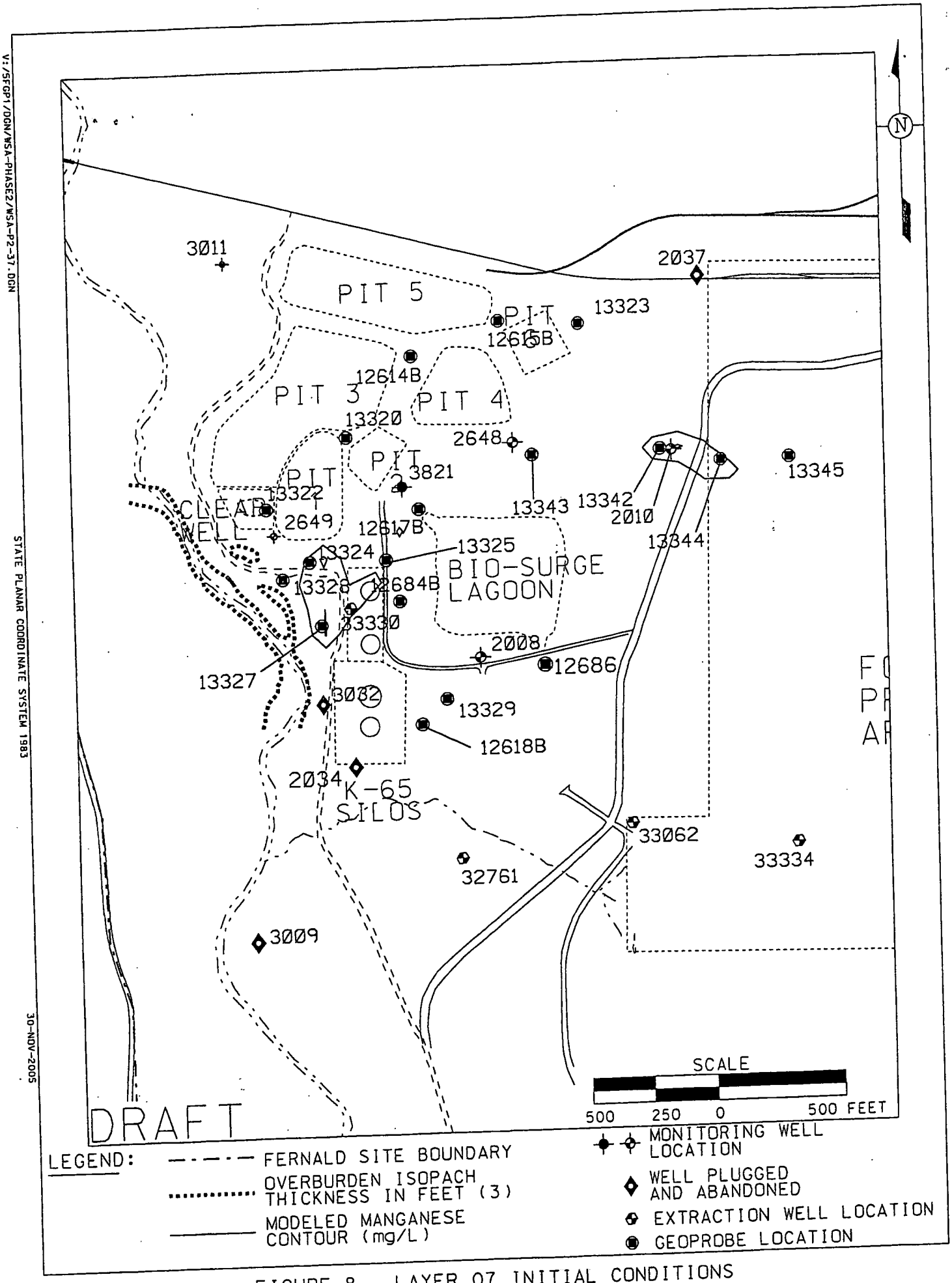

FIGURE 8. LAYER 07 INITIAL CONDITIONS

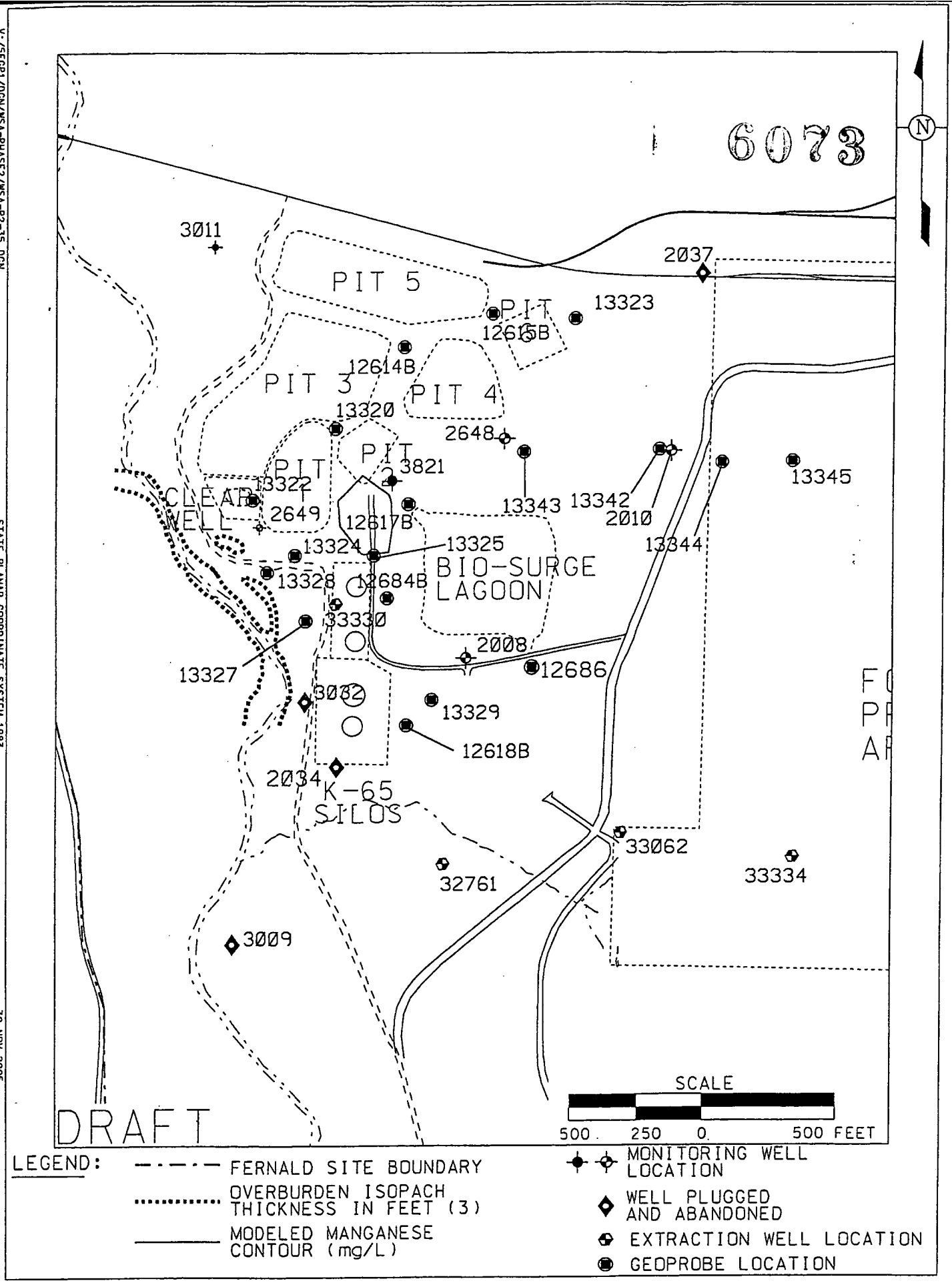

FIGURE 9. LAYER 12 MODEL CONDITIONS AT 4-1-2007

V:/SFGP1/DGN/WSA-PHASE2/WSA-P2-35.DGN STATE PLANAR COORDINATE SYSTEM 1983 30-NOV-2005

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This addendum addresses a recommendation made in the Waste Storage Area (Phase II) Design Report to conduct additional direct-push sampling between Monitoring Well 2648 and Monitoring Well 2010 to determine if the high manganese concentrations measured in those wells are a result of bio-fouling. This addendum also addresses comments received from the U.S. EPA and Ohio EPA on the Waste Storage Area (Phase II) Design Report concerning; manganese speciation, Kd values, and modeling results for remediation of the manganese plume.

2.0 MANGANESE SPECIATION AND COMPILED KD VALUES

The geochemical code EQ3NR was used to calculate the manganese speciation in groundwater collected from Direct Push Location 13342 (Mn = 1.1 mg/L, September 2005). Results are as follows: Mn^{2+} 84.6%, $MnCO_3$ (aq) 9.65%, $MnSO_4$ (aq) 3.07%, and $MnHCO_3^+$ 2.64%. The manganese (II) ion is very mobile in carbonate groundwater, because Ca^{2+} ions compete for sorption sites on the sediment (Merdy, et al. 2002). Moreover, manganese will not be removed from the aquifer by precipitation of MnO_2, due to oxidation of manganese (II) to manganese (IV). Based on the observed concentrations for Mn (II) in the GMA, redox conditions in the Great Miami Aquifer are below 500 millivolts (mV) at the near-neutral pH. As MnO_2 has a very low solubility product, the observed concentrations for Mn (II)

would not be possible if redox conditions were above 500 mV. The long-term stability of the carbonate geochemical system is ensured by the large percentage of carbonate minerals (calcite + dolomite >50%) in the aquifer sediments.

Partition coefficients for manganese, molybdenum, nickel, nitrate, carbon disulfide and trichloroethylene, are as follows:

COMPILED K_d VALUES

Specie	K_d (L/kg)	Carbonate System	Reference
Mn^{2+}	0.4 to 1.3	Yes	Bryan, et al. 2004
MoO_4^{2-}	0.2 to 1.0	No, but pH = 7	Goldberg, et al. 2002
Ni^{2+}	48 to 368	Yes	Cantrell, et al. 2003
NO_3^-	0.65 to 1.1	Yes	Mikolajkow 2003
Carbon disulfide	0.46 to 0.54	NA*	ADEC 2004
			NYSDEC 2005
Trichloroethylene	0.87 to 1.5	NA*	U.S. EPA 2005

*Not applicable, as sorption of organic compounds is dependent on organic carbon in the sediment. K_d calculated ($K_d = K_{oc}*f_{oc}$) from reported water/organic-carbon partition coefficient (K_{oc}), assuming fraction of organic carbon (f_{oc}) is 0.01 in the Great Miami Aquifer.

The Kd values reflect aqueous conditions similar to those in the Great Miami Aquifer (i.e., carbonate groundwater at near neutral pH), with the exception of carbon disulfide and trichloroethylene. Adsorption of organic constituents is primarily a function of the fraction of organic carbon in the sediment.

Sorption studies by Sandia National Laboratory (Bryan, et al. 2004), using Great Miami Aquifer sediment and groundwater, indicate that Mn Kd values range from 0.4 to 1.3 L/kg. Although the Sandia National Laboratory sorption studies focused on uranium and did not report results for manganese, manganese Kd values can be extracted from the data because major and minor cations were tracked along with the uranium concentrations.

Excluding nickel, the Kd values are all less than the Kd value used to model uranium (3.0 L/Kg). This indicates that the contaminants will be captured during the remediation of the uranium plume. For nickel, Kd values are much greater than uranium, and persistent contamination is possible as nickel slowly desorbs from the sediment. However, nickel contamination is limited to a single location and it may not persist at Well 2649, because it is located within 500 feet of active recharge along Paddys Run. Nickel will be monitored at Well 2649 during remediation of the uranium plume, and further action may be warranted if the nickel contamination persists.

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3.0 DIRECT-PUSH SAMPLING RESULTS

Direct-push sampling was conducted at four additional locations (13342, 13343, 13344, and 13345). Locations are illustrated in Figure 1. Location 13342 is next to Monitoring Well 2010. Location 13343 is next to Monitoring Well 2648. Locations 13344 and 13345 were selected to determine where the eastern edge of the manganese plume is located.

Each location was sampled for the following list of constituents: uranium, technetium-99, nitrate/nitrite, manganese, molybdenum, and nickel. Preliminary sampling results are provided in Tables 1 through 4. Final remediation level (FRL) exceedances are shaded in the tables. There were no new FRL exceedances measured for uranium, so the uranium plume map from the Waste Storage Area Phase II Report was not revised. FRL exceedances were measured for technetium-99, nitrate/nitrite, and manganese. These exceedances are discussed below.

3.1 Technetium-99

The groundwater FRL for technetium-99 is 94 picoCuries per liter (pCi/L). An FRL exceedance for technetium-99 was measured at Location 13343 (163 pCi/L, at a depth of 10 feet below the water table). Sampling results for Location 13343 are provided in Table 2. This location is right next to Monitoring Well 2648. Exceedances for technetium-99 have been measured at Monitoring Well 2648 in the past. The last groundwater FRL exceedance for technetium-99 at Monitoring Well 2648 was 111 pCi/L (January 13, 2003). Monitoring Well 2648 is within the footprint of the uranium plume that is being targeted for remediation.

3.2 Nitrate/Nitrite

The groundwater FRL for nitrate/nitrite is 11 mg/L. FRL exceedances for nitrate/nitrite were measured at Location 13343 (15.5 mg/L, 19.0 mg/L, and 19.5 mg/L) at depths of 10 and 20 feet below the water table. Sampling results for Location 13343 are provided in Table 2. This location is right next to Monitoring Well 2648. Monitoring Well 2648 is within the footprint of the uranium plume that is being targeted for remediation.

3.3 Manganese

The groundwater FRL for manganese is 0.90 mg/L. FRL exceedances for manganese were measured at Locations 13342, 13343, and 13344. However, the FRL exceedances measured in these new locations were considerably lower than the exceedances measured in Monitoring Wells 2648 and 2010. No FRL exceedances for manganese were measured at Location 13345. Location 13345 bounds the eastern extent of the manganese plume. A new maximum manganese plume map for the Waste Storage Area is provided in Figure 2.

Results for Location 13342 are presented in Table 1. Location 13342 is next to Monitoring Well 2010. One FRL exceedance for manganese (1.10 mg/L) was measured at 60 feet below the water able. This concentration is considerably lower than the manganese concentration reported for Monitoring Well 2010 (6.14 mg/L) in the Waste Storage Area (Phase II) Design Report. Monitoring Well 2010 is screened at the water table. No FRL exceedance was detected at Location 13342 within 50 feet of the water able. The difference in measured concentrations between Monitoring Well 2010 and Location 13342 implies that bio-fouling is occurring at Monitoring Well 2010 and concentrating manganese around the well screen.

Results from direct-push Location 13343 are presented in Table 2. Location 13343 is next to Monitoring Well 2648. One FRL exceedance for manganese (0.973 mg/L) was measured at 40 feet below the water table. This concentration is considerably lower than the manganese concentration reported for Monitoring Well 2648 (4.08 mg/L) in the Waste Storage Area (Phase II) Design Report. Monitoring Well 2648 is screened at the water table. No FRL exceedance was detected at Location 13343 within 30 feet of the water table. Again, the difference in concentrations between Monitoring Well 2648 and Location 13343 implies that bio-fouling is occurring at Monitoring Well 2648 and concentrating manganese around the well screen.

Results from direct-push Location 13344 are presented in Table 3. Location 13344 is east of Monitoring Well 2010. Two FRL exceedances for manganese were measured at Location 13344 (0.943 mg/L at 10 feet below the water table and 2.320 mg/L at 60 feet below the water table.

Three of the four FRL exceedances for manganese measured at the four new sampling locations occur at the deepest sampled depth interval. This could be due to naturally occurring geologic conditions in the aquifer, as there does not appear to be any exceedances occurring at the water table or just beneath the water able, which would be expected if the plume were sourced from one of the former waste pits. Regardless of the cause, the deep exceedances were considered in producing a new maximum manganese plume map for the Waste Storage Area. The new map is shown in Figure 2. The main difference between this new manganese map and the map presented in the Waste Storage Area (Phase II) Design Report is that the higher concentrations, for the most part, are situated near the silos area in the new map. The higher manganese concentrations are located in an area that will be strongly influenced by the new extraction well being installed in the silos area.

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4.0 NEW MODELING FOR MANGANESE REMEDIATION

The groundwater model was used to predict how well the Waste Storage Area (Phase II) Design would remediate the newly characterized manganese plume, using a Kd value of 1.3 L/kg instead of the 10 L/kg value previously used.

4.1 Modeled Target Pumping Rates

Target pumping rates remained at the rates defined in Table 3-1 of the Waste Storage Area (Phase II) Design Report. The target pumping rates range from 100 gallons per minute (gpm) to 500 gpm. The additional extraction well modeled in the WSA near the silos is identified in Table 3-1 as WSA-5. It has a target-pumping rate of 300 gpm. This pumping rate was selected because it provided a clean-up end date for the uranium plume that is consistent with the WSA Phase I module, as shown in Figure 3-18 of the WSA Phase II Design Report. Because the modeled prediction for cleanup of the uranium plume was deemed satisfactory using these pumping rates, additional modeling runs with different pumping rates were not conducted for the Phase II Design.

4.2 Transport Modeling Assumptions for Manganese

Initial conditions for manganese were developed from hand-drawn contours of concentration data collected in the Waste Storage Area. Hand-drawn contours of manganese concentrations were digitized, and then converted by hand into model grid node values for each effected model layer. Initial conditions for manganese in model layers 12, 11, 10, 9, 8, and 7 are shown in Figures 3 through 8, respectively. No manganese source terms were used for the model runs because all of the source terms in the WSA have been removed, or are in the process of being removed.

4.3 Transport Modeling Results for Manganese

Modeled manganese concentrations in Layer 12 for the year 2007 are shown in Figure 9. These modeling results support that the manganese plume will be remediated given the current well field design that consists of one additional extraction well in the silos area.

5.0 CONCLUSIONS

- Manganese concentrations measured at direct-push sampling locations next to Monitoring Wells 2648 and 2010 were considerably lower than the concentrations last measured at Monitoring Wells 2648 and 2010. This implies that bio-fouling is occurring around the well screens in the monitoring wells and concentrating manganese there.

- The footprint of the newly mapped manganese plume is larger than the uranium plume being targeted for remediation, but the manganese concentrations are not as high as previously mapped.

- The highest manganese concentrations are situated near the silos area not near Monitoring Wells 2648 and 2010.

- Sorption studies by Sandia National Laboratory indicate that the manganese Kd ranges from 0.4 to 1.3 L/kg. Much lower than the Kd of 10 L/Kg used to model manganese cleanup for the Waste Storage Area (Phase II) Design Report.

- Modeling cleanup of the new manganese plume interpretation, at a Kd of 1.3 L/kg, indicates that below-FRL concentrations for manganese will be achieved in 2007.

- The Waste Storage Area (Phase II) Design is sufficient to remediate the manganese plume in the Waste Storage Area.

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TABLE 1
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13342

Easting '83: 1348178
Northing '83: 481495.2
Reference Elevation: 579.375 feet amsl
Depth to Water Table: 61 feet bgs (518.375 feet amsl)
Work Completed: September 8, 2005

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	514.375	65	4	3.3	U	0.179	0.855	0.0107	0.0103
2	510.375	69	8	13.1	U	0.0974	0.781	0.0088	0.0093
3	498.375	81	20	17.2	U	2.59	0.856	0.0094	0.0098
4	498.375	81	20-D	15.5	U	3.2	0.897	0.0126	0.0147
5	488.375	91	30	19.7	U	3.26	0.73	0.0095	0.0085
6	478.375	101	40	5.0	26.7	0.0657	0.233	0.0138	0.0123
7	468.375	111	50	< 1	24.4	0.0402	0.479	0.0156	0.0151
8	458.375	121	60	1.8	U	0.0875	1.100	0.0216	0.0248

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TABLE 2
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13343

Easting '83: 1347668
Northing '83: 481487.2
Reference Elevation: 579.83 feet amsl
Depth to Water Table: 61 feet bgs (518.83 feet amsl)
Work Completed: September 1

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	517.83	62	1	8.9	U	U	0.889	0.0114	0.0146
2	508.83	71	10	12.5	163	15.5	0.725	0.0104	0.0166
3	498.83	81	20	3.9	54.1	19.0	0.677	0.012	0.0131
4	498.83	81	20-D	4.0	50.1	19.5	0.678	0.0107	0.0135
5	488.83	91	30	4.8	U	0.123	0.693	0.0086	0.0083
6	478.83	101	40	3.1	U	2.640	0.973	0.0429	0.0247

TABLE 3
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13344

Easting '83: 1348415.924
Northing '83: 481444.449
Reference Elevation: 582.623 feet amsl
Depth to Water Table: 66 feet bgs (516.623 feet amsl)
Work Completed: September 21, 2005

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	513.623	69	3	1.3	U	U	0.656	0.0061	0.0048
2	506.623	76	10	12.7	U	U	0.943	0.0063	0.003
3	496.623	86	20	5.5	U	U	0.672	0.0053	0.0046
4	496.623	86	20-D	5.5	U	U	0.679	0.0052	0.0045
5	486.623	96	30	5.1	U	U	0.508	0.0224	0.0108
6	476.623	106	40	< 1	U	U	0.206	0.015	0.0068
7	466.623	116	50	< 1	U	U	0.21	0.0087	0.0062
8	456.623	126	60	6.5	U	U	2.320	0.0229	0.0232

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TABLE 4
PRELIMINARY SAMPLING RESULTS FROM DIRECT-PUSH LOCATION 13345

Easting '83: 1348673.041
Northing '83: 481434.184
Reference Elevation: 583.95 feet amsl
Depth to Water Table: 67 feet bgs (feet amsl)
Work Completed: October 13, 2005

Sample Point	Elevation (ft amsl)	Depth (ft, bgs)	Depth (bwt)	Uranium (ug/L)	Tech-99 (pCi/L)	Nitrate/Nitrite (mgL)	Manganese (mgL)	Molybdenum (mgL)	Nickel (mgL)
1	515.95	68	1	<1	U	0.0445	0.305	0.0065	0.0058
2	506.95	77	10	2.1	U	U	0.481	0.0073	0.0067
3	496.95	87	20	< 1	4.17	U	0.269	0.007	0.0067
4	496.95	87	20-D	< 1	3.26	U	0.265	0.0055	0.0068
5	486.95	97	30	< 1	3.34	U	0.252	0.0081	0.0092
6	476.95	107	40	< 1	2.88	0.812	0.203	0.0081	0.0072
7	466.95	117	50	< 1	3.56	0.132	0.216	0.0095	0.0093
8	456.95	127	60	< 1	5.10	0.109	0.685	0.0078	0.0105

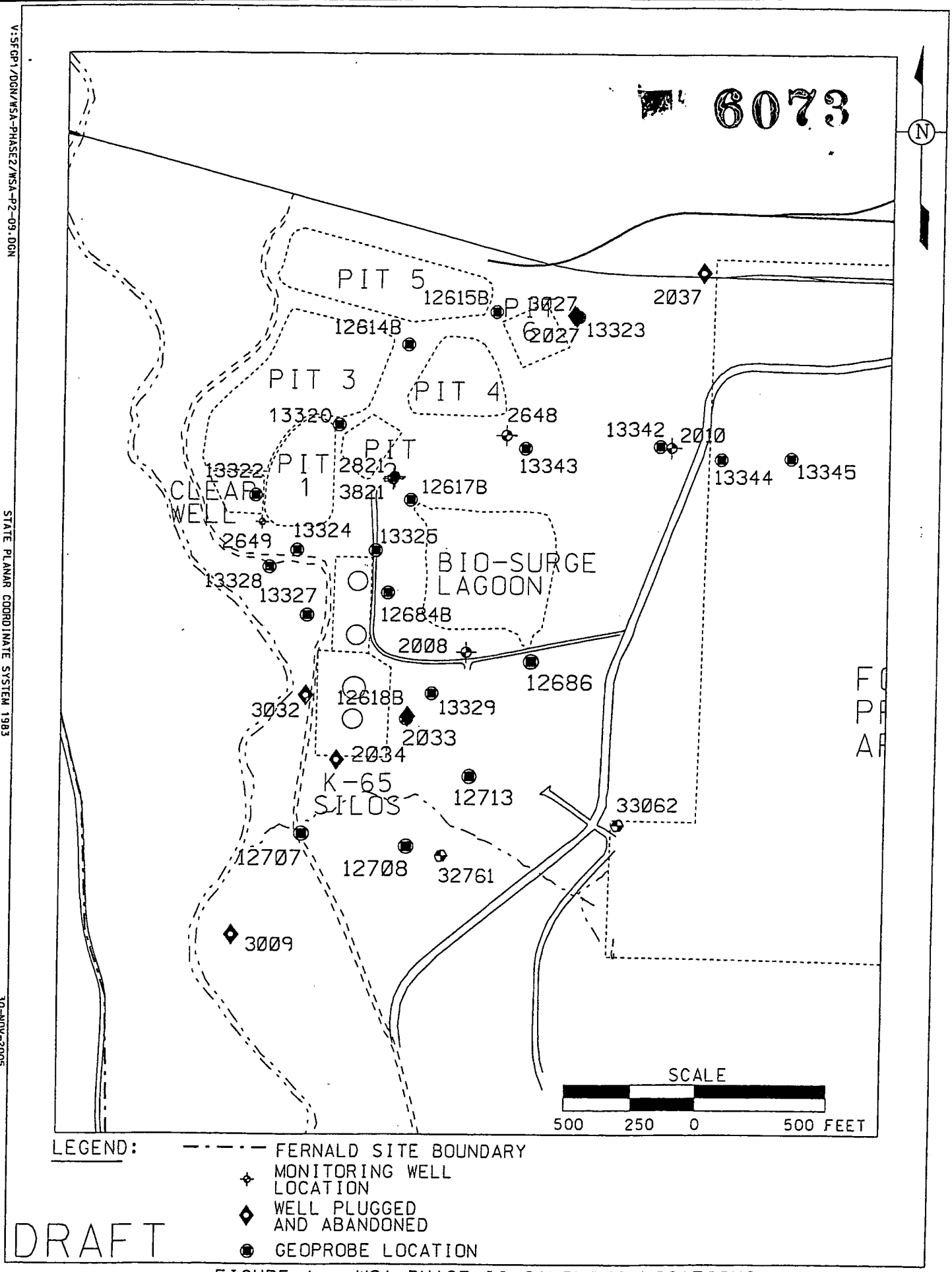

FIGURE 1. WSA PHASE II SAMPLING LOCATIONS

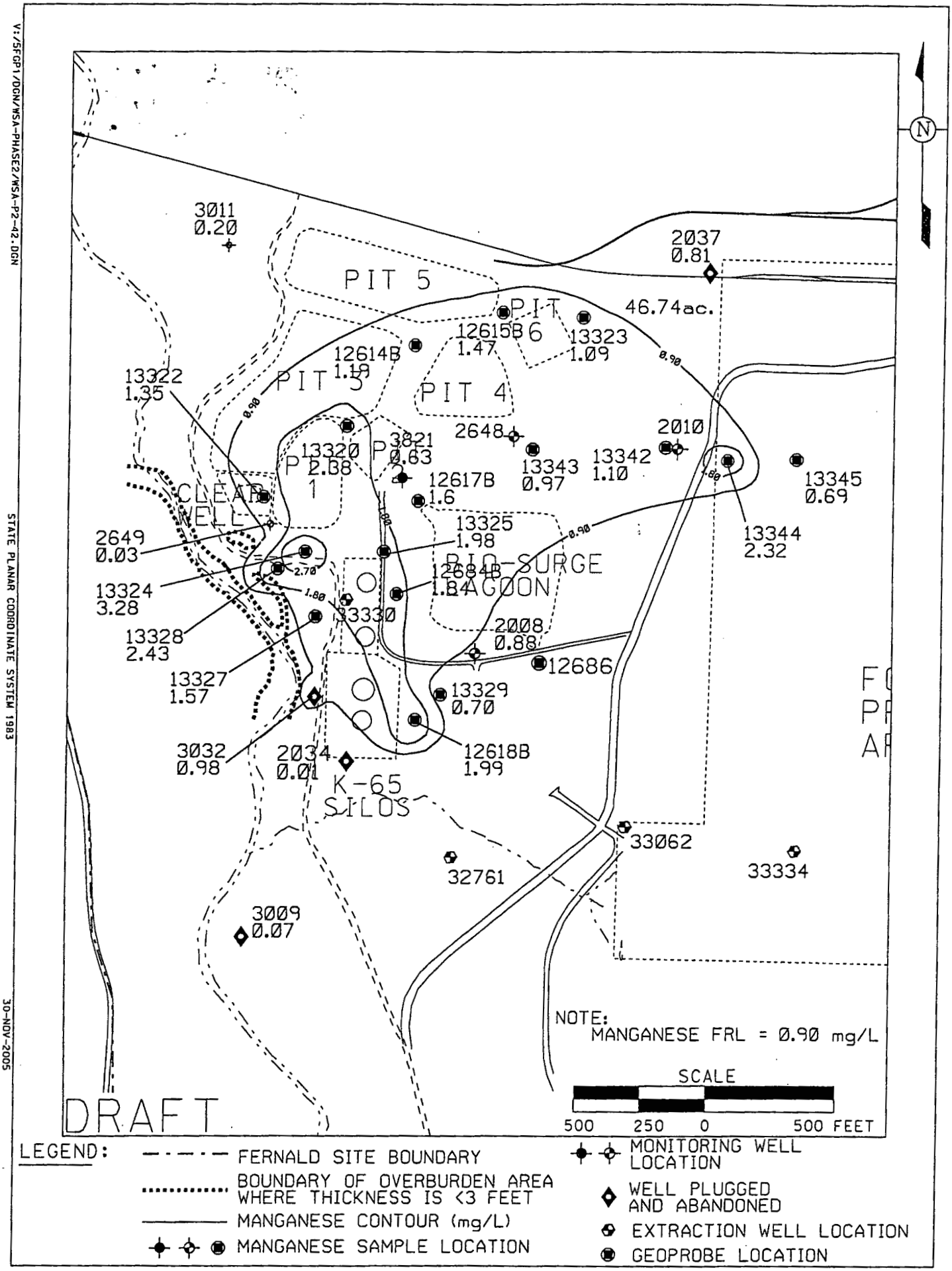

FIGURE 2. MAXIMUM MANGANESE PLUME IN THE WASTE STORAGE AREA

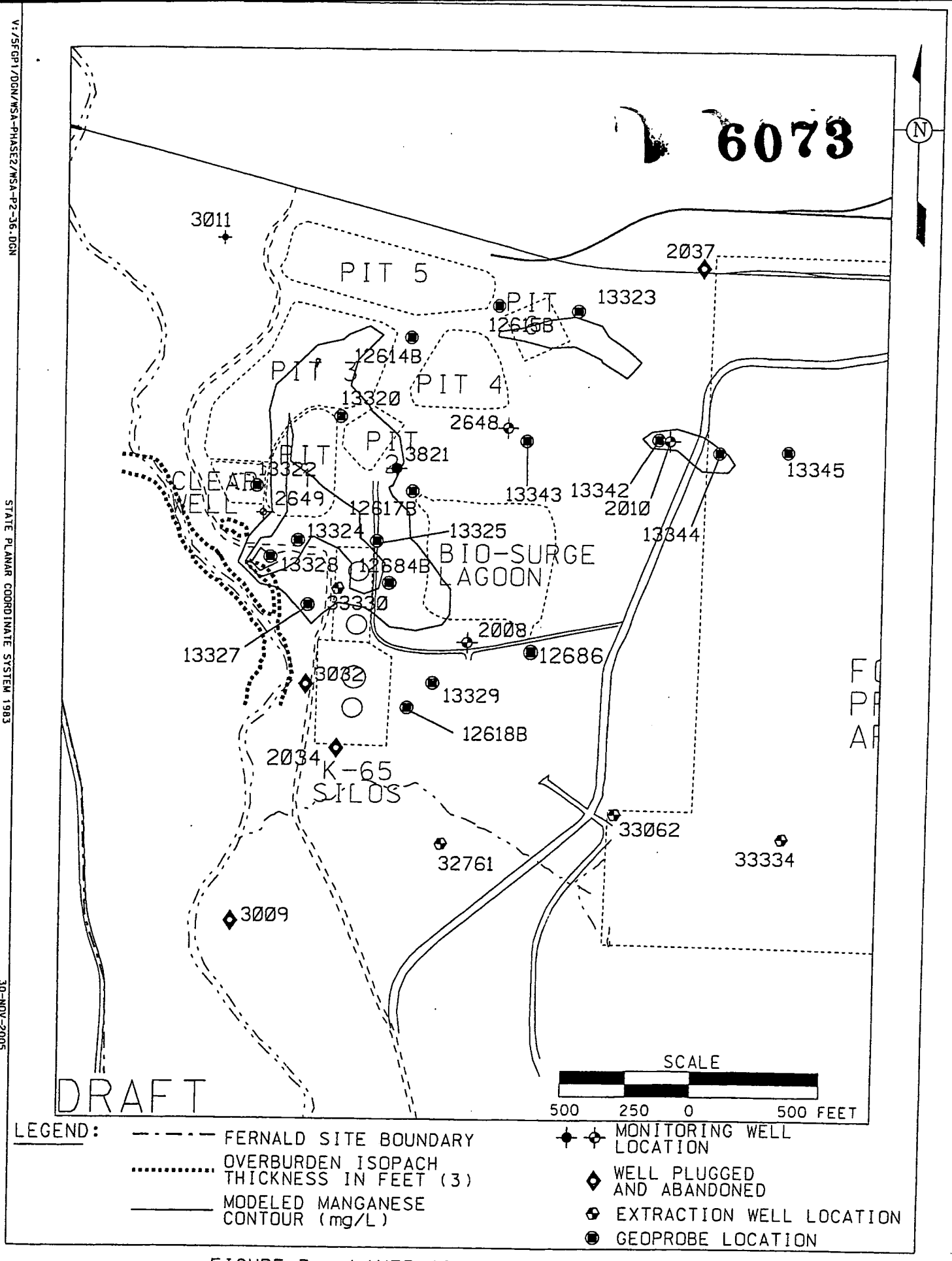

FIGURE 3. LAYER 12 INITIAL CONDITIONS

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STATE PLANAR COORDINATE SYSTEM 1983

30-NOV-2005

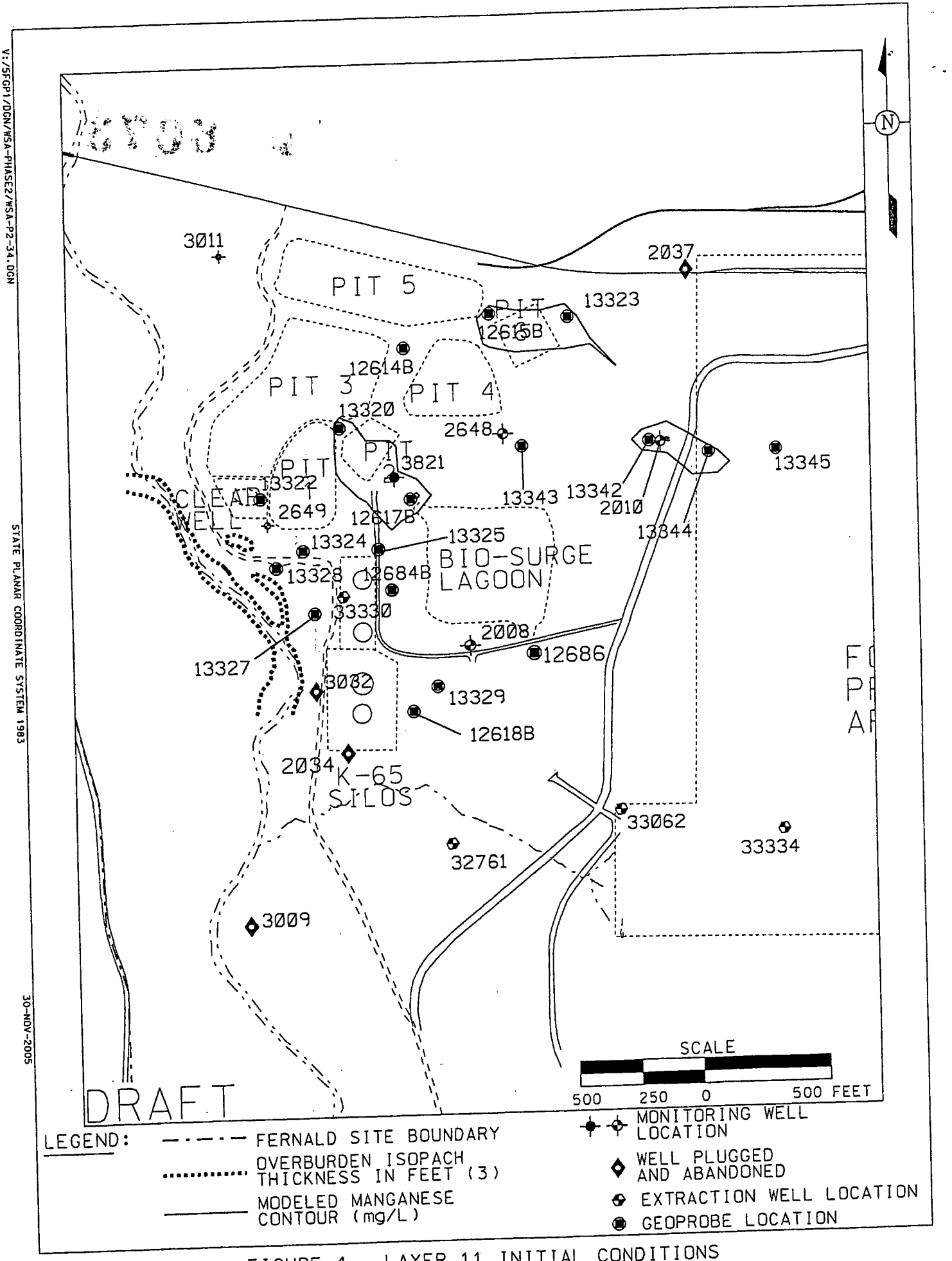

FIGURE 4. LAYER 11 INITIAL CONDITIONS

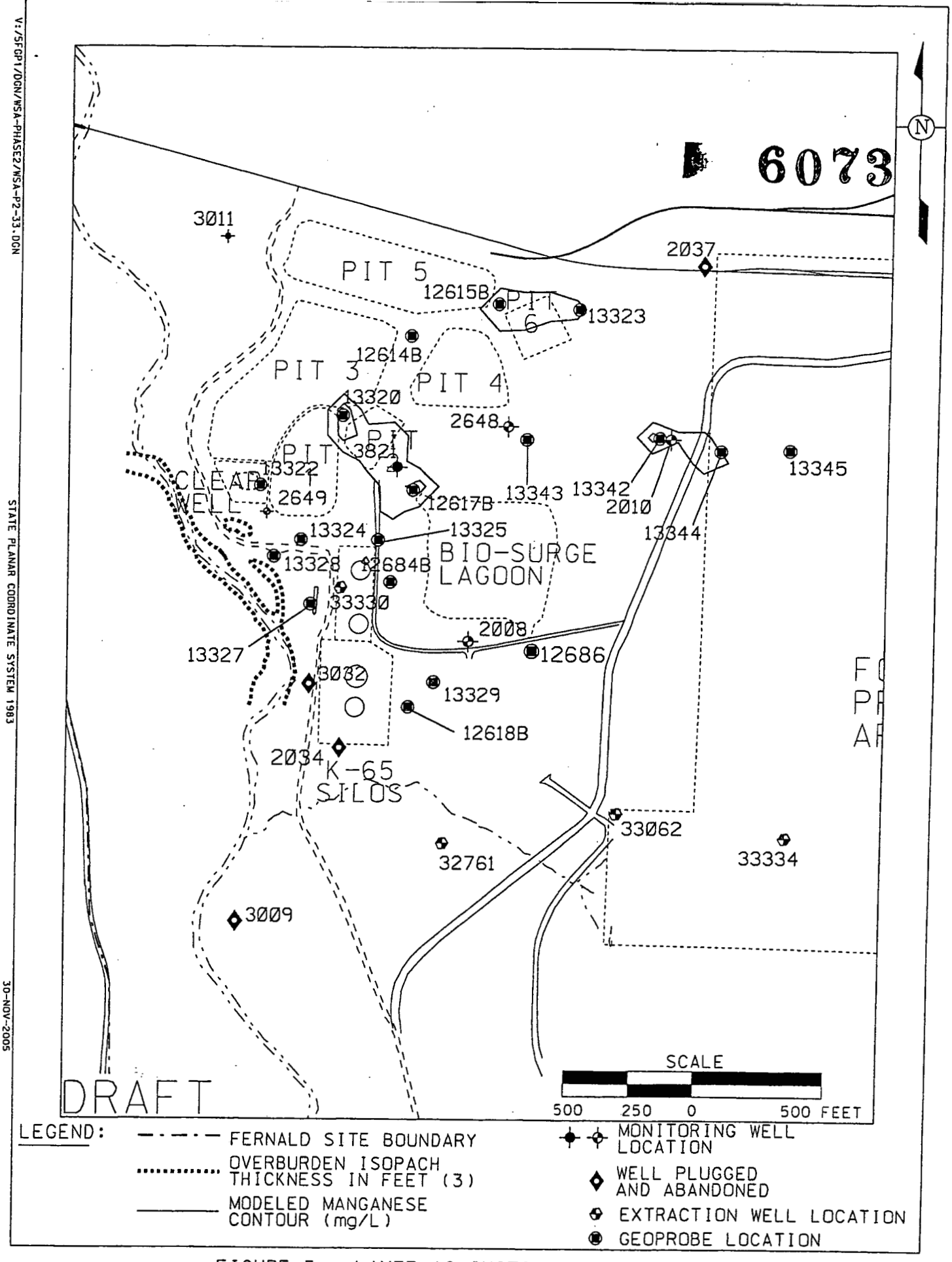

FIGURE 5. LAYER 10 INITIAL CONDITIONS

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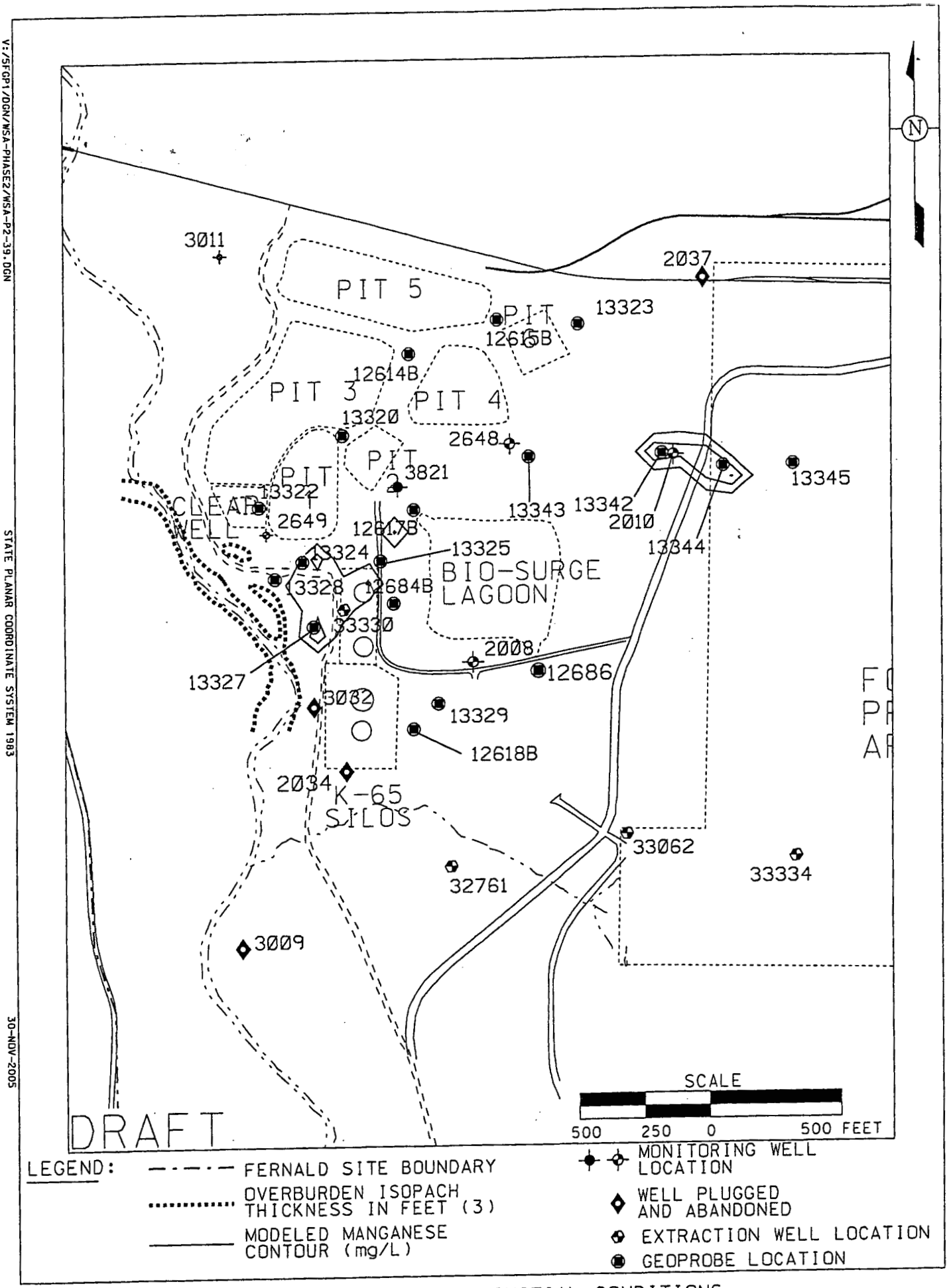

FIGURE 6. LAYER 09 INITIAL CONDITIONS

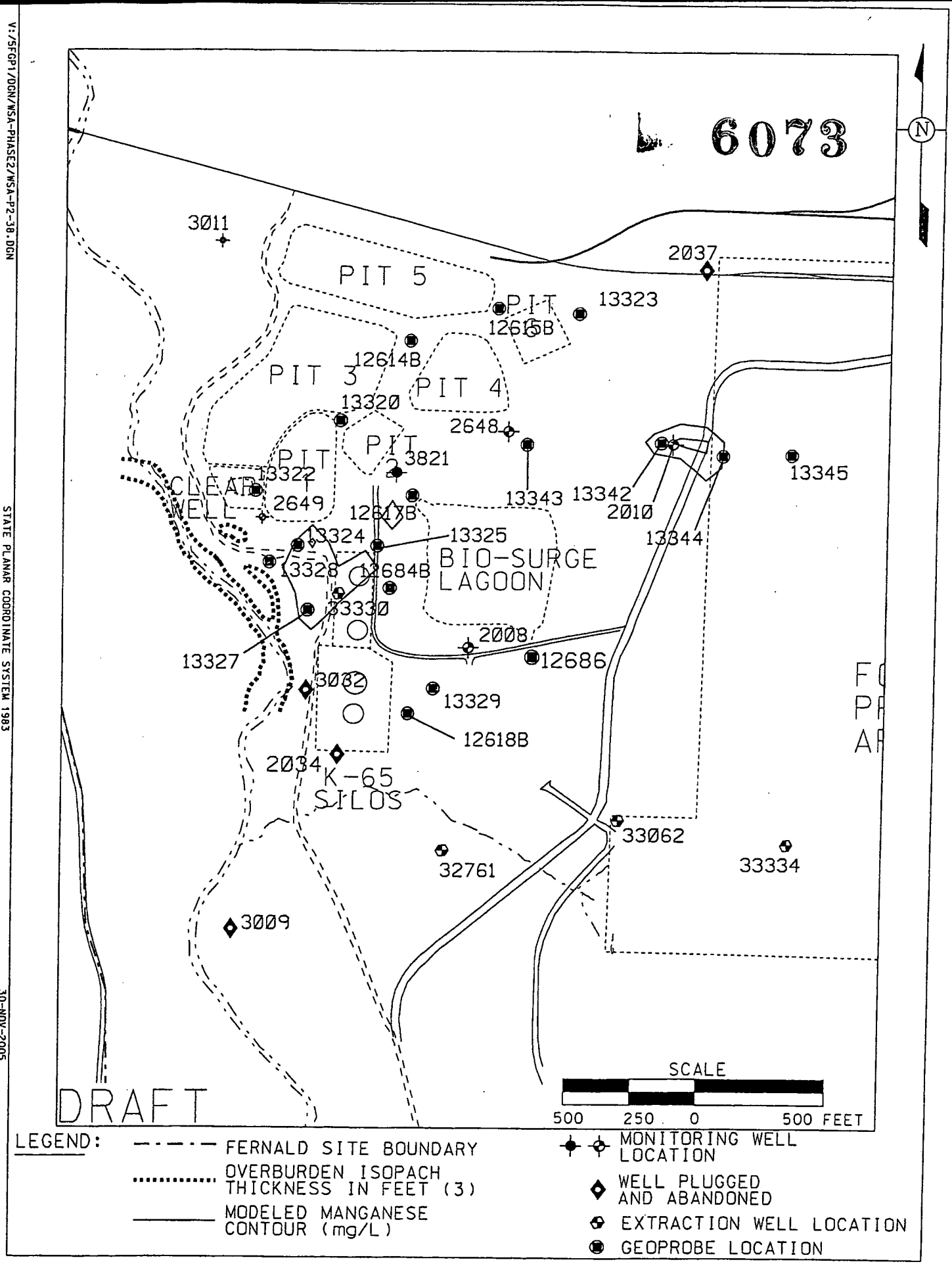

FIGURE 7. LAYER 08 INITIAL CONDITIONS

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30-NOV-2005

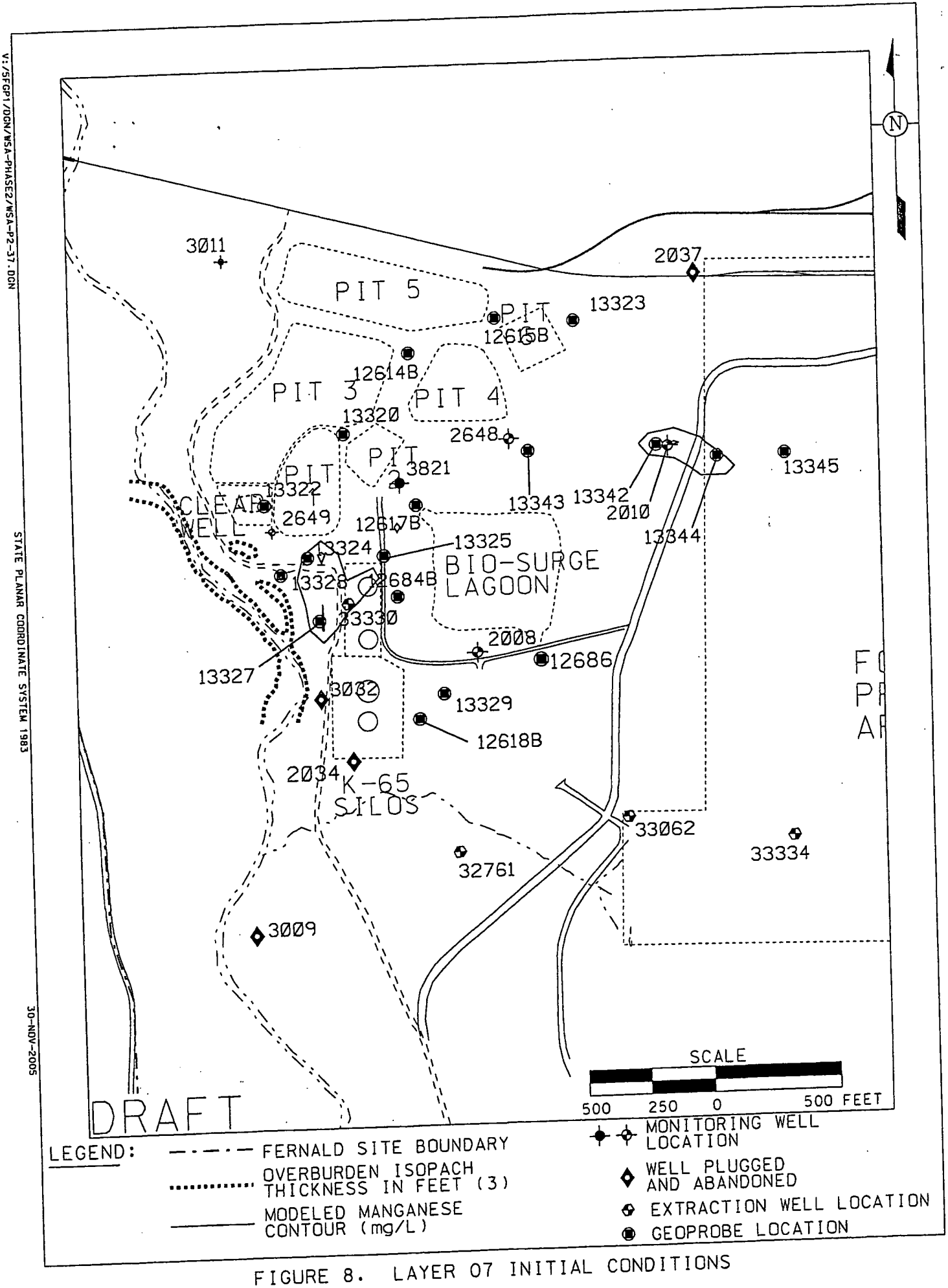

FIGURE 8. LAYER 07 INITIAL CONDITIONS

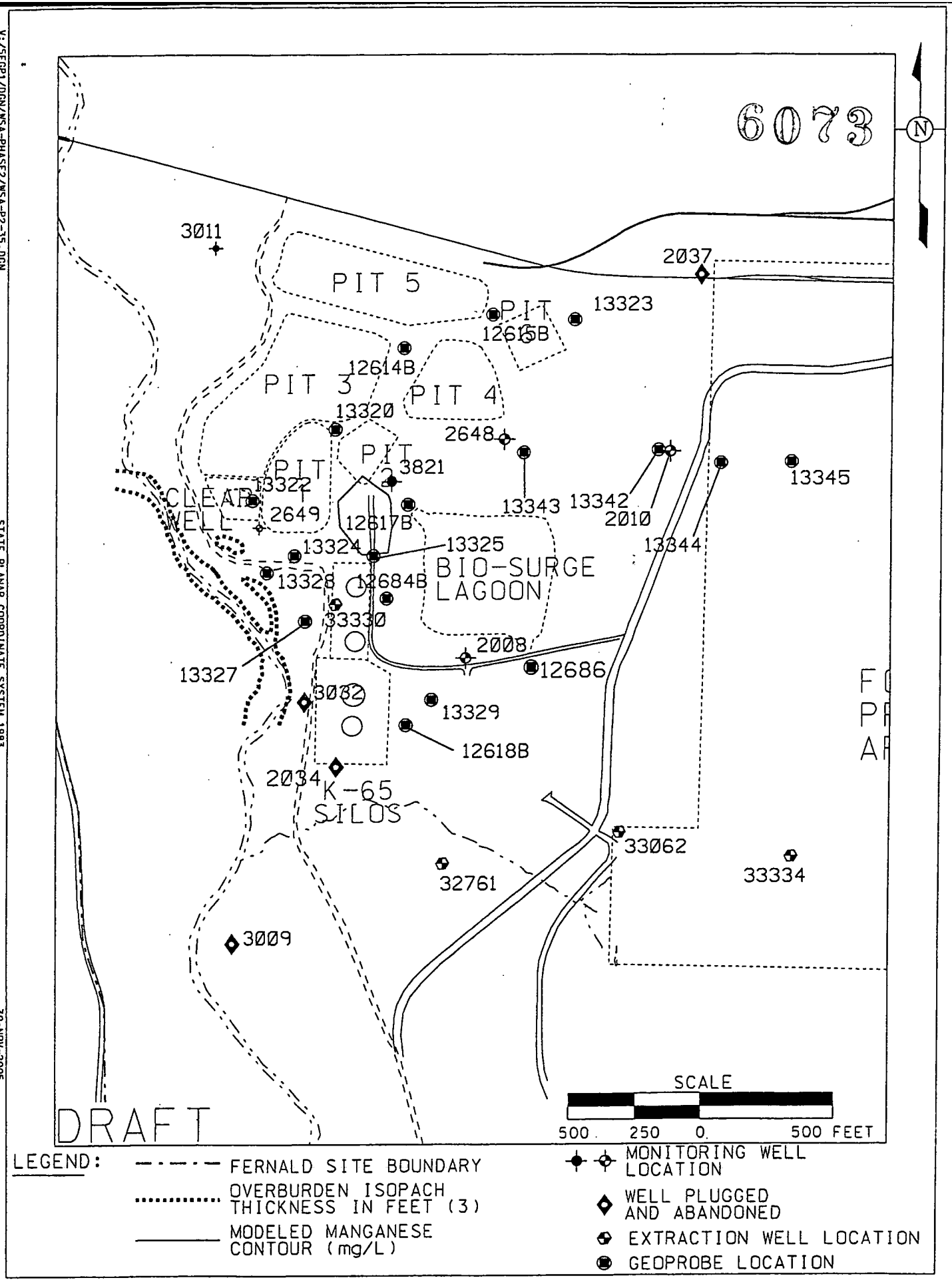

FIGURE 9. LAYER 12 MODEL CONDITIONS AT 4-1-2007

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STATE PLANAR COORDINATE SYSTEM 1983

30-NOV-2005