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REPORT
EVALUATION OF EXISTING CONDITIONS
WESTINGHOUSE PLANT, AREA A-9
BEAVER, PENNSYLVANIA

September 17, 1985

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REPORT
EVALUATION OF EXISTING CONDITIONS
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1.0 INTRODUCTION

Westinghouse Electric Corporation (Westinghouse) currently operates a manufacturing facility in Beaver, Pennsylvania which includes electroplating operations in a plant structure known as Area A-9. The electroplating operations utilize a series of dip tanks that contain a variety of chemicals in both acid and basic solutions. In the past, wastes from these tanks were conducted through a series of trenches, sumps, and pipes to staging tanks outside the A-9 area.

Approximately two years ago, Westinghouse personnel noticed a fluid seep near the outside storage tanks. The incident was reported to the Pennsylvania Department of Environmental Resources (DER) in a spill report dated October 27, 1983. This prompted a series of actions, including the drilling of sample borings, well installations, and a chemical analysis program. Also, during this interval, the old waste holding tanks were deactivated and old waste transfer piping was plugged or removed. The newly installed monitoring wells indicated the presence of both acid and basic chemicals, but were not adequate to define the extent of any plumes.

In May 1985, Westinghouse retained Paul C. Rizzo Associates (Rizzo Associates) to evaluate existing conditions. This report presents the results of the Rizzo Associates study.

As part of this study, water samples from existing wells were obtained and analyzed and a geophysical survey was conducted to achieve a better understanding of existing conditions. During the time frame of this study, the outside storage tanks were removed under the observation of

Rizzo Associates personnel. Soil samples were obtained from underneath the tanks and chemically analyzed in accordance with the Closure Plan submitted to the Pennsylvania Department of Environmental Resources (DER) on July 25, 1984 and modified by the letter to the DER on June 14, 1985.

Subsequent sections of this report present the general site conditions including a description of past and present plant operations and the chemicals involved (Section 2.0) and the subsurface conditions based on all existing and new information (Section 3.0). Conclusions summarizing existing conditions are presented in (Section 4.0).

2.0 GENERAL SITE CONDITIONS AND HISTORICAL BACKGROUND

The Westinghouse manufacturing facility in Beaver, Pennsylvania was originally operated by Curtis Wright during World War II as a plant for the manufacture of airplane propellers. In Area A-9, where electroplating operations are currently conducted, the building bay was used for access to railroad cars outside the actual plant structure. The construction of Area A-9 in 1953 involved placing a floor over approximately four feet of backfill and enclosing the area.

Area A-9 ~~currently~~ consists of a series of 21 tanks used for electroplating copper and aluminum bus bars with silver (Figure 1). The chemicals contained in each tank are listed in Table 1. ~~Presently, the~~ acid and cyanide rinsewaters from the operation ~~are~~ hard-piped separately to two receiving sumps which ~~are~~ then piped to ~~an~~ on-site wastewater treatment facility. Prior to August 1984, rinsewater and spillage from the electroplating operations were contained within the building by means of two systems of collection trenches that discharged liquid into two sumps, one containing acidic fluid and the other containing a basic solution with cyanide, also referred to as the cyanide sump. Beginning with the construction of Area A-9, waste was temporarily stored in five brick-lined, reinforced concrete holding tanks, approximately 20 feet outside of the plant. The acid and cyanide rinsewaters were piped directly to the acid rinse and cyanide rinse tanks, which functioned as equalizer tanks prior to piping the rinse water to the on-site treatment facility. Plating waste piped to the remaining three tanks was collected by a transporter for off-site disposal. ~~The~~ information ~~supplied by Westinghouse~~ regarding each of the tanks is as follows:

- Cyanide Waste
  This tank had a volume of 1,946 gallons and contained spent cyanide plating bath solutions from the elctroplating operations.

WPL 005 5432

DCR

132/ 6118618

- <u>Cyanide Rinse</u>
  <u>This 973-gallon</u> equalizer tank retained cyanide rinsewater prior to transfer to the on-site wastewater treatment facility.

- <u>Acid Rinse</u>
  <u>This 1,190-gallon</u> equalizer tank retained acid rinsewater prior to transfer to the on-site wastewater treatment facility.

- <u>Acid Waste</u>
  <u>This tank</u> had a volume of 2,163 gallons that once contained spent acid stripping and cleaning bath solutions from electroplating operations where cyanide is used in the process.

- <u>Alkaline Waste</u>
  <u>This 2,163-gallon</u> tank contained spent caustic stripping and cleaning bath solutions from electroplating operations where cyanide is used in the process.

~~As previously mentioned,~~ In 1983, ~~seepage of~~ acidic liquid was noted on the ground in the vicinity of the Acid Waste tank, and in October 1983 four borings were drilled around the tanks to investigate the extent of leakage (Borings B-1, B-2, B-3, and B-4 on Figure 1). One of the borings, B-4, detected significant amounts of low pH groundwater adjacent to the Acid Waste tank and on October 27, 1983 the DER was informed that a spill had occurred (Baker TSA, 1984a, b, and c).

On November 17, 1983, a fifth boring (B-1A) was drilled to determine if the spill affected ~~possible contamination of~~ subsurface materials ~~had occurred inside~~ beneath the plant, in the vicinity of the plating operations (Figure 1). In this boring, a high pH liquid containing cyanide was encountered. In January 1984, the outside storage tanks were emptied and their use discontinued. Two additional borings were drilled on February 4, 1984 to attempt to determine the location of both high and low pH fluids. High pH fluid was encountered in Boring B-1B, while B-2B showed no anomalies (Figure 1).

After a site visit by DER personnel on May 31, 1984, a Closure Plan for the removal of the outside storage tanks was presented to the DER on

WPL 005 5433

DCR

132/ 6118619

July 25, 1984 and subsequently approved. Also, beginning in July 1984, all of the old pipelines connecting the plant facilities with the old tanks were either plugged or removed, the use of the equalizer tanks was discontinued, and new PVC lines were installed to ~~send~~ transport acid and cyanide rinsewater directly from the sumps to the wastewater treatment plant.

In May 1985, Rizzo Associates was contracted for the scope of work discussed in this report. The outside tanks were ~~physically~~ removed from June 21 through 28, 1985, consistent with the Closure Plan and revisions submitted to the DER on April 4 and June 14, 1985. Phase II of the Closure Plan, as defined in the June 14 letter, indicates that if soil beneath the tanks has been impacted, an assessment plan including a literature search, surface geophysical study, and test boring plan will be prepared. In fact, the soil under the tanks has been impacted; and, hence, this report also serves as the basis for a submittal to the DER as part of the Phase II efforts described in the Closure Plan.

3.0 SUBSURFACE CONDITIONS

3.1 HYDROGEOLOGICAL SETTING

The Westinghouse plant in Beaver, Pennsylvania is founded on a large terrace overlooking the Ohio River. The terrace is comprised of a mixture of sand and gravel which is coarse near the bottom and becomes finer and more sandy near the top. A layer consisting predominantly of silt covers the terrace. The sand and gravel originated as glacial outwash from the Wisconsin ice sheet, which stopped about ten miles north of the site. The silt unit is of relatively recent age.

Although the depth to bedrock under the site is not precisely known, borings for the railroad bridge at Beaver encountered bedrock near El 625 feet; considering that the bedrock surface is probably fairly flat across the valley, it is estimated that the depth to bedrock at the site is about 150 feet. The thickness of the silt unit is not precisely defined, but it is expected to extend to a depth of about 50 feet based on borings in other terraces. The unit is not pure silt, but may contain some clay and numerous zones of fine sand. The existing shallow borings at the plant define conditions within the recent silt unit as discussed in Section 3.2.

The glacial outwash is a highly productive aquifer utilized for both municipal and private use in Beaver. Based on well records for Beaver, groundwater is estimated to be present at a depth of about 60 feet beneath the plant, with a piezometric surface dipping towards the river. This groundwater table can be expected to fluctuate several feet depending on pumping rates and variations in rainfall. Perched water is probably present in small zones within the silt unit, but it is anticipated that water flow is generally downward towards the main water table.

3.2 EXISTING HYDROGEOLOGIC CONDITIONS AT THE PLANT

A total of seven borings have already been completed in the area where a fluid seep was originally identified at the plant (Figure 1).

WPL 005 5435

DCR

132/ 6118621

As indicated on the generalized cross sections (Figure 2), the study area at the plant is underlain by three different soils. The surficial soil from the area of the former tanks and Area A-9 consists of man-deposited material: sand fill underneath Area A-9, and a fill consisting primarily of slag in the area immediately outside of the building. In the area of the former tanks, this fill material is approximately three feet thick. Beneath the fill, a layer of clayey silt/silty clay is found at depths ranging from 7.0 feet in Boring B-2B to 15.2 feet in Boring B-2. This unit decreases in thickness towards the plant, but it is not known if it pinches out under the plant or is breached by any of the building structures. A predominantly sandy unit is present at the base of the clayey silt/silty clay to a depth of at least 20 feet. The overall thickness of the sand is not known.

Five of the seven borings at the site were converted into groundwater monitoring wells. The two borings not converted into wells, B-2 and B-3, did not encounter water. The depths screened and static water levels are shown on Figure 2. Details of the well installation process are provided in three reports by Michael Baker, Jr. Inc., (Michael Baker, 1984a, b, and c). The diversity of water levels indicates that a complex flow regime is present in the study area.

Although three borings (B-1, B-2B, and B-4) are screened in what is apparently a locally continuous sand zone, significant water was encountered only in Boring B-4 with minor amounts in Borings B-1 and B-2B; no water was encountered in B-2 and B-3, which also penetrated the sand. As there is no apparent reason why water would be perched only under Boring B-4, the information suggests that water is entering or has entered the sand from a local breach or breaches in the overlying silty clay/clayey silt unit. The water appears to be percolating downward, as evidenced by the variation in depths at which wet zones were encountered. Borings B-1A and B-1B are both screened above the sand layer, although the base of the screened zone in B-1B may just enter the top of the sand. Water levels in both of these borings are higher than observed from wells screened in the sand layer and appear to reflect the presence of perched water on top of the clayey silt/silty clay unit that percolates into the wells from above. During the excavation of the tanks, water was observed to seep into the excavation at the base of the fill material, indicating that some perched water is present.

3.3 RESULTS OF CHEMICAL ANALYSES OF SOIL SAMPLES

Shake extraction testing was conducted from soil samples collected from all of the existing borings, as reported by Michael Baker (1984a, b, and c). The highest levels of soil contamination were encountered in Boring B-1A, where 540 mg/l cyanide and 550 mg/l silver were encountered at a depth of 8.0 feet. Anomalously high cyanide was also encountered in Boring B-1B, at a depth of 8.5 feet (160 mg/l). The results of all of the soil extraction tests from the borings, as documented by Michael Baker (1984a, b, and c), are presented in Table 2. The zones of anomalous concentration are shown schematically on Figure 3.

Soil pH values were also measured and proved to be one of the best indicators of the impact in the localized soil. Soil pH values were anomalously low in B-4 between 9.0 and 13.5 feet. High pH readings were encountered in B-1A down the entire boring, but especially above 15.0 feet. Similarly, anomalously high pH values were noted in B-1B in a sample taken between depths of 7.0 and 8.5 feet. The remaining borings did not exhibit any anomalous soil pH values. Soil pH values, as documented by Michael Baker (1984a, b, and c), are provided on Figure 3.

As part of this study, shake extraction tests were made on samples taken under the outside storage tanks after they were removed. Testing was conducted for pH, silver, and cyanide consistent with the amendment to the Closure Plan provided in the June 14, 1985 letter to the DER. Also in accordance with the June 14 letter, silver was analyzed using the extraction procedure toxicity test method as described in Appendix II of 25 PA Code Ch. 75.261. The results of this testing are provided in Table 3. The soil samples, taken from the clayey silt/silty clay beneath the tanks, indicate that at least one of the tanks leaked.

There is no direct indication of any leak of an acid solution from the outside storage tanks. Most of the soil samples exhibit a basic pH, even those taken from under the acid waste and acid rinse tanks. The concentration of cyanide progressively increases from 22 mg/l under the acid waste tank to 200 mg/l under the cyanide waste tank, suggesting that the area of the cyanide waste tank was the source of the contamination under all of the tanks.

3.4 RESULTS OF GROUNDWATER CHEMICAL ANALYSES

Prior to this study, chemical analyses were made from water samples from Borings B-1, B-1A, and B-4 during the period from October 1983 through May 1984. As part of this study, water samples were obtained from these wells (except for B-1 which is too damaged to insert a sampling device) in order to observe whether the groundwater chemistry has changed over the past year. In addition, water samples were tested from Borings B-1B and B-2B, which had not previously been tested. The analytical results of groundwater samples taken from all of the screened wells at the site are presented in Table 4.

The analysis of water samples taken from the five screened wells at the site confirm the complex geochemical environment determined from the shake extraction analyses of the soil samples. Boring 4 contains acidic water and the presence of significant concentrations of nitrate, sulfate, copper, and cyanide, in particular. On approximately 90 days during the period from December 1983 to the present, typically 200 gallons per day of this groundwater were pumped from B-4, with pH values ranging from 2.0 to 4.4, with most values falling in the range of 2.2 to 2.7. The remaining wells contain much less fluid and do not exhibit acidic conditions.

In Borings B-1A and B-1B, cyanide, sulfate, nitrate, and copper were measured in significant concentrations. In particular, Boring B-1B, not previously analyzed, was determined in this study to have a cyanide concentration of 2300 mg/l. Water samples from both of these borings exhibit pH values in the 10 to 11 range. In contrast to these borings, samples from Borings B-1 and B-2B are relatively unaffected, with samples from Boring B-2B exhibiting only significant concentrations of nitrate and sulfate. Both B-1 and B-2B exhibit nearly neutral pH values.

Two events have occurred since the test borings were installed which may have had an effect on groundwater quality: the first was the decommissioning of the tanks in January 1984 and the second was the removal or plugging of the old pipes to the outside tanks and the installation of new PVC lines for the disposal of the acid and cyanide rinsewaters in the late summer of 1984. Data are not sufficient to assess whether the tank decommissioning had an effect on groundwater quality, as analyses were made before and after the tank decommissioning only from water samples taken from B-4, and in this case the data are somewhat contradictory. Cyanide concentrations were reduced between November 1983 and May 1984 from 250 mg/l to 2.3 mg/l, but copper and silver concentrations remained approximately the same.

The installation of the PVC lines appears to have had a more directly observable beneficial effect from borings where a comparison can be made. In water samples obtained from Boring B-4, nitrate, sulfate, and copper concentrations have decreased, while cyanide has remained relatively low. Silver concentrations are noticeably greater, but still at a low level. In Boring B-1A the improvement is more apparent. Between May 1984 and May 1985 cyanide concentrations improved from 1050 to 210 mg/l; nitrate fell from 156 to 33 mg/l; sulfate dropped from 1240 to 650 mg/l; and copper was reduced from 1000 to 100 mg/l. Silver represents an apparent anomaly, as it increased from 0.08 to 38 mg/l.

Samples of groundwater from Boring B-1B obtained during the course of this study were found to contain 2300 mg/l cyanide, 390 mg/l nitrate, 345 mg/l sulfate, and 1600 mg/l copper. Although these values are relatively high, no testing was previously conducted to determine if the groundwater chemistry from this boring has changed with time.

WPL 005 5439

132/ 6118625

3.5 GEOPHYSICAL SURVEYS

As part of the current study, three types of geophysical surveys were conducted in the immediate vicinity of Area A-9: electromagnetics (EM), resistivity, and ground probing radar (GPR). As the chemicals previously found in the groundwater cause the soil saturated with this fluid to become conductive, these techniques were selected as having the best potential for identifying conductive plumes which could originate from the chemical leaks. All of the surveys were conducted along profile lines parallel to the exterior wall of the plant, on both sides of the excavation created when the tanks were removed (Figure 4). The details of the theory and field procedures followed for each of the techniques are presented in Appendix A. The following subsections discuss the results of each of the techniques.

3.5.1 Electromagnetics (EM)

At the A-9 site, conductivity measurements were made from both the vertical and horizontal dipole configurations along three profile lines (Figure 4), as plotted on Figure 5. The measurements using the vertical dipole configuration do not suggest the presence of any anomalous condition, other than obvious cultural interference such as the presence of the overhead nitric acid and sulfuric acid tanks (Figure 4). The horizontal dipole configuration shows a sharp response adjacent to the location of the former tanks only along Line 1 between the tank excavation and the plant, indicative of very shallow ground conductivity changes. This high conductivity anomaly continues to the northeast end of the line (Figure 5). However, it was noted in the field that this portion of the line follows the route of the new PVC pipelines from the A-9 area towards the wastewater treatment plant. Accordingly, a cross line (Line 3) was run to observe if the pipes, or the fluid in the pipes, affected the results. As indicated from the results for Line 3 (Figure 5) the presence of the pipes appears to affect the instrument response in the horizontal dipole position. Nevertheless, the highest conductivity readings were obtained at the southwestern end of the former tank locations, where these pipes are not present, indicating that the instrument response is most likely due to shallow ground conductivity changes. Although the results from Line 2 do not indicate an anomaly adjacent to the former tank locations, they do indicate that ground conductivity increases with depth.

3.5.2 Resistivity

Vertical Electrical Sounding (VES) measurements were conducted at two locations along Line 2, as indicated on Figure 4. The interpretation of these profiles (Figure 6) indicates that a three-layer system is present in the shallow subsurface. The top layer of a resistivity of 130 to 150 ohm-feet extends to a depth of about three feet. This layer could correspond to fill material, or could simply be a boundary in the natural soil. The available borings (B-1, B-2, and B-3) do not suggest the presence of fill under Line 2. Beneath this layer, 21 feet of material of a resistivity of 75-84 ohm-feet is interpreted. Both of the top two layers have resistivity values consistent with a saturated clayey soil. The apparent resistivity of material beneath the two surficial layers has a resistivity too small to measure and has been modeled as a layer of zero resistivity. This layer might be an indication of the presence of groundwater impacted by chemicals such that the resistivity has decreased (conductivity has increased). However, the resistivity profiles were run parallel to a chain-link fence that could have partially shorted out the measurement system at the two largest "A" spacings. Hence, these data must be viewed as inconclusive.

In addition to the VES measurements, a fixed-spacing survey was conducted along Line 2 to detect any lateral variations of ground resistivity that might suggest the presence of a plume. Fixed "A" spacings of 10 and 20 feet were used, as shown on Figure 6. The results indicate no anomalous conditions in the vicinity of the tank excavation, consistent with the results of the EM profile. In both the EM and resistivity profiles along Line 2, ground resistivity appears to decrease with depth.

3.5.3 Ground Probing Radar (GPR)

Continuous GPR profiles of the subsurface were obtained along the previously established profile lines using 120-, 300-, and 600-megahertz antennas. Two GPR profiles with the deepest penetration were obtained with the 120-megahertz antenna, as shown on Figure 7. Ground surface is shown by the first strong reflector. Below this fairly flat surface, a number of tight, parabolic shapes can be identified which correspond to shallow, buried pipes or underground utilities. The location of the reflections from the pipes is consistent with the location of pipes or trenches known to extend to the former tanks, or other obvious sources such as drainage lines or water lines going to fire hydrants. The GPR profile confirms the removal of several of the pipelines originally going to the tanks.

In addition to the shallow reflectors, a deep reflector is present in the vicinity of the former tanks on both Lines 1 and 2. This reflector extends over 50 feet and has the shape of a concave - downward arc centered between station locations 0 + 00 and -0 + 10 feet on Line 1 and centered between 0 + 00 and 0 + 10 feet on Line 2 (Figures 7 and 8). This reflector does not appear to be related to the contact between the clayey silt/silty clay unit and the underlying sand, and may be related to the distribution of a plume. It is emphasized, however, that this is highly speculative, because sufficient supporting data are not available to interpret this feature.

4.0 SUMMARY OF EXISTING CONDITIONS

More than one chemical release has occurred at Area A-9. The presence of a high pH material encountered in Borings B-1A and B-1B suggests a release of fluid originally destined for or contained in the cyanide waste and cyanide rinse tanks. The acidic water encountered in Boring B-4 suggests that fluid having a concentration at least equal to that of the acid rinsewater has also been released.

The presence of acidic and basic groundwater in wells so close together is an unusual situation, but explainable when considering well emplacement. Well B-4 containing the acid groundwater is screened completely in the lower sand unit, while Wells 1A and 1B are both screened primarily within and above the clayey silt/silty clay unit (Figure 2). The clayey silt/silty clay unit appears to separate the zones, although some of the high pH groundwater could be percolating into the sand unit through the base of the screened zone in B-1B.

Observations made during the excavation of the tanks suggest that the high pH groundwater is essentially confined to the fill above and within the clayey silt/silty clay layer. During the removal of the tanks, basic groundwater flowed into the excavation along the top of the clayey silt/silty clay and from old segments of pipe within the fill. The water level observed in B-1A indicates that high pH fluid is essentially perched in the surface fill. The deeper water table encountered in B-1B suggests that high pH liquid is entering the borehole from above and falling down the hole where it has collected near the bottom of the screened zone. It is not known if basic fluid is leaking out of the bottom of the zone screened by B-1B while it is being continually recharged, or if the fluid present represents the sum of all that has entered the well.

The available test results indicate the liklihood that more than one source has contributed to the formation of the high pH plume. Water samples taken from B-1B as part of this study indicate that significantly higher concentrations of cyanide are present in this boring than in B-1A. The soil samples taken during this study from underneath the tank exhibit the greatest amount of cyanide concentration underneath the old cyanide waste tank, with decreasing amounts of cyanide in samples taken from beneath other tanks at increasing distances away. This indicates that the cyanide waste tank may have leaked and that the chemical species observed in B-1A were from a different source, probably from a leak at the collection sump for the cyanide rinsewater.

As both known sources of high pH liquid have been eliminated (the cyanide waste tank has been removed and the cyanide sump has been lined with PVC and a new waste pipeline installed), it appears likely that the plume of high pH groundwater is residual. This view is supported by the improvement of groundwater quality in B-1A since the new cyanide line was installed. It is also noted that the flow of high pH groundwater into the area of the tank excavation has essentially dryed up.

The nature of the low pH groundwater is not well defined. Boring B-4 is still the only boring that encountered low pH soil or groundwater. Low pH groundwater was not found in Borings B-1, B-2, B-2B, and B-3 which also penetrated the sand. Groundwater in B-4 may be perched on top of a clay layer not encountered in any of the previous borings. Another explanation is that an active leak is being detected by Boring B-4 and the fluid is migrating in a generally downward direction.

The origin of the low pH groundwater is not known. The soil samples from underneath the acid waste and acid rinse tanks were not contaminated with acidic chemicals, but were actually basic. This indicates that these tanks probably did not leak and were not likely the source of the relatively large volume of low pH groundwater encountered in Boring B-4. The source of low pH groundwater initially observed outside the tanks was probably from a pipeline leak that has since been remedied by the installation of the new PVC line. Only a small low pH discharge into the area of the tank excavation was noted from underneath the old trench that led to the acid rinse tank and this quickly dried up. The available information indicates that the low pH water in Boring B-4 originates or originated from a source within the plant. The groundwater quality from B-4 has improved somewhat over the past year, suggesting that the installation of the new PVC pipeline has helped. However, the test results from the sand layer at B-4 suggest that a breach in the clayey silt/silty clay unit is present which has not been documented. It is not clear that the acid sump area or the pipelines to the former storage tanks would have been deep enough to cause that breach and some other source may be present.

Very truly yours,

William J. Johnson

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TABLES

TABLE 1
CHEMICAL CONSTITUENTS OF THE TANKS USED IN ELECTROPLATING OPERATIONS IN AREA A-9

PROCESS	TANK	DESCRIPTION	COMPOSITION
Aluminum Bus Bar-Silver Plate	1	Alkaline Cleaner (hot)	5 oz of C-6/gal/water 140°F
	2	Alkaline Cleaner	5 oz of C-6/gal/water 110°F
	3	Cold Water Rinse	Water (discard weekly)
	4	Acid Dip	23-32% HNO_3
	5	Cold Water Rinse	Water (discard weekly)
	6	Zinc Coating	NaOH - 70 oz/gal Zinc Oxide - 13/oz/gal 70°F
	7	Cold Water Rinse	Water
	8	Cold Water Rinse	Water
	9	Copper Strike	CuCN - 8 oz/gal NaCN - 10 oz/gal $NaCO_3$ - 4 oz/gal
	10	Water Rinse	Water
	11	Silver Plating	AgCN - 3 oz/gal KCN - 9 oz/gal KCO_3 - 8 oz/gal
	12	Cold Rinse	Water
	13	Hot Rinse	Water

WPL 005 5449

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132/ 6118635

TABLE 1
(Continued)

PROCESS	TANK	DESCRIPTION	COMPOSITION
Copper Bus Bar-Silver Plate	1	Alkaline Cleaner	C-6 - 7 oz/gal
	2	Cold Water Rinse	Water
	3	Bright Dip	1 part HNO_3 2 parts H_2SO_4
	4	Rinse	Water
	5	Silver Plating	NaCN - 4 oz/gal AgCN - 1 oz/gal
	6	Rinse	Water
	7	Rinse	Water

TABLE 2
SHAKE EXTRACTION ANALYTICAL RESULTS OF SOIL SAMPLES TAKEN FROM SITE BORINGS (JANUARY - MARCH 1984)

BORING NO.	BOTTOM DEPTH OF SAMPLE BELOW SURFACE (ft.)	ZINC (mg/l)	CADMIUM (mg/l)	CHROMIUM (mg/l)	MERCURY (mg/l)	LEAD (mg/l)	SILVER (mg/l)	TOTAL CYANIDE (mg/l)
1	1.5	.03	<.02	<.05	<.5	<.01	<.01	<.005
1	4.5	.09	<.02	<.05	<.5	<.01	.01	.009
1	7.5	.05	<.02	<.05	<.5	<.01	<.01	<.005
1	10.5	1.8	.06	<.05	<.5	.018	<.01	<.005
1	13.5	.01	<.02	<.05	<.5	<.01	<.01	.057
1	16.5	.03	<.02	<.05	1.4	<.01	.22	2.0
1	19.5	.01	<.02	<.05	.9	<.01	.02	.087
2	1.5	.02	<.02	<.05	<.5	<.01	<.01	.005
2	4.5	.21	<.02	<.05	<.5	<.01	.01	.015
2	7.5	.39	.04	<.05	<.5	<.01	<.01	.069
2	10.5	.01	<.02	<.05	1.7	<.01	<.01	.020
2	13.5	.03	<.02	<.05	<.5	<.01	.02	.20
2	16.5	.03	<.02	<.05	<.5	<.01	<.01	.011
2	19.5	.05	<.02	<.05	<.5	<.01	.01	.005
2	22.5	.01	<.02	<.05	<.5	<.01	<.01	.005
3	1.5	.01	<.02	<.05	<.5	<.01	<.01	<.005
3	4.5	.05	<.02	<.05	.75	<.01	<.01	<.005
3	7.5	.05	<.02	<.05	<.5	<.01	<.01	<.005
3	10.5	<.01	<.02	<.05	<.5	<.01	<.01	<.005
3	13.5	.01	<.02	<.05	<.5	<.01	<.01	<.005
3	16.5	.01	<.02	<.05	<.5	<.01	<.01	<.005
3	19.5	.01	<.02	<.05	<.5	<.01	.01	<.005
4	1.5	.28	.02	<.05	<.5	<.01	.43	3.0
4	4.5	.80	.02	<.05	<.5	<.01	.04	8.3
4	7.5	.06	<.02	<.05	<.5	<.01	.06	39.0
4	10.5	2.4	.04	<.05	6.0	<.01	.05	<.005
4	13.5	.79	<.02	<.05	1.3	<.01	.02	<.005
4	16.5	.01	<.02	<.05	.6	<.01	<.01	.014
4	19.5	.02	<.02	<.05	1.2	<.01	<.01	.087

TABLE 2
(Continued)

BORING NO.	BOTTOM DEPTH OF SAMPLE BELOW SURFACE (ft.)	ZINC (mg/l)	CADMIUM (mg/l)	CHROMIUM (mg/l)	MERCURY (mg/l)	LEAD (mg/l)	SILVER (mg/l)	TOTAL CYANIDE (mg/l)
1A	2.0	0.34	0.12	0.23	4.5	0.084	107.0(1)	120.0
1A	5.0	0.05	<0.02	0.20	8.6	0.058	164.0(1)	85.0
1A	8.0	2.0	0.05	0.38	<0.5	0.20	550.0(1)	540.0
1A	11.0	0.07	<0.02	<0.05	2.2	0.011	12.9(1)	16.0
1A	14.0	0.91	0.05	<0.05	1.8	0.078	208.0(1)	300.0
1A	17.0	0.03	<0.02	<0.05	7.7	<0.01	4.6(1)	20.0
1A	18.5	0.12	<0.02	<0.05	2.2	<0.01	8.6(1)	40.0
1A	20.0	0.01	<0.02	<0.05	0.9	<0.01	4.4(1)	4.5
1B	2.5	0.06	<0.02	<0.05	5.5	<0.01	0.04	1.1
1B	5.5	0.19	<0.02	<0.05	1.8	<0.01	0.22	130.0
1B	8.5	0.17	0.09	<0.05	1.8	0.011	14.2	160.0
1B	11.5	0.12	<0.02	<0.05	0.7	<0.01	0.43	74.0
1B	14.5	0.11	<0.02	<0.05	1.2	<0.01	0.30	0.67
1B	17.5	0.02	<0.02	<0.05	1.1	<0.01	0.28	0.31
1B	20.5	0.02	<0.02	<0.05	1.0	<0.01	0.02	0.23
2B(2)	2.5	—	—	—	—	—	—	—
2B	5.5	0.05	<0.02	<0.05	2.0	<0.01	0.05	0.58
2B	8.5	1.9	0.04	<0.05	2.8	<0.01	<0.01	<0.005
2B	11.5	0.02	<0.02	<0.05	<0.5	<0.01	0.01	0.019
2B	14.5	0.02	<0.02	<0.05	1.8	<0.01	0.01	0.038
2B	17.5	0.01	<0.02	<0.05	<0.5	<0.01	<0.01	0.032
2B	20.5	0.03	<0.02	<0.05	0.9	<0.01	<0.01	0.017

1. No quantitative - possibly higher.
2. Sample not recovered.

TABLE 3
SHAKE EXTRACTION ANALYTICAL RESULTS
OF SOIL SAMPLES TAKEN FROM
BENEATH THE A-9 STORAGE TANKS
AND A REMOTE LOCATION

LOCATION OF SAMPLES	pH	SILVER (mg/l)	CYANIDE (mg/l)
Remote Location	8.0	<0.01	0.25
Alkaline Waste Tank	5.7	<0.01	0.76/0.65(1)
Acid Waste Tank	8.7	<0.01	22
Acid Rinse Tank	9.6	0.50	110
Cyanide Rinse Tank	8.65	0.52/0.52(1)	110
Cyanide Waste Tank	9.65	0.04	200

1. The indicated sample was analyzed in duplicate.

WPL 005 5453

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FIGURES

TABLE 4
ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
TAKEN FROM SITE BORINGS

	WELL NO.										
	1	1A	1A(1)	1A	1B	2B	4(2)	4(3)	4	4	4
	(10-83)	(6-84)	(8-84)	(5-85)	(5-85)	(5-85)	(10-83)	(10-83)	(11-83)	(5-84)	(5-85)
Ammonia (NH_3)				140	76	3.5					2.0
Residual Chlorine (Cl)								160	650	<1	
Chloride (Cl)				585	1500	380					490
Cyanide (CN)		990	1050	210	2300	1.5	11	48	250	2.3	11
Nitrate (NO_3)		450	156	33	390	160			6440	825	520
Sulfate (SO_4)		910	1240	650	345	260			1160	5600	340
Copper (Cu)		170	1000	110	1600	3.4			198	190	130
Silver (Ag)	0.72	0.4	0.08	38	2.3	0.39	3.3	2.2	0.08	0.05	1.5
Zinc (Zn)	0.19		37				64	75			
Cadmium (Cd)	0.06						0.73	0.64	0.38		
Chromium (Cr)	<0.05		0.40				0.19	2.6	0.55		
Mercury (Hg)							13	11	3		
Lead (Pb)	3.8						4.2	1.1	0.11		
Barium (Ba)									1.0		
Nickel (Ni)		1.0							1.42	0.59	
Selenium (Se)									<0.02		
pH	7.4	10.6	10.8	10.7	10.3	7.5	2.6-3.2	2.1	3.0	2.7	2.8

NOTE: All concentrations are provided in mg/l, except for mercury, which is provided in _g/l. Where blanks are present in the table, no tests were conducted.

1. Water sample actually taken from A-9 trench, considered to be equivalent to B-1A.
2. Before purging.
3. After purging.

WPL 005 5455

TABLE 4

ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
TAKEN FROM SITE BORINGS

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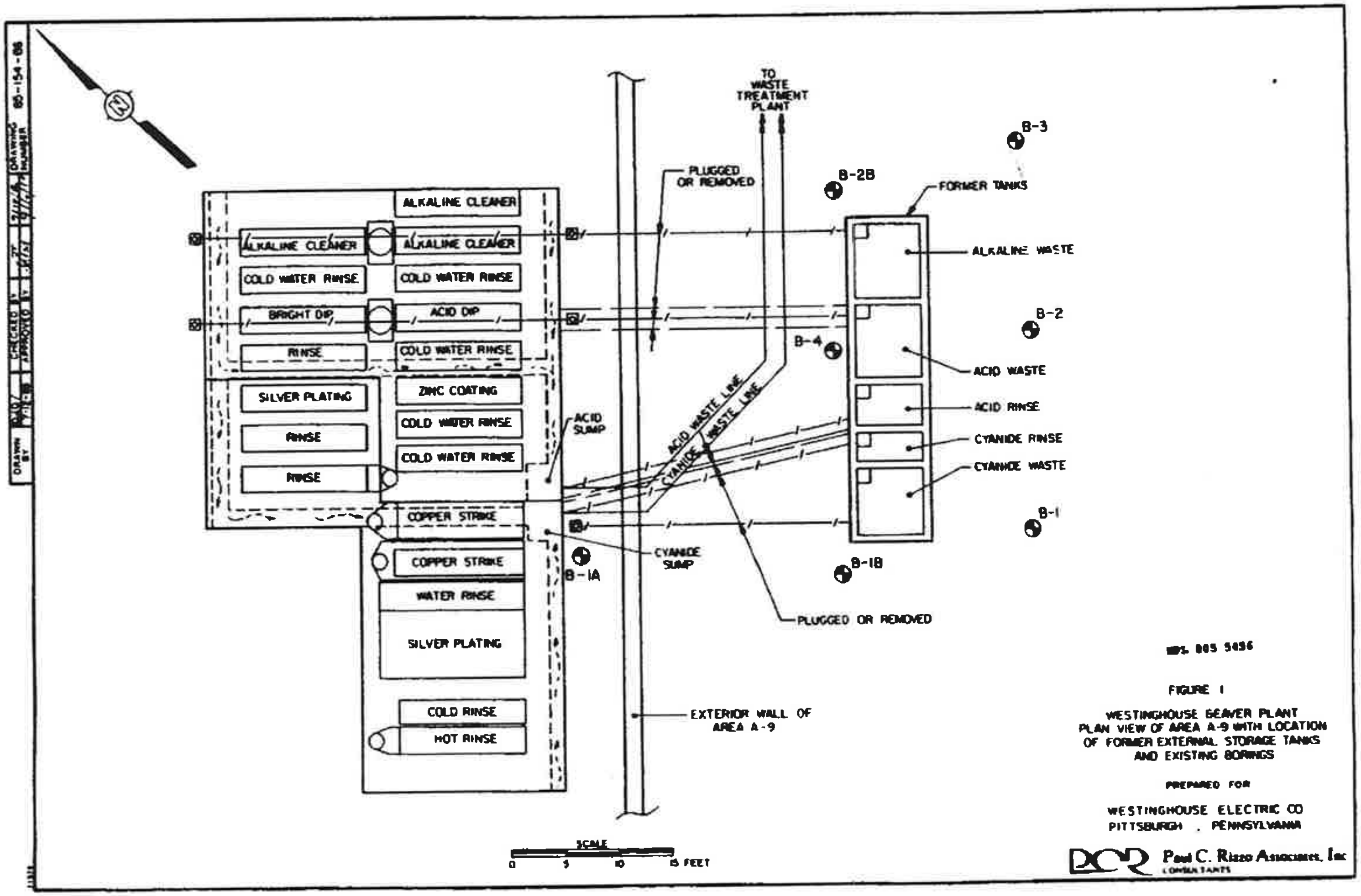
132/ 6118642



WPS 005 5456

FIGURE 1

WESTINGHOUSE BEAVER PLANT
PLAN VIEW OF AREA A-9 WITH LOCATION
OF FORMER EXTERNAL STORAGE TANKS
AND EXISTING BORINGS

PREPARED FOR

WESTINGHOUSE ELECTRIC CO
PITTSBURGH , PENNSYLVANIA

Paul C. Rizzo Associates, Inc
CONSULTANTS

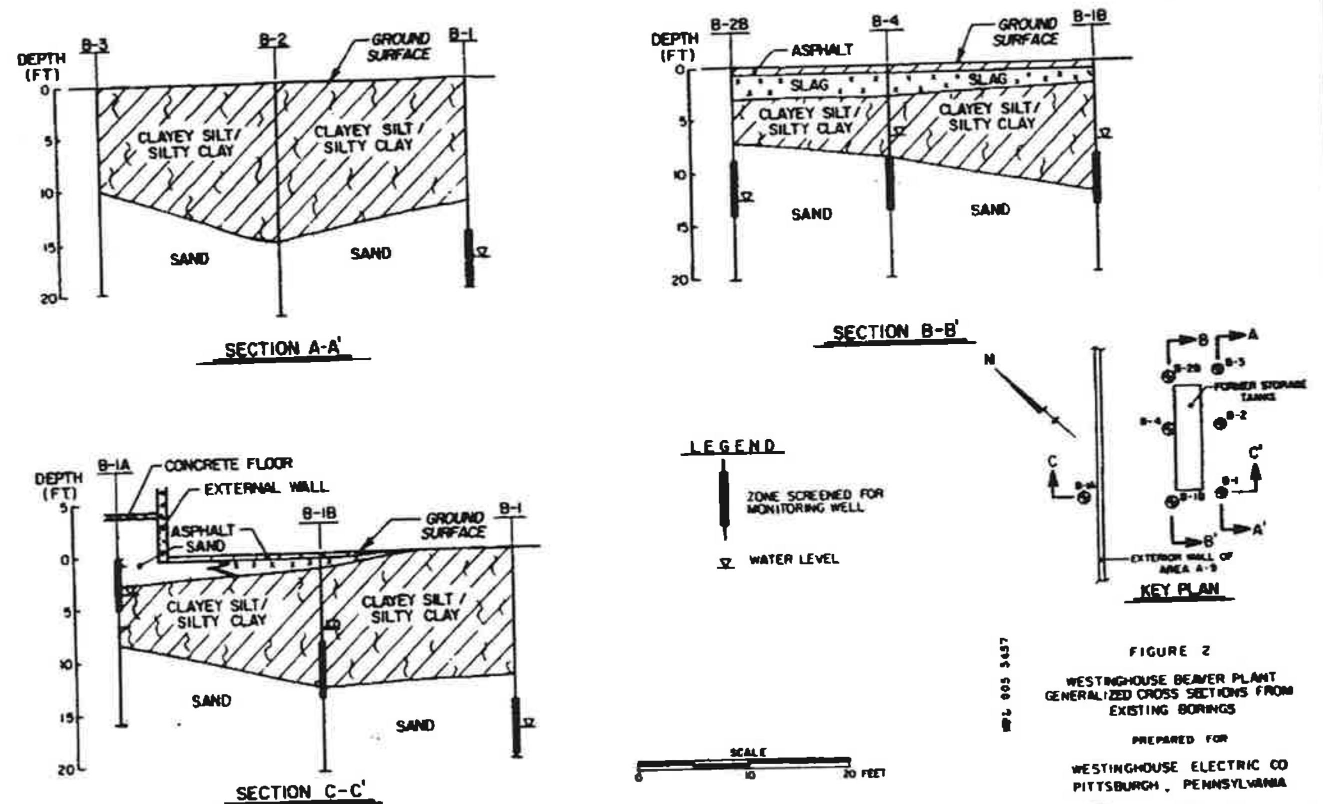


FIGURE 2

WESTINGHOUSE BEAVER PLANT
GENERALIZED CROSS SECTIONS FROM
EXISTING BORINGS

PREPARED FOR

WESTINGHOUSE ELECTRIC CO
PITTSBURGH, PENNSYLVANIA

Paul C. Rizzo Associates, Inc.
CONSULTANTS

DRAWING NUMBER 85-154-85

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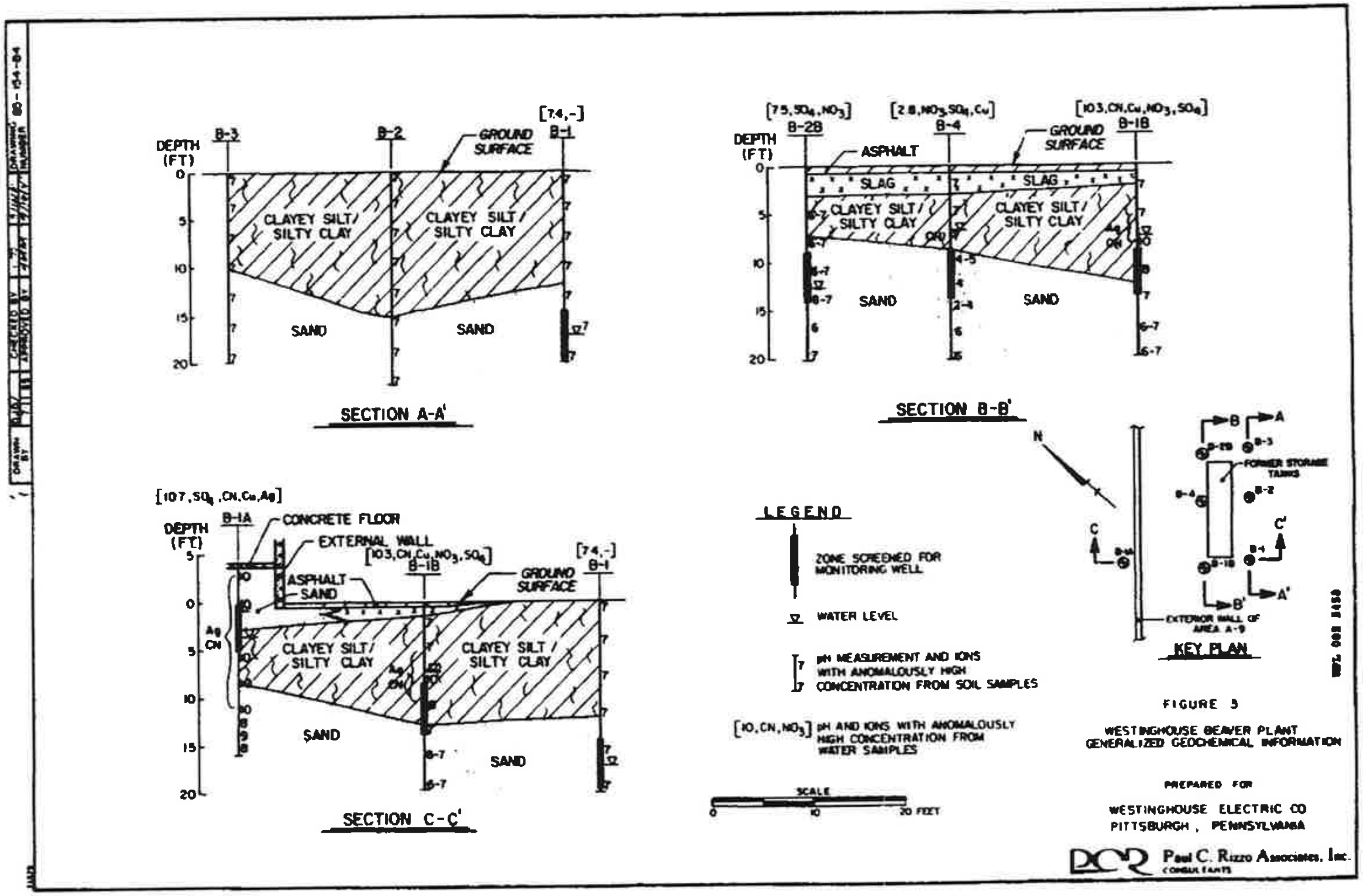

FIGURE 3

WESTINGHOUSE BEAVER PLANT
GENERALIZED GEOCHEMICAL INFORMATION

PREPARED FOR

WESTINGHOUSE ELECTRIC CO
PITTSBURGH, PENNSYLVANIA

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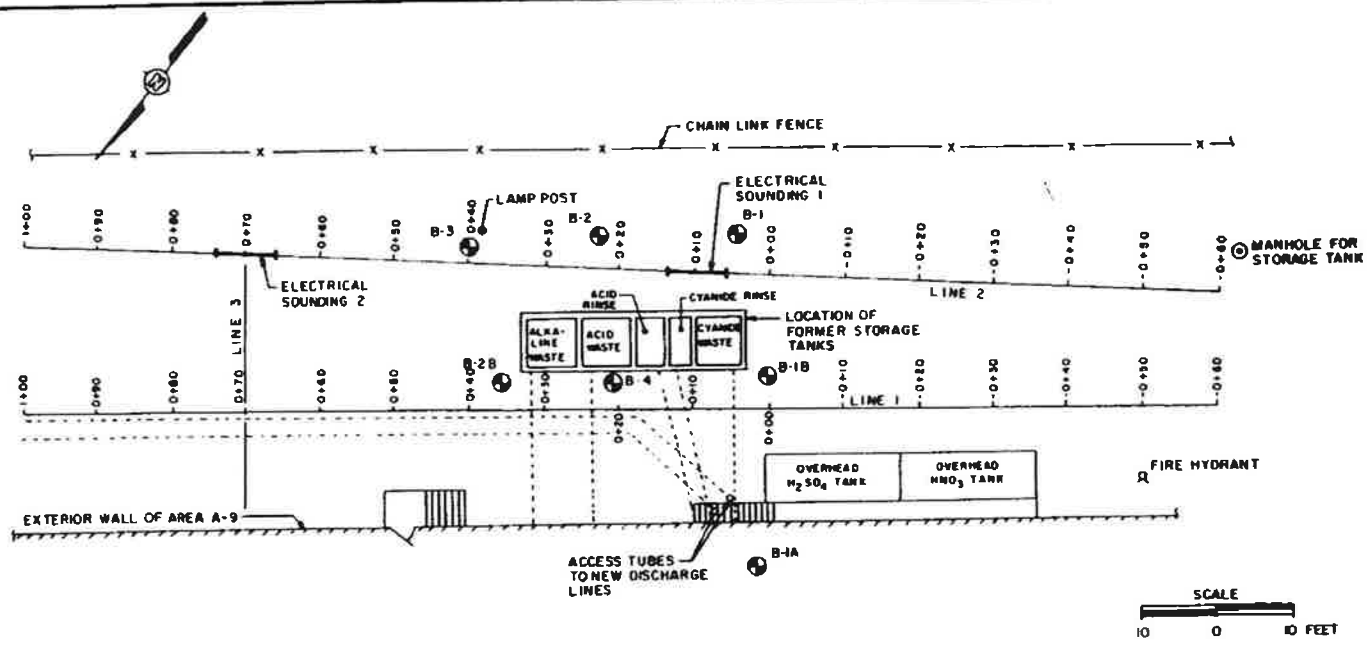

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WPL 005 5459

FIGURE 4
WESTINGHOUSE BEAVER PLANT
LOCATION MAP OF GEOPHYSICAL PROFILE LINES AND ELECTRICAL SOUNDINGS

PREPARED FOR

WESTINGHOUSE ELECTRIC CO
PITTSBURGH, PENNSYLVANIA

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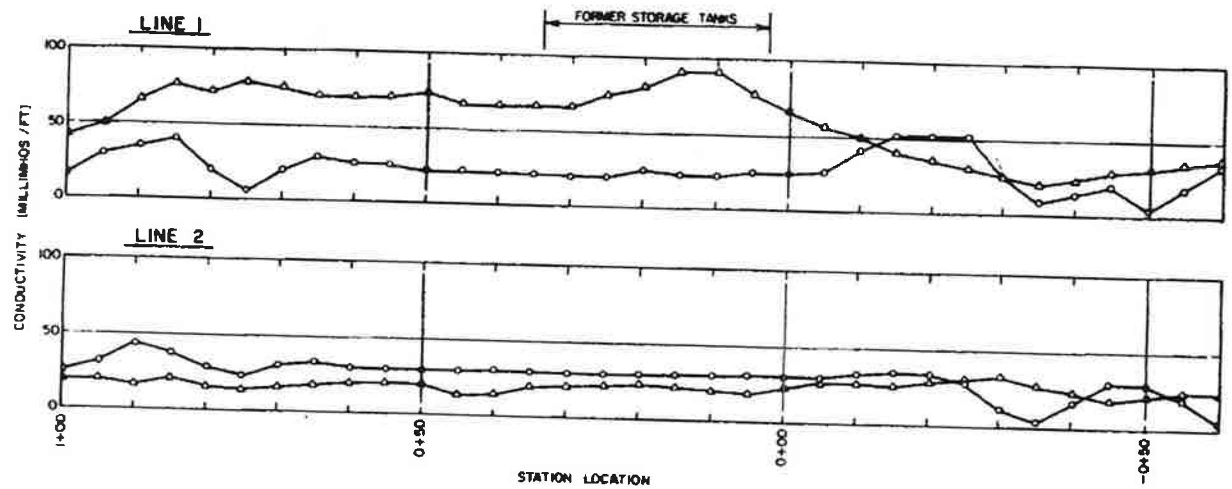
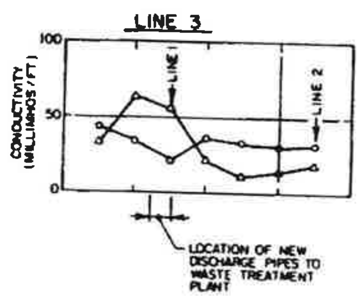
			85-154-B2



SCALE
0 10 20 FEET



NOTES:

1 FOR LOCATION OF PROFILE LINES AND STATION LOCATIONS SEE FIGURE 4.

2 MEASUREMENTS MADE WITH GEONICS EM31 GROUND CONDUCTIVITY METER FROM:
HORIZONTAL DIPOLE POSITION —△—△—
AND VERTICAL DIPOLE POSITION —○—○—

3 FOR THE VERTICAL DIPOLE POSITION, APPROXIMATELY 70% OF THE INSTRUMENT RESPONSE IS FROM SOIL SHALLOWER THAN ABOUT 20 FEET; IN THE HORIZONTAL DIPOLE POSITION SIMILAR RESPONSE IS FROM SOIL LESS THAN 10 FEET DEEP.

NPL 005 5460

FIGURE 5

WESTINGHOUSE BEAVER PLANT
GROUND CONDUCTIVITY PROFILES

PREPARED FOR

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PITTSBURGH, PENNSYLVANIA

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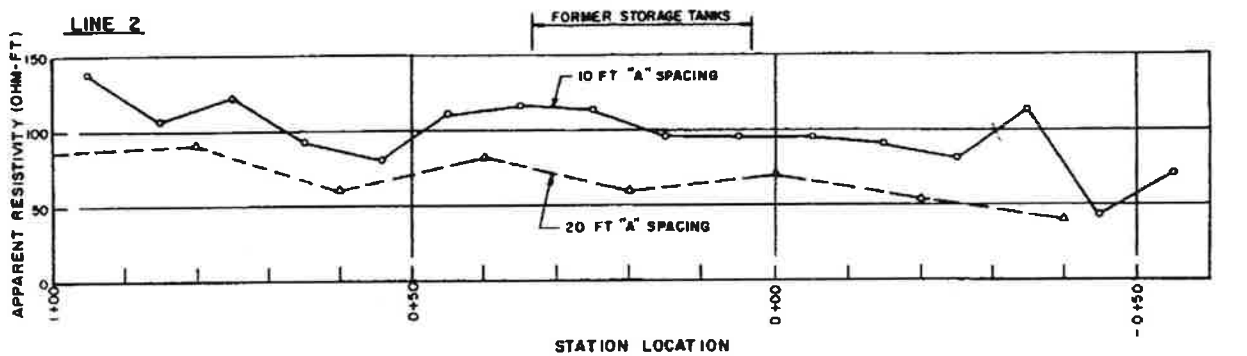

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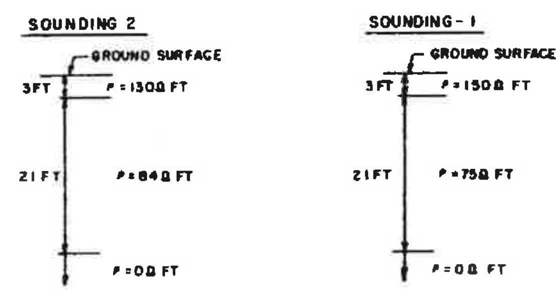

NOTE
FOR LOCATION OF PROFILE LINE 2 AND STATION LOCATIONS SEE FIGURE 4

WPL 085 5461

FIGURE 6

WESTINGHOUSE BEAVER PLANT
ELECTRICAL PROFILES AND RESULTS
OF VERTICAL ELECTRICAL SOUNDINGS
USING WENNER ELECTRODE CONFIGURATION

PREPARED FOR

WESTINGHOUSE ELECTRIC CO
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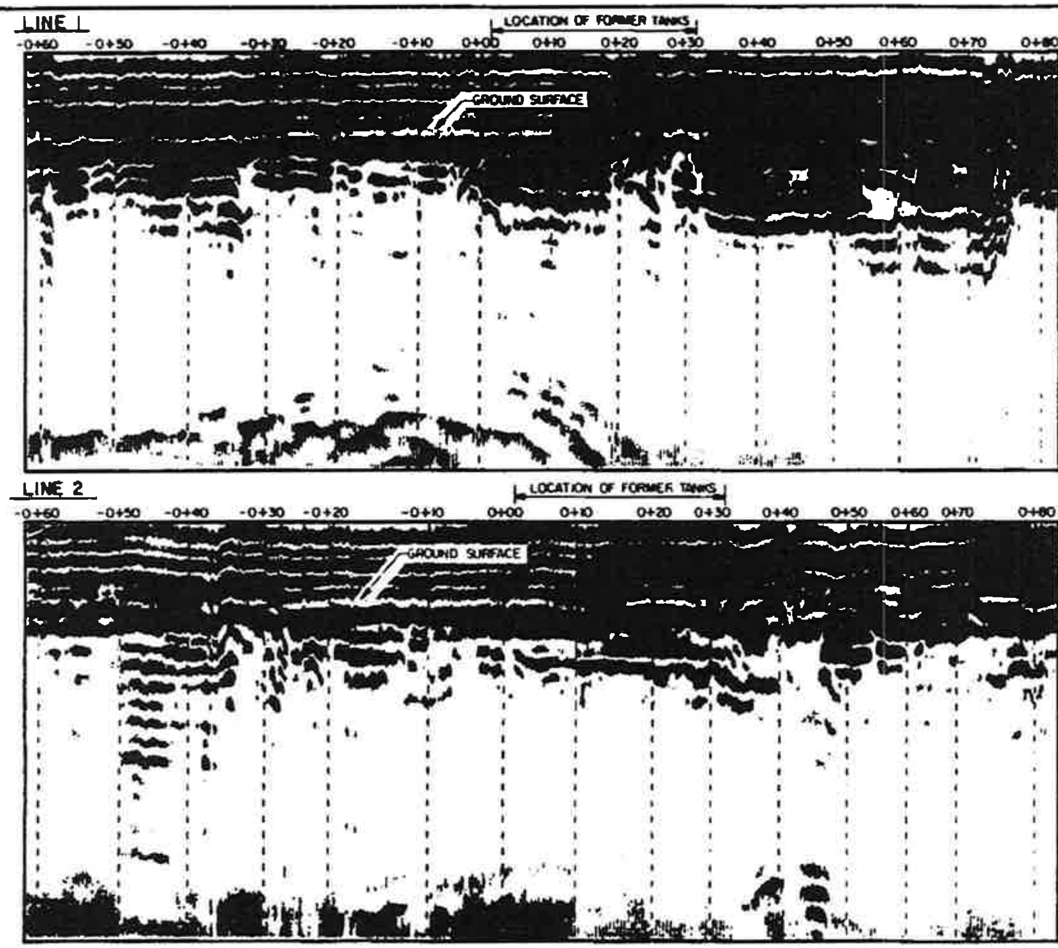

NOTE FOR LOCATION OF PROFILE LINES AND STATION LOCATIONS SEE FIGURE 4

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WPL 885 5462

FIGURE 7

WESTINGHOUSE BEAVER PLANT
GROUND PROBING RADAR (GPR) PROFILES

PREPARED FOR

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PITTSBURGH, PENNSYLVANIA

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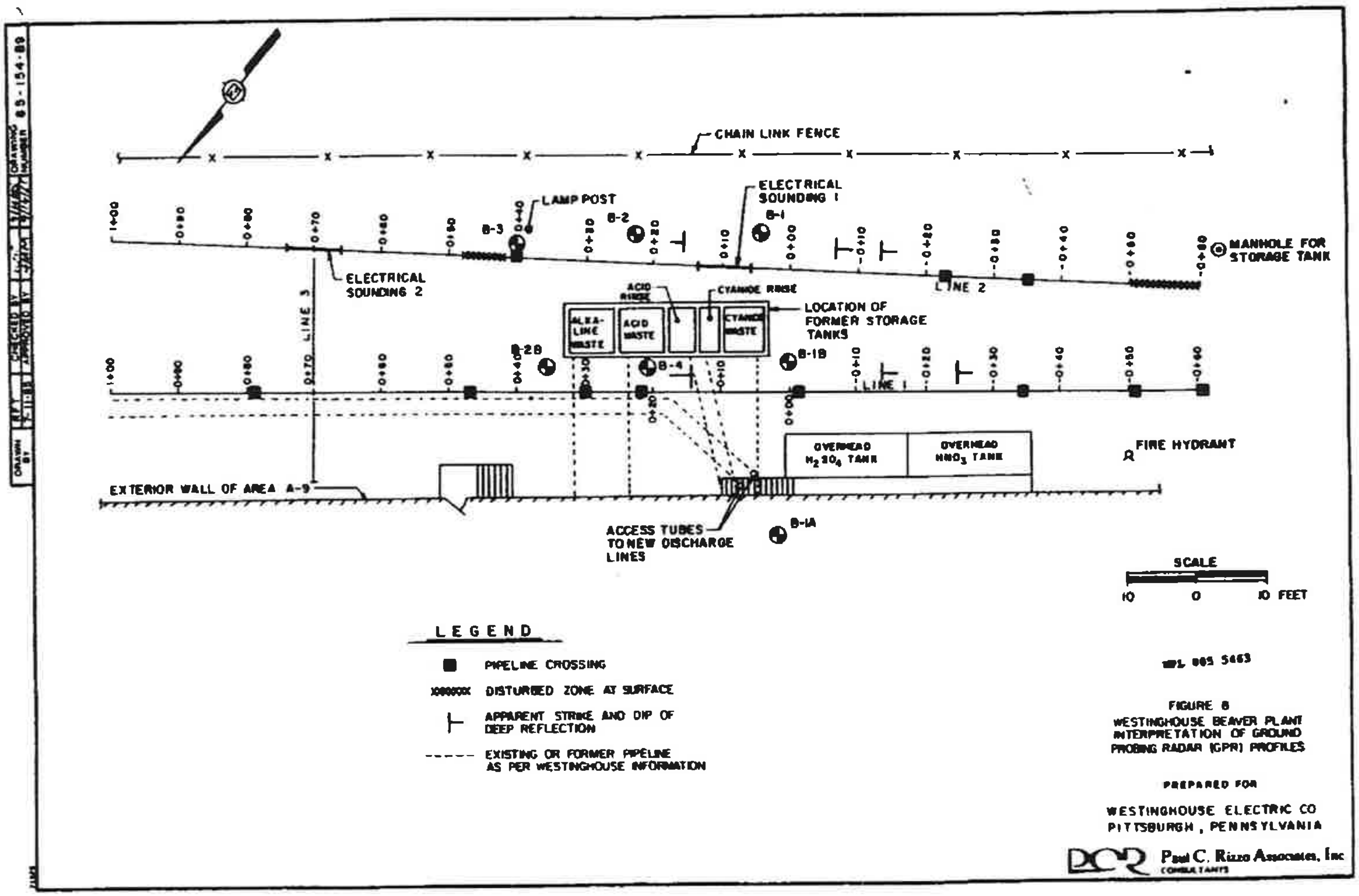

FIGURE 8
WESTINGHOUSE BEAVER PLANT
INTERPRETATION OF GROUND
PROBING RADAR (GPR) PROFILES

APPENDIX A

APPENDIX A

SUMMARY OF GEOPHYSICAL TECHNIQUES APPLIED AT WESTINGHOUSE BEAVER PLANT, AREA A-9

The following discussion briefly summarizes the theory and field procedures used for the electromagnetics (EM), resistivity, and ground probing radar (GPR) techniques utilized at the Westinghouse Beaver plant, Area A-9.

Electromagnetics (EM)

The principle of operation for the EM technique is that it measures variation of bulk ground conductivity, which makes it highly appropriate for detecting changes in conductivity that might be caused by the presence of chemicals or metals. Measurements of conductivity in the groundwater from Boring B-1 indicated conductivity values of approximately 900 to 1100 millimhos/foot, which is significantly higher than would be expected from natural local groundwater or soil, confirming that conditions were potentially favorable for the use of this technique.

EM equipment consists of transmitter and receiver coils, separated by a fixed distance. An alternating current in the transmitter coil produces a time-varying audio frequency EM field which induces very small currents in the subsurface. These currents generate a secondary EM field which, along with the primary field, is detected by the receiver coil. The strength of the secondary EM field is a function of the intercoil spacing, the transmitter frequency, and the ground conductivity. In the case where the frequency of the transmitter is designed to be compatible with the intercoil spacing, the ratio of the secondary to the primary electromagnetic field becomes linearly proportional to the terrain conductivity. This fact makes it possible to construct the direct reading linear terrain conductivity meter used in this study. The units of conductivity reported are the mho per foot or, as is conventionally stated, the millimho per foot (mmho/ft).

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The EM unit used in this study is the EM31 manufactured by Geonics Limited. The EM31 is a portable unit operated by one man and provides a direct readout of conductivity to an accuracy of about 5 percent at 6.1 mmho/ft ground conductivity. The coil separation is 12 feet and the transmitter has an operating frequency of 9.8 kilohertz.

The operation of the EM31 can be conducted in both vertical and horizontal dipole antenna configurations. In its normal, upright position, the instrument is in the vertical dipole configuration. In this position, the contribution of the signal from soil at depths greater than 20 feet is about 30 percent. By placing the instrument on its side, the horizontal dipole position is achieved, where the contribution of the ground beyond a depth greater than about 10 feet is 30 percent of the total signal. Thus, the instrument can provide some depth discrimination, with the vertical dipole configuration "seeing" to a depth of about 20 feet, and the horizontal configuration responding to ground at half of that depth.

<u>Resistivity</u>

The resistivity of a material is a fundamental physical property related to the ability of a material to conduct electricity and is defined as the electrical resistance between the opposite faces of a unit cube of the material. The unit of resistivity is commonly given in ohm/feet, which is simply the inverse of conductivity. Accordingly, the resistivity method is applicable on the same basis as the EM method at the A-9 site. The advantage of the resistivity technique over EM measurements is the improved ability to measure vertical variations of the ground electrical properties. The disadvantage is that with the resistivity method it is necessary to place electrodes in the ground, precluding measurements along Line 1, which is covered by asphalt.

Electrical resistivity methods are based on the induction of direct current (DC) into the ground through two current electrodes and measurement of the voltage drop across two potential electrodes.

The electrode configuration used at Area A-1 is referred to as the Wenner configuration, where all four electrodes are separated by an equal spacing, known as the "A" spacing.

In order to investigate variations of resistivity with depth, two vertical electrical soundings (VES) were conducted. For VES measurements with the Wenner configuration, the "A" spacing is incrementally expanded to obtain data from successively deeper layers. For very small electrode spacings (one foot or less), the reading is presumed to be a resistivity value for the very near surface. However, as the electrodes are expanded, the data are influenced by successively deeper layers. By removing the effects of the shallow layers, a representation of the deeper intervals can be obtained from which a profile can be generated.

In addition to two VES measurements, apparent resistivity of the ground was also measured by keeping the "A" spacing constant and moving the electrode spaced along the line at regular intervals. Although true resistivity is not measured, relative horizontal variations of ground resistivity can be measured better than with the VES technique. "A" spacings of 10 and 20 feet were utilized along line 2.

Ground Probing Radar (GPR)

The GPR method consists of using an FM-frequency pulse source, antenna, and a graphic recorder to map reflections from subsurface interfaces. In order for a reflection to occur, an electromagnetic impedance contrast, which is related to the dielectric constant and conductivity of the material, must be present. The depth of penetration of the radar signal is a function of the nature of the material and the frequency of the antenna used. Energy is impeded by materials of high dielectric constant, such as water-saturated, highly plastic, clays, where detectable reflections may be restricted to a few feet from the surface. Sandy soil allows for considerably greater penetration, depending primarily on moisture content. An estimate of the depth of penetration achieved at the A-9 site is about 10 to 15 feet, with the lowest frequency antenna used.

The equipment used at the A-9 site was a GSSI SIR Model 8, manufactured by Geophysical Survey Systems, Inc., one of the most advanced systems commercially available. The unit consists of three components:

- A microprocessor controlled input module
- 120-, 300-, and 600-megahertz transmitter/receiver antennas mounted in portable cases
- An ADTEK analog graphic recorder.

The goal of the GPR technique at the A-9 site was to detect subsurface structure, or areas of reduced penetrations that could be related to the flow of groundwater. In addition, it was anticipated that the GPR technique could also detect the location of un-mapped subsurface pipes.