NUCLEAR REGULATORY COMMISSION

RADIOACTIVE MATERIALS LICENSE # SMA-1018

AMENDMENT No. 4

PROGRESS REPORT FOR OCTOBER, 1987 - MARCH, 1988

GREENVILLE SITE, Lot 2

WHITTAKER CORPORATION

Prepared by

ENERGY IMPACT ASSOCIATES

May 1988

By A. J. Krause
A. J. Krause

J. H. Wright
J. H. Wright

TABLE OF CONTENTS

INDEX OF TABLES AND FIGURES ii

I SUMMARY 1

II SCOPE OF AND COMPLIANCE WITH NRC LICENSE 2

III FIELD OPERATIONS FOR THIS REPORT PERIOD 4

A. NRC License Requirements and Compliance (Section 12 of Amendment #4)..... 4
B. Compliance with Section 13 5

IV MONITORING PROGRAM DATA AND ANALYSES 8

A. Radioactivity Assay for Current Samples 8
1. Ground Water Analyses
2. River Water Analyses
3. Sediment Analyses
B. Analyses of Gross Alpha/Beta Data 10
1. Ground Water Analyses Review 10
2. River Water And Sediment Data Evaluation 12
3. Statistical Inferences of River Radioactivity Data 17
C. Fence Line Radiation Levels, Oct,87-Mar,88 20
D. Summary of Observations 22

V CONCLUSIONS 23

APPENDIX
Part A Statistical Inferences of the River Data 24
Procedure 24
Example 25
Results 25
Part B Ground Water Levels 29
Part C Data Correction from Prior Report 30
Part D CALIBRATION of MICRO R METER 32
Part E Fence Inspection Report 33

INDEX OF TABLES AND FIGURES

Fig 1 Sample Locations at Whittaker Site 7
Fig 2 Gross Alpha in Ground Water..... 10
Fig 3 Gross Alpha in Ground Water at Location..... 11
Fig 4 Gross Beta in Ground Water at Location..... 11
Fig 5 Gross Beta in Ground Water..... 12
Fig 6 All Alpha Data in River Water..... 14
Fig 7 Gross Alpha, All Data..... 14
Fig 8 Gross Alpha, Selected Data..... 15
Fig 9 Alpha in River Water..... 15
Fig 10 All Beta Data in River Water..... 16
Fig 11 Beta in River Water..... 16
Fig 12 Gross Alpha in Sediment..... 18
Fig 13 Gross Beta in River Sediment..... 18

TABLE 1 Gross Radioactivity in Ground Water,pC/L..... 8
TABLE 2 Gross Radioactivity in River Water,pC/L..... 9
TABLE 3 Gross Radioactivity in River Sediment,pC/gm..... 9
TABLE 4 Summary of Statistical Results..... 19
TABLE 5 Radiation Level at Main Fence, uR/hr..... 20
TABLE 6 Radiation Level at New Fence, uR/hr..... 21

Table A-1 Gross Radioactivity Data, Statistical Analyses.. 26
TABLE A-2 Statistical Data for River Samples 27
TABLE A-3 Percentage Points of Many-one *t* Statistics..... 27
TABLE A-4 Summary of Statistical Results 28
TABLE A-5 Ground Water Levels in Sample Wells..... 29
Table A-6 Corrects T-3 prior report, Water Analyses..... 30
Table A-7 Corrects T-6 Prior Report, Sediment Analyses.... 31

I. SUMMARY

This report covers the results of two site visits conducted during the fourth quarter of 1987 and the first quarter of 1988. The results of the radioactivity analyses for the third quarter, 1987, are also included.

These site visits and radioactivity analyses were conducted in compliance with NRC License # SMA-1018 as modified in Amendment #4.

Highlights of this report period are the result of a review of all data taken since the outset of this project. This review of the data included both careful examination and statistical analyses. The result is two important findings:

(1) The analyses reported by Teledyne Isotopes were both internally consistent and consistent with the data from Oak Ridge Associated Universities.

(2) Statistical analysis of these qualified data clearly indicates that there is no significant change in radioactive content of river water or sediment between upstream and downstream sampling stations.

This information is used as a basis for a request to significantly reduce the monitoring requirements of this NRC license.

II. SCOPE OF AND COMPLIANCE WITH NRC LICENSE

The license as specified in Amendment #4 consists of the following parts:

A. Standard Scope

Sections 1 through 10 are standard fare, such as licensee name and location and description of site. This has not changed during the course of this report.

B. Quarterly Monitoring Program

Section 12 of License SMA-1018, as modified by Amendment #4, requires quarterly site visits, observations, radiation surveillance and various water and sediment samples. The purpose of this quarterly requirement is to assure that the radioactivity on the site poses no danger to the public.

The visual observations of site erosion are included in Section III, Part A, of this report.

The sampling and analyses of ground water for gross alpha and beta were conducted in each of the quarters as required. The analytical results are presented in Section IV, Part A.

The Shenango River water and sediments were sampled and analyzed in each of the quarters. These results are presented in Section IV, Part A.

The measurement of the ionizing radiation levels at the Whittaker site boundaries are presented in Section IV, Part B.

C. Access Control

Section 13 requires restricting the access to the contaminated area. The access control arrangement at the Whittaker site consists of a physical constraint of secure fencing around the entire perimeter of the site and administrative controls regarding access to the site through locked gates. More information on this subject is contained in Section III, Part B.

D. Licensee Intentions

The current NRC license for this site expires in July of this year. While the Whittaker Corporation will request the required extension to this license, a major reduction in the compliance requirements associated

with this license will be requested. The most recent data, reported in Section IV, provides a consistent extension to prior results, which reflect no significant differences between upstream and downstream radioactivity levels.

III. FIELD OPERATIONS, 4th Quarter, 1987 and 1st Quarter, 1988

This portion of the report covers the field operations for the last quarter of 1987 and the first quarter of 1988. A total of two site visits were made during this period. Observations were made of erosion of top soil, samples were taken from ground water, river water and sediment, and the site boundary was examined on each of the visits to determine the radiation levels at the fence line.

A. NRC License Requirement of Section 12 of Amendment 4

1. Erosion Observations

Two site visits were made to the Whittaker property during these six months. They were on November 5, 1987, and March 19, 1988 . There was no visible evidence of surface erosion during any of these site visits.

2. Environmental Sampling for Radioactive Material

During the November of 1987 and March of 1988 visits, two sets of samples of ground water, river water and sediment were taken from the site and its environs. These river water, river sediment and well water samples were taken from the sample positions shown in Figure 1, according to established procedures, and submitted for gross Alpha and Beta analyses.

During the November ground water sampling Wells W-8 and W-9 had no water. Well W-9 was also dry during the March visit. These wells have been dry at least half the time and do not constitute consistent sources for routine sampling.

The levels of ground water were carefully measured in each well during these two quarters: the resulting water levels are presented in Table A-6 of Part B of the Appendix.

The gross alpha and beta radiation levels of ground water samples taken during this reporting period are given in Table 1 of Section IV.

While the results of prior site visits were reported in the Progress Report dated October 1987, the analyses from the samples collected on September 4, 1987, were not completed at that time and are included in the appropriate section of

this progress report.

Similarly, samples of river water and river sediment were taken during the November, 1987, and March, 1988, site visits. The radioactivity analyses of river water for the third and fourth quarters of 1987 and the first quarter of 1988 are reported in Table 2, Section IV, and river sediment is reported in Tables 3.

3. Direct Radiation at the Site Boundaries

Measurements of the ionizing radiation at several different locations were made during each of the site visits during this reporting period. The instrument used was a Ludlum Model 19 Micro R Meter. The periodic calibration of this instrument was conducted by G P Instrument Services, Inc, during this period. The resulting calibration information is contained in Part D of the Appendix.

The observed radiation levels for the site visits are recorded in Tables 5 and 6 of Section IV D.

B. Compliance with License Section 13 Limiting Access to Site

Unauthorized movement of personnel and materials to and from the site is restricted by fencing, and the gate access record log is constantly reviewed.

1. Fencing to Restrict Access

A chain link fence was constructed between the Whittaker site and the Greenville Metals property in 1986. The gates on the chain link fence are kept locked except for a fire emergency which might necessitate access to the river water. A barbed wire fence on the east side completes the enclosure of the Whittaker temporary disposal site.

The location of this fencing is approximately one foot inside the property line from a point approximately 77.5 feet from M (toward a), counter clockwise to a point approximately 550 feet from N (toward M). At the departure from the property line, the new fence is routed from the Shenango River to the Reynolds Water Company fence approximately 77.5 feet from M.

Figure 1 shows the location of fencing and radiation measuring sites, as well as river and ground water sampling positions.

2. Security Inspection

The security system at the Whittaker site consists of both physical (fencing) and administrative constraints. The plant guards at Greenville Metals Company hold keys to the Whittaker property in case of emergency and log the use of these keys. Also, the gate locks and fence condition are periodically inspected and a Fence Inspection Report is submitted each month to record these findings. The gate report form is attached in Part E of the Appendix.

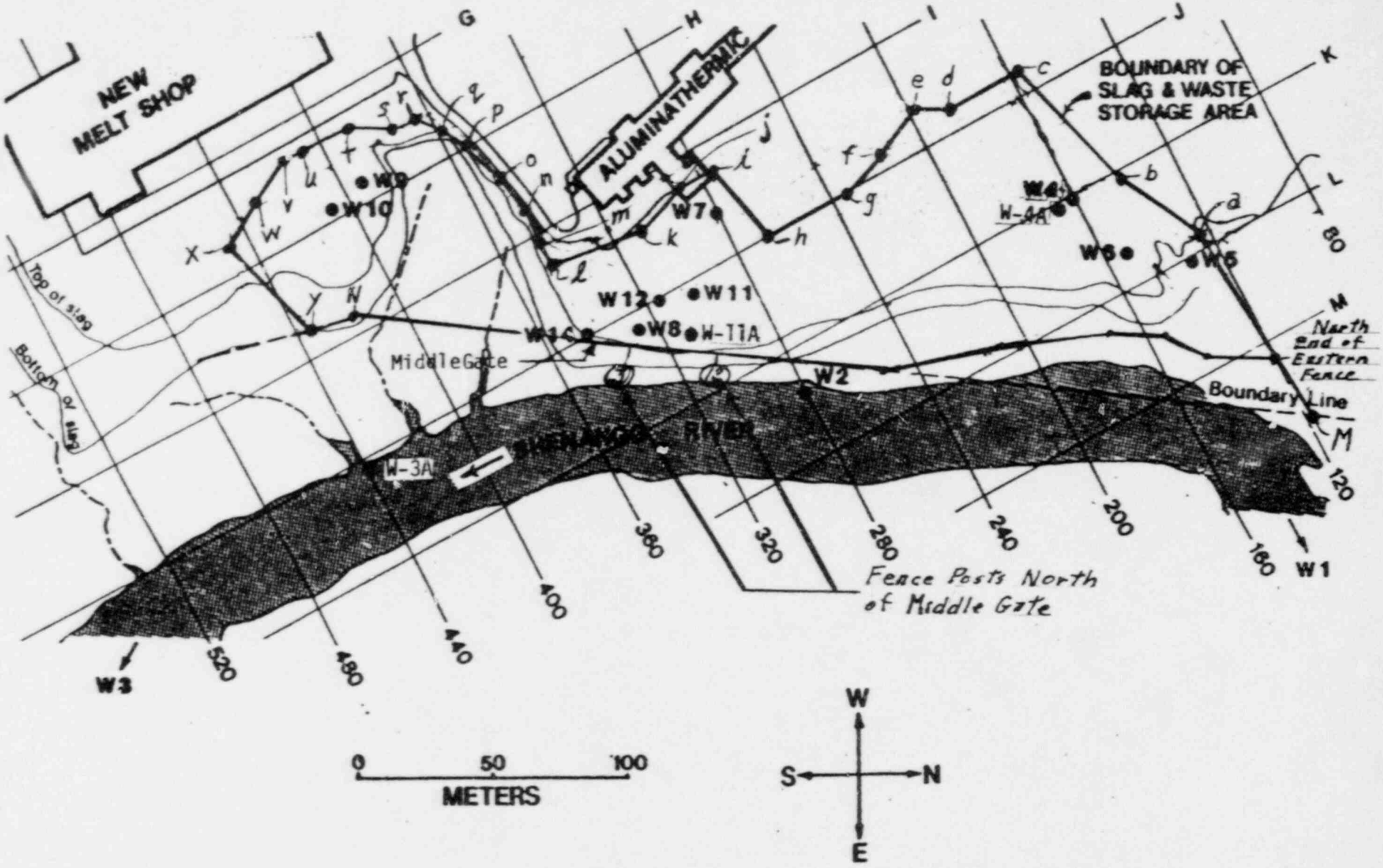


FIGURE 1

SAMPLE LOCATIONS AT WHITTAKER SITE

IV. Monitoring Program Data And Analyses

A. Radioactivity Assay for Current Samples

This section reports the laboratory results of gross alpha and gross beta analyses conducted on samples collected during the third and fourth quarters of 1987 and during the first quarter of 1988.

1. Ground Water Analyses

The ground water samples continued to show radioactivity levels, while the river water and sediment showed results quite consistent with prior analyses.

TABLE 1

GROSS RADIOACTIVITY IN GROUND WATER, pC/L

	9/04/87		11/5/87		3/19/88	
	TELEDYNE	+/-	TELEDYNE	+/-	TELEDYNE	+/-
Gross Alpha						
W-4A	< 1		< 2		< 3	
W-8	< 4		*		< 10	
W-9	< 4		*		*	
W-11A	< 3		< 4		< 5	
W-12	*		*		*	
W-14	< 2		< 4		< 5	
Gross Beta						
W-4A	4.3	1.7	< 4		6.1	2.6
W-8	33	4	*		45	10
W-9	36	4	*		*	
W-11A	< 3		< 5		6.3	3.1
W-12	*		*		*	
W-14	5.6	1.9	7.8	3.5	7.6	3.3

* no water

2. River Water Analyses

The gross alpha and gross beta radioactivity analyses for this reporting period are reported in Table 2.

In all of these samples the gross alpha was reported to be below 2 pico Curies per liter, a result in the range of lowest levels or detectability. These analyses continue to show extremely low levels of radioactivity continuing the values presented in the last progress report.

TABLE 2

GROSS RADIOACTIVITY IN RIVER WATER, pC/L

Date	9/04/87 TELEDYNE	+/-	11/5/87 TELEDYNE	+/-	3/19/88 TELEDYNE	+/-
Gross Alpha						
W-1	< 1.0		< 2.0		< 2.0	
W-2	< 1.0		< 2.0		< 2.0	
W-3	< 1.0		< 2.0		< 2.0	
W-3A	< 1.0		< 2.0		< 2.0	
Gross Beta						
W-1	3.3	1.6	< 4.0		5.4	2.5
W-2	2.7	1.5	< 4.0		4.1	2.3
W-3	2.4	1.5	< 4.0		< 3	
W-3A	2.3	1.5	< 4.0		3.9	2.3

3. Sediment Data

The results of river sediment analyses are reported in Table 3.

TABLE 3

GROSS RADIOACTIVITY IN RIVER SEDIMENT, pC/gm

Date	9/04/87 TELEDYNE	+/-	11/5/87 TELEDYNE	+/-	3/19/88 TELEDYNE	+/-
Gross Alpha						
W-1	14	7	18	8	15	7
W-2	17	7	17	7	12	6
W-3	22	8	9.5	6	14	7
W-3A	20	8	12	7	12	6
Gross Beta						
W-1	27	3	25	3	29	3
W-2	30	3	23	2	29	3
W-3	24	3	28	3	31	3
W-3A	26	3	24	2	25	3

These new data will be integrated into all prior data and examined for consistency, trends and meaningful relationships.

Many of these and former analyses do not specify values or value ranges but only give a "not greater than" level. This "not greater than" value was used in the following series of graphs and in the statistical inferences. Although this usage is not rigorously correct, the simplification may tend to reflect a somewhat conservative result. But, the simplification is necessary for the quantitative analyses which now follows.

B. ANALYSES OF GROSS ALPHA/BETA DATA

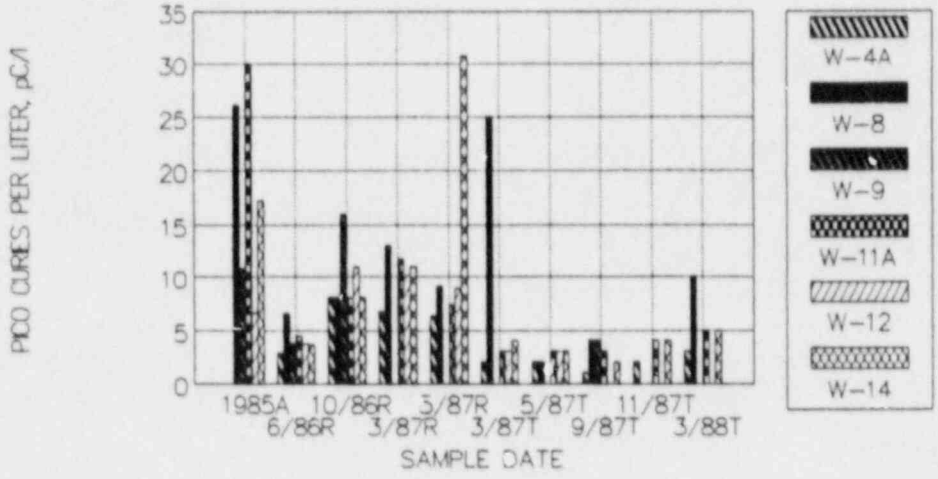
1. Ground Water Analyses Review

The ground water sample sites are located within the Whittaker Temporary Disposal Site and shown on Figure 1, Section III. These sample sites were specified by the NRC during past examinations and site visits.

The ground water data collected during the last four years are presented graphically in Figures 2, 3, 4 and 5 which follow. Figures 2 and 3 present gross alpha radiation.

FIGURE 2

GROSS ALPHA IN GROUND WATER



Figures 4 and 5 depict gross beta radiation levels of the ground water from the test sites.

Figures 2 and 5 are bar charts showing the comparison of data obtained at different times and analyzed by different labs. Each sample date shows the result, if available, from each of the six test wells. Figures 3 and 4 use sample location, rather than time, as the abscissa.

At first observation it would appear that there has been a reduction in gross radioactivity from 1985 to present. A closer examination, however, shows considerable disparity between the two labs

FIGURE 3

GROSS ALPHA IN GROUND WATER AT LOCATI

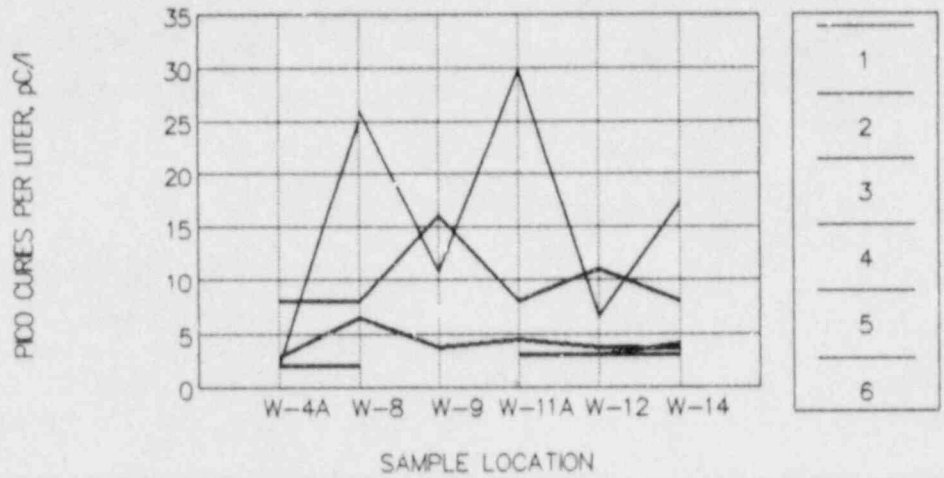
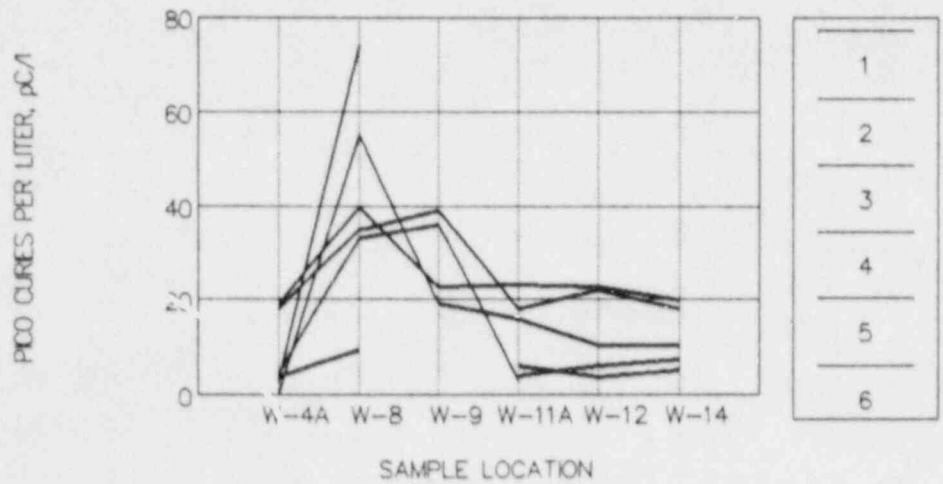


FIGURE 4

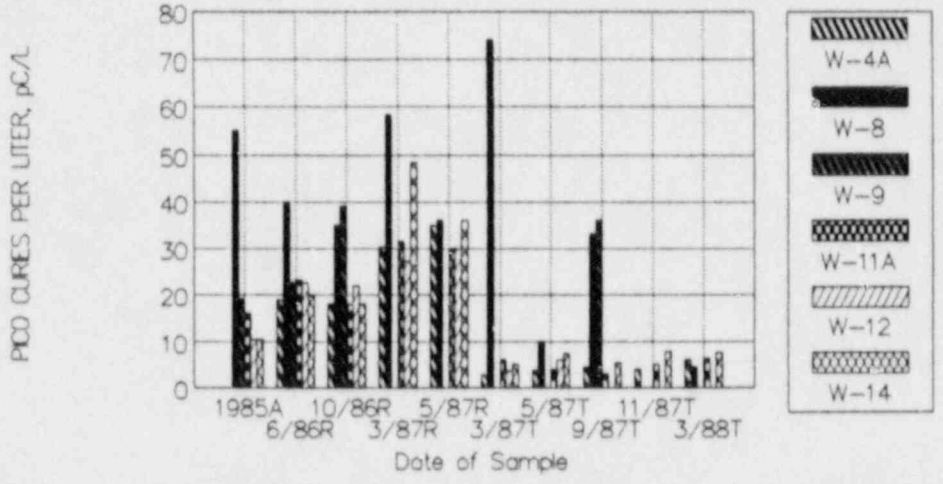
GROSS BETA IN GROUND WATER AT LOCATION



doing the analyses. Duplicate samples were tested from the first and second quarters of 1987, and the test results differed, on average, by a factor of three, with Radiation Services Organization being higher than Teledyne Isotopes.

FIGURE 5

GROSS BETA IN GROUND WATER



There appears to be no pattern to the gross alpha and beta sample contents other than a general tendency for wells W-8 and W-11A to run a little higher than the other wells. This is to be expected because those well locations are in the same area as the locations for the highest gamma readings at the site boundary.

2. River Water and Sediment Data Evaluation

River Water Data Figure 6 presents the river water alpha analyses beginning with the Oak Ridge Associated Universities work of 1985 and including the new data from part A of this section. For ease of review these data are plotted in a bar chart as sets of data from specific sampling periods, month/year-analytical lab.

Each set contains the four river water sample locations comprising a complete data set. (For location of the sample points see Figure 1).These eight sets of data show results obtained by RSO and Teledyne. It is important to note that two of these sets, 3/87 and 5/87, were duplicate samples analyzed by both labs. The RSO data shows results typically in the range of 4-10 pC/L, while the

Teledyne data reflect values of less than 2 pC/L. Only the Teledyne data is reasonably consistent with the ORAU data.

Figure 7 presents the same data in a different graphical format, with the sample location as the abscissa rather than the sample date.

In Figures 7 and 8 the upstream sample is W-1, the downstream W-3 and intermediate points between where plant site surface drainage occurs, W-2 and W-3A. By observation it can be noted that there is no data here which would indicate an increase in gross alpha levels as a result of flowing through the plant site. In some cases the data from RSO and ORAU show a *decrease* in alpha levels as the river water runs alongside the Whittaker site.

Figure 7 shows that the RSO data was much higher in magnitude than either the ORAU data or the Teledyne data and has considerable scatter. While it must be remembered that these gross alpha levels are in the range of natural background and, by any standards, must be considered extremely low, the large differences between RSO and ORAU are not easily explained.

Figure 8 displays the Teledyne data compared to ORAU.

From these figures it is apparent that Oak Ridge Associated Universities (ORAU) data and the Teledyne data are reasonably consistent while the Radiation Service Organization (RSO) data is somewhat higher.

For reasons previously discussed in this report and in the last progress report it was concluded that the RSO data should not be used in further analyses.

Figure 9 represents the selected data for gross alpha levels in Shenango River water.

Beta analyses comparisons were made for the same sample sets. All the beta results are shown in Figure 10 where the disparity between RSO samples and others are again noted.

Figure 11 presents the selected gross beta levels in river water. This is essentially the same data except the RSO results were eliminated.

These relatively consistent data span a period from 1985 through 1987. The alpha data for study is shown

in Figure 9 and the beta data in Figure 11. These data are presented in tabular form in the APPENDIX, Part A, Table A-1.

FIGURE 6

ALL ALPHA DATA IN RIVER WATER

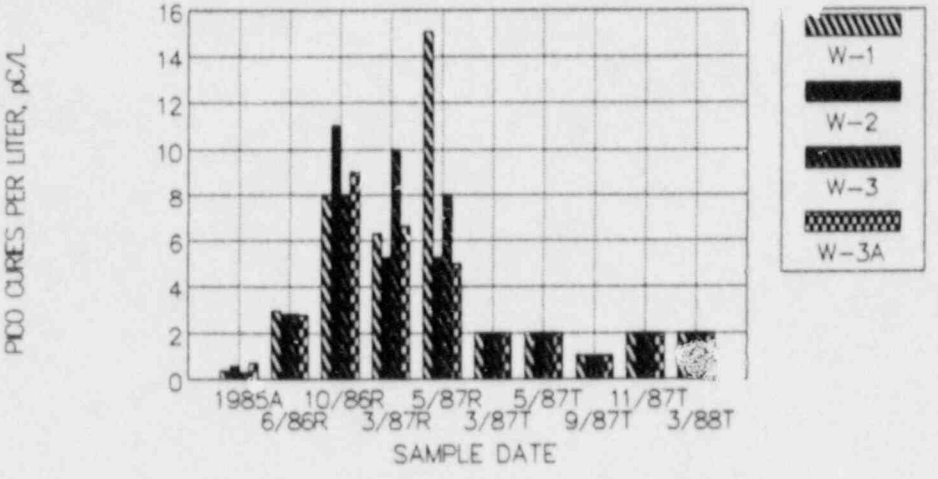


FIGURE 7

GROSS ALPHA, ALL DATA

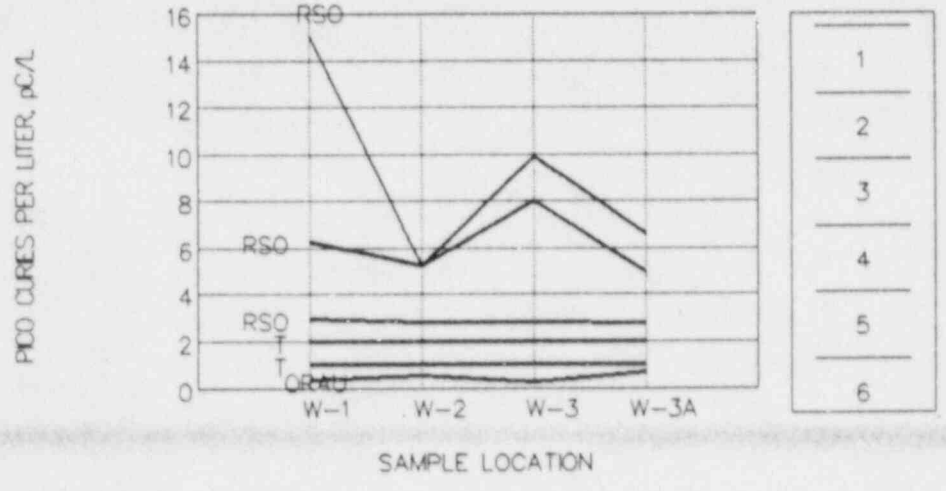


FIGURE 8

GROSS ALPHA, SELECTED DATA

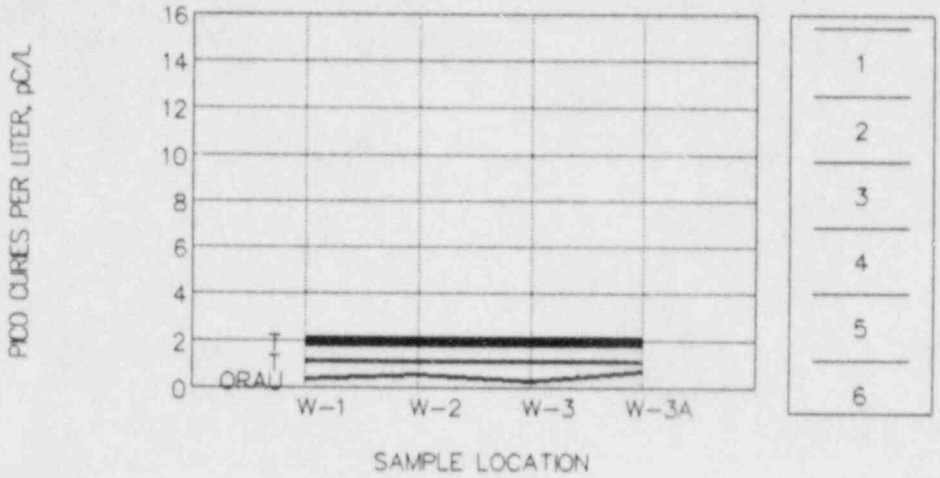


FIGURE 9

ALPHA IN RIVER WATER

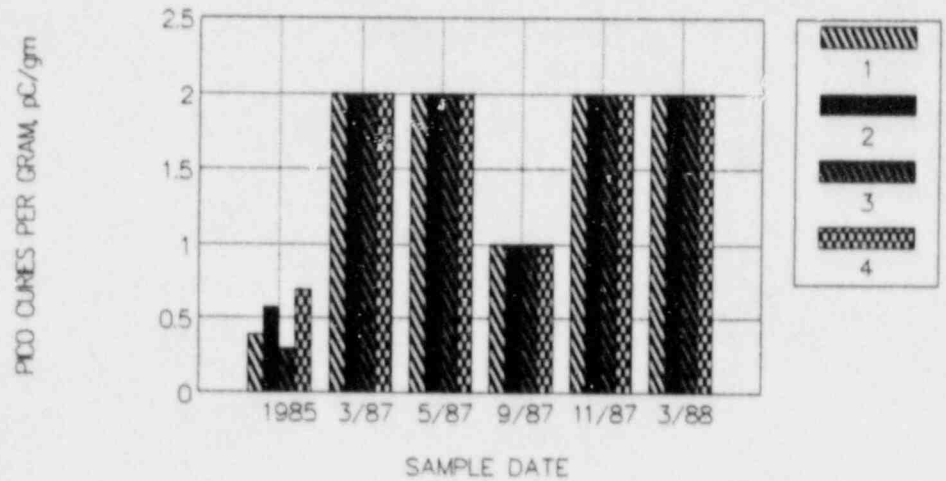


FIGURE 10

ALL BETA DATA IN RIVER WATER

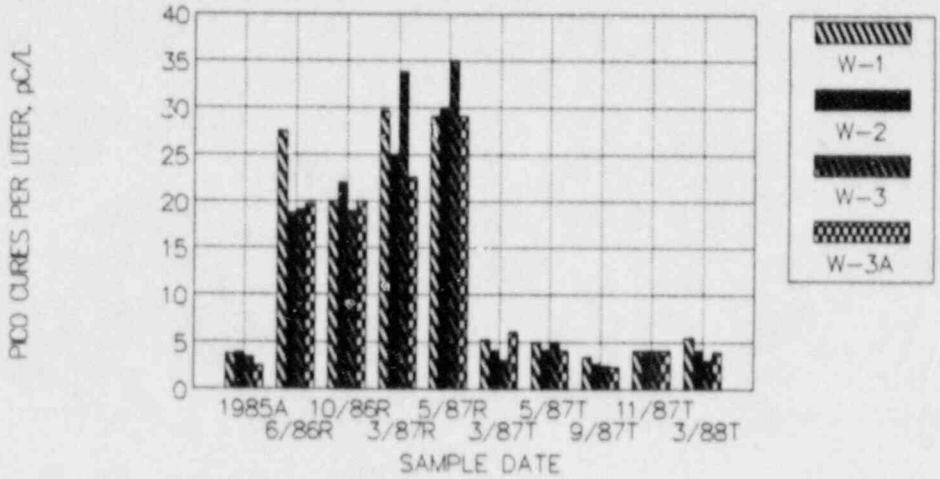
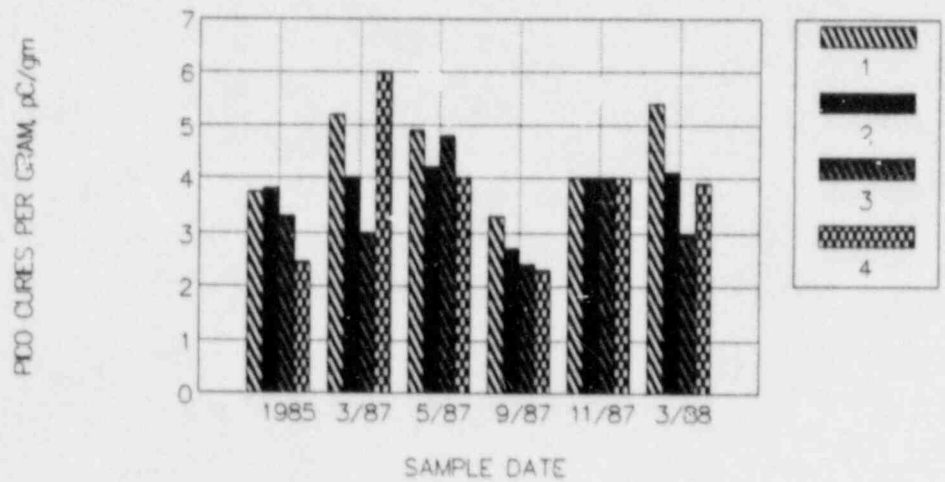


FIGURE 11

BETA IN RIVER WATER



Sediment Data Although Teledyne Isotopes was incorporated as the laboratory of record for this license in the summer of 1987, analyses by Teledyne were extended into 1988 through analyses of archive samples.

Figures 12 and 13 present the gross radioactivity analyses of river sediment as determined by Teledyne Isotopes.

Similar to the examination of river water, the sediment samples were examined to see if there is any higher radiation levels in the areas adjacent to the plant locations (W-2 and W-3A) or downstream of the plant (W-3) compared to the upstream samples (W-1). A review of these figures suggest that there is no pattern to the radioactive measurements over time or location.

It can be noted that in some cases the upstream radioactivity of sediment were even higher than any of the downstream locations. It would appear that the variation in radiation contents of sediment may be due to analytical inaccuracies at these extremely low levels.

This relative consistency in the sediment sampling further substantiates the justification made in the last progress report for eliminating the early RSO sediment data; namely, the Teledyne data covers a three-year period and was conducted to uniformly consistent analytical procedures and quality controls in contrast to the RSO analyses that were scrubbed.

These data, nevertheless, were subjected in the following statistical analyses to determine if, indeed, these samples are from the same or differing populations.

3. Statistical Inferences of River Radioactivity Data

Statistical methods for examining these data were carefully evaluated. Although Student's *t* Test might be applied in comparing the upstream value(W-1) with any one downstream value (W-3 or W-2 or W-3A), it was concluded that the more meaningful analysis would consist of a statistical method for simultaneous inference of the three downstream points against the upstream value. The *many-one t statistics* (1) approach was selected.

The data were subjected to statistical analysis using the referenced *many-one t* test and the null hypothesis, "the selected river data are from the same population".

The details of the procedure and application of these tests and the subsequent results of the analyses are contained in Part A of the Appendix of this report and the results are summarized in Table 4.

FIGURE 12

GROSS ALPHA IN SEDIMENT

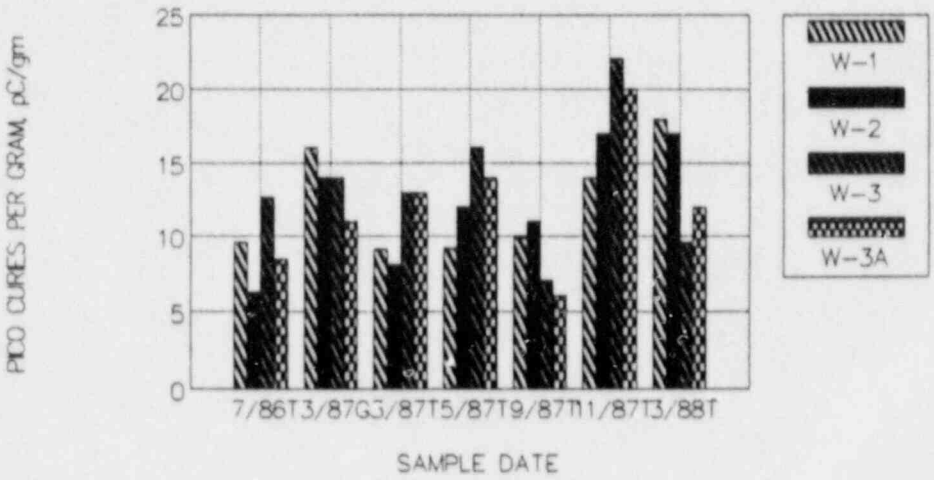


FIGURE 13

GROSS BETA IN RIVER SEDIMENT

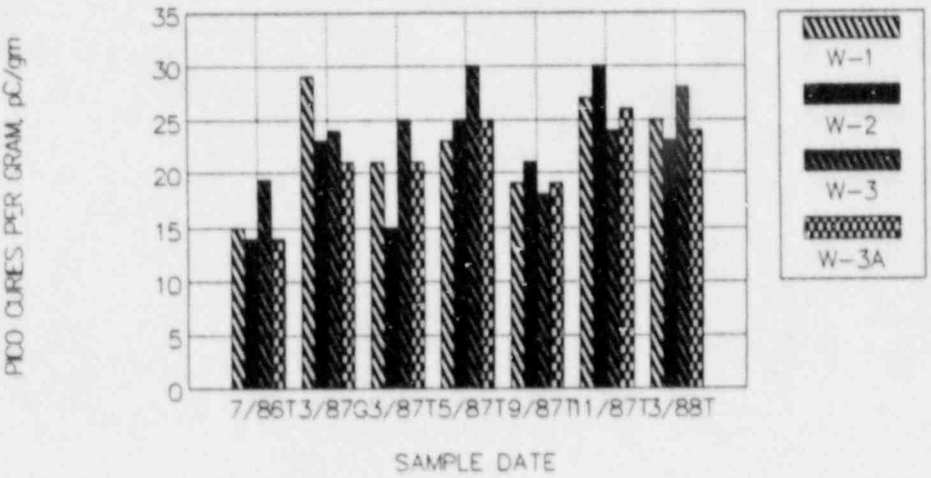


TABLE 4
SUMMARY OF STATISTICAL RESULTS

POSITION	SAMPLE			Calc Ti	Crit *Ct*	NULL HYPOTHESIS	CONCLUSIONS
W-2	WATER	-	ALPHA	INTUITIVE		Not Rejected	Same population
W-3	WATER	-	ALPHA	INTUITIVE		Not Rejected	Same population
W-3A	WATER	-	ALPHA	INTUITIVE		Not Rejected	Same population
W-2	WATER	-	BETA	-0.51	2.19	Not Rejected	Same population
W-3	WATER	-	BETA	-0.63	2.19	Not Rejected	Same population
W-3A	WATER	-	BETA	-0.31	2.19	Not Rejected	Same population
W-2	SEDMT	-	ALPHA	0.02	2.17	Not Rejected	Same population
W-3	SEDMT	-	ALPHA	0.05	2.17	Not Rejected	Same population
W-3A	SEDMT	-	ALPHA	-0.08	2.17	Not Rejected	Same population
W-2	SEDMT	-	BETA	-0.12	2.17	Not Rejected	Same population
W-3	SEDMT	-	BETA	0.12	2.17	Not Rejected	Same population
W-3A	SEDMT	-	BETA	-0.33	2.17	Not Rejected	Same population

In each case the calculated *many-one t statistic* was found to be lower in value than the one-tailed critical *t* value; thus, the statistical inference is that the upstream and the downstream observations are not from different populations; e.g. there is no significant difference in radioactivity levels from the upstream reference to any of the downstream locations.

If the calculated values of *t* (Ti) would have been comparable in size to the critical value of *Ct*, then the inference would have been that the downstream values would have been from a different (higher radioactivity) population than the upstream and the null hypothesis would have been rejected.

The statistical analyses of the beta concentrations in upstream and downstream river water (Table 4) inferred that the four sample points, W-1,W-2,W-3 & W-3A, were not of statistically different populations; e.g, there is no significant difference between upstream and downstream beta activity in the river water or sediment.

These data and analyses indicate that there is no alpha nor beta containing radioactive material entering the Shenango River from the site in detectable quantities.

C. Fence Line Radiation from Current Field Trips

Fence line measurements taken during this reporting period are recorded in Tables 5 and 6. Radiation levels were measured during the two site visits (November 1987 and March 1988).

The data are reported in a more meaningful manner at this time. In Table 5, for example, first the prior data is summarized in three columns, average, maximum and minimum. Then the new data with their appropriate dates are added. The third portion shows the new average and the changes in the average that these data caused and shows new maximum or minimum that occurred during this reporting period.

TABLE 5

RADIATION LEVEL AT MAIN FENCE, uR/hr

Date	OLD DATA (3)			NEW DATA (2)		NEW RESULTS (5 OBSERVATION			
POSITION	AVG	MAX	MIN	11/87	3/88	AVG	CHG AVG	NEW HI	NEW LO
a	5.8	6.5	5.5	5.5	5.5	5.75	-0.1	NO	NO
b	6.1	6.5	6.0	6.0	6.5	6.1	0.0	NO	NO
c	7.1	7.5	6.0	6.5	7.5	7.05	-0.0	NO	NO
d	8.2	9.0	7.0	8.5	9.0	8.3	0.1	NO	NO
e	9.2	10.0	8.0	9.0	10.5	9.3	0.1	10.5	NO
f	5.9	7.0	5.0	6.5	7.0	6.1	0.2	NO	NO
g	5.3	6.0	5.0	5.5	7.0	5.5	0.2	7.0	NO
h	12.6	13.5	11.5	12.0	12.5	12.5	-0.1	NO	NO
i	7.3	8.0	7.0	7.0	7.5	7.25	0.0	NO	NO
j	7.6	8.0	7.0	8.5	9.0	7.8	0.2	9.0	NO
k	10.2	11.0	8.5	9.5	12.0	10.3	0.1	12.0	NO
l	7.6	8.5	6.5	7.0	8.0	7.6	-0.0	NO	NO
m	7.4	8.0	7.0	8.0	8.0	7.5	0.1	NO	NO
n	6.6	7.0	6.0	6.5	7.0	6.65	0.0	NO	NO
o	5.9	6.5	5.0	6.0	6.0	5.95	0.0	NO	NO
p	5.7	6.5	5.5	5.5	6.5	5.75	0.1	NO	NO
q	5.2	6.0	4.5	5.5	6.0	5.3	0.1	NO	NO
r	5.1	6.0	5.0	5.0	5.5	5.15	0.0	NO	NO
s	4.9	5.5	4.5	5.5	5.5	5	0.1	NO	NO
t	4.6	5.0	4.0	5.0	5.0	4.7	0.1	NO	NO
u	4.9	6.0	3.5	5.0	5.5	4.95	0.1	NO	NO
v	5.1	6.0	4.5	5.0	5.5	5.15	0.0	NO	NO
w	6.0	7.0	5.0	6.0	7.0	6.1	0.1	NO	NO
x	6.0	7.0	5.0	6.0	6.5	6.05	0.0	NO	NO
y	6.2	11.0	5.0	5.5	6.0	6.1	-0.1	NO	NO
N	8.5	15.0	7.0	7.5	9.0	8.45	-0.1	NO	NO
M	3.7	4.5	3.0	3.5	3.5	3.6714	-0.0	NO	NO

From Table 5 it can be noted that there was very little change in the overall average as a result of these measurements, but four locations registered higher level readings than had ever been recorded before at those locations. In almost every case it can be noted that the March 1988 measurements were higher than the November of 1987 measurements.

Table 6 presents the measurements taken at the new Eastern fence along the back of the property. This portion of the property has much higher levels at the fence line, but access to this portion of the site is much more difficult in that the chain link fence provides security from the front and the river, brush, topography and barbed wire fence limit and restrict access from the East side. These radiation levels are presented in Table 6.

TABLE 6
RADIATION LEVEL AT NEW FENCE, uR/hr

Date	OLD DATA (3)			NEW DATA (2)		NEW RESULTS (5 OBSERVATION			
POSITION	AVG	MAX	MIN	11/5/87	3/19/88	AVG	CHG AVG	NEW HI	NEW LO
1	13.8	14.5	13.5	14.0	14.5	14.0	0.2	14.5	NO
2	11.7	12.0	11.5	12.5	13.0	12.1	0.4	13.0	NO
3	13.3	15.0	12.0	12.0	15.5	13.5	0.2	15.5	NO
4	59	65	49	63	65	61	2	65	NO
5	78	85	70	68	83	77	-1	83	68
6	93	95	88	95	97	94	1	97	NO
7	93	97	90	98	105	96	3	105	NO
FLAG	112	115	110	112	127	115	3	127	NO
8	162	170	150	167	170	164	3	170	NO
9	109	111	105	112	118	111	3	118	NO
10	187	190	185	193	185	188	1	193	NO
11	127	130	120	160	145	137	10	160	NO
12	12.5	13.5	11.0	15.0	15.5	13.6	1.1	15.5	NO
								13 NEW HIGHS	
								1 NEW LOW	

These data are presented in the same format as data in Table 5. While the averages changed very, very little, new high radiation levels were recorded at every single site. One new low was also recorded during the November session.

The hand held instrument, LUDLUM MODEL 19 MICRO R METER, was calibrated by GP Instruments in the first quarter of 1988. The fence location and some of the radiation measurement locations can be noted in Figure 1, Section III.

D. Summary of Observations

Considerable data has been taken and analyzed over the past several years. A thorough review of these data led to the following conclusions:

1. The measurements of radioactivity in river water have shown a great deal more natural variation with year and season than variation between upstream and downstream samples.

2. The variations that have been noted in these samples are minor in magnitude and are, generally, in the background noise level.

3. Statistical analyses does not support that there is any significant difference between upstream river water and sediment radioactivity and the other sampling points parallel to or below the plant.

4. There is a seemingly random variation in radioactive content of the ground water.

5. Direct gamma radiation measurements at the main fence line show rather consistent levels for the last two site visits but may be increasing in the springtime as rainwater causes erosion of the earth shielding.

6. There appears to be no monitoring information which would in any way imply that radioactive material has escaped the site during the course of this sampling.

V. CONCLUSIONS

The NRC license will come due for reissue in the summer of 1988. Next actions must include consideration of how the Whittaker temporary storage site for source grade material can continue to avoid posing any threat to the public or operating staff at minimum cost to the operator.

The site compliance requirements have included physical and administrative security, site inspection, and radiation surveillance and gross alpha and beta radioactivity of ground and surface water and sediments.

The gross radioactivity data gathered thus far does not indicate that there is any identifiable amount of radioactive material migrating from the site into the general environment. The site does not appear to be a threat to the public safety nor to the environment at this time.

These considerations suggest that the license extension should have as its principal compliance requirement the maintenance of security to the site, including site inspection and fence line radiation monitoring. Monthly inspections of the gate and locks might include observations regarding any change in on-site storage or retention of radioactive material. Such a scope would seem to provide essentially all of the monitoring value for this license. The shifting priorities would then provide for the elimination or reduction in scope and frequency of the site sampling and analyses.

If all sampling is not eliminated, then the highest priority items will be reduction in the frequency and number of samples required. The first item to be eliminated would be the river sediment sampling and analysis. Because there is no standard method for these analyses, it would be very desirable to eliminate them from the compliance requirements.

There may be limited merit to some continuing surveillance of the river water analyses on a less frequent basis, perhaps once per year. The primary purpose of this continuing surveillance would be to provide a secondary means of determining any new burst of leakage from the Whittaker site which might accompany a breach in the storage containment system there.

APPENDIX

PART A STATISTICAL INFERENCES OF THE RIVER DATA

The data describing the radioactivity levels of river water and sediment in the Shenango River were subjected to Dunnett's *many-one t* statistics examination. This examination tested each group of downstream samples against the null hypothesis,

> "the downstream radioactivity levels are not different from the upstream (control) locations".

This thesis will be rejected or not rejected depending on the comparison of the calculated *many one t* value with the critical value of *Ct* from Table A-3.

Procedure

The data for each of the water and sediment analyses is found in Table A-1. In Table A-2 the statistical calculations using the LOG (base 10) of the data are listed, the mean, variance, standard deviation, k value, n value, v value, the calculated *many one t* value and the critical value from Table A-3. It is proper to use the LOG in conducting statistical analyses of counting data because counting data generally does not reflect a normal distribution, whereas the LOG of counting data shows a more normal distribution.

The calculated value of Ti is obtained from statistical formulae which follow, and Table A-3 is used to obtain the critical value for *t* when using the *many-one t* statistical inference for confidence levels of 95% and 99%. The tables are entered using the degrees of freedom, v, the number of treatments (locations) k, and the desired confidence level.

The actual *many-one t statistic* is calculated from the following formulae:

$$Ti = |(\bar{Y}i. - \bar{Y}o.) - (ui - uo)| / s * SQR(2/n)$$

where

$\bar{Y}i.$ is the mean of the observations at the i'th downstream location
$\bar{Y}o.$ is the mean of the observations at the control location
ui is the population mean for the i'th location
uo is the population mean for the control location
n is number of observations for each location

and the variance, s^2, is defined as follows:

$$s^2 = [1/(k+1)*(n-1)] * SUM(\bar{i},j)(Yij - Yi.)^2$$

Example The alpha sediment sample, W-3, is used by way of example. The data for all alpha sediment samples are included in Table A-1. The mean of the log of all data from this group is 1.10141. The corresponding data for the control (W-1) is 1.098017.

The variance and standard deviation for the example case are 0.013204 and 0.114908 respectively. The corresponding values for the control are 0.015965 and 0.126351. The values for k, n, and v are given in Table A-2.

The average difference is extremely small leading to a calculated *many one t* value of 0.017047 which must be compared to the critical value, *Ct* from Table A-3 of 2.17. The dissimilarity between these two numbers causes the null hypothesis to be accepted.

The critical *t* was much greater (more than 100 X) than the *many-one t*(calculated Ti) so the hypothesis of identical populations in upstream vs. downstream radioactivity levels is supported to a 95% confidence level.

Results The results of the statistical analyses among the upstream (control) observations of river water and river sediment for gross alpha and gross beta and the three downstream positions are presented in Table A-4.

TABLE A-1

GROSS RADIOACTIVITY DATA FOR STATISTICAL ANALYSES

	1985A ORAU	7/86T Tdyn	3/87G GaTech	3/87T Tdyn	5/87T Tdyn	9/87T Tdyn	11/87T Tdyn	3/88T Tdyn
GROSS ALPHA RADIOACTIVITY								
River Water								
W-1	0.38			2	2	1	2	2
W-2	0.56			2	2	1	2	2
W-3	0.29			2	2	1	2	2
W-3	0.68			2	2	1	2	2
Sediment								
W-1		16	9	9.1	9.8	14	18	15
W-2		14	8	12	11	17	17	12
W-3		14	13	16	7	22	9.5	14
W-4A		11	13	14	6	20	12	12
GROSS BETA RADIOACTIVITY								
Riv Water								
W-1	3.74			5.2	4.9	3.3	4	5.4
W-2	3.81			4	4.2	2.7	4	4.1
W-3	3.3			3	4.8	2.4	4	3
W-3	2.45			6	4	2.3	4	3.9
Sediment								
W-1		29	21	23	19	27	25	29
W-2		23	15	25	21	30	23	29
W-3		24	25	30	18	24	28	31
W-4A		21	21	25	19	26	24	25

TABLE A-2

STATISTICAL DATA FOR RIVER SAMPLES

RIVER WATER ALPHA	(Aa-Sa)	Variance	STD DEV	Avg Dif	many t	k	n	v	Ct
W-1									
W-2	INTUITIVE CORRELATION OF SAME					3	6	20	
W-3	POPULATION					3	6	20	
W-3A						3	6	20	
BETA									
W-1	0.638673	0.007505	0.086633	* * BASIS FOR COMPARISON * *					
W-2	0.575407	0.005177	0.071952	-0.06327	-0.50765	3	6	20	2.19
W-3	0.522711	0.011182	0.105744	-0.11596	-0.63314	3	6	20	2.19
W-3A	0.554038	0.024075	0.155162	-0.08463	-0.31492	3	6	20	2.19
SEDIMENT ALPHA									
W-1	1.098017	0.015965	0.126351	* * BASIS FOR COMPARISON * *					
W-2	1.10141	0.013204	0.114908	0.003393	0.017047	3	7	24	2.17
W-3	1.110795	0.025528	0.159776	0.012777	0.046171	3	7	24	2.17
W-3A	1.077001	0.024487	0.156483	-0.02102	-0.07754	3	7	24	2.17
BETA									
W-1	1.388114	0.005	0.070712	* * BASIS FOR COMPARISON * *					
W-2	1.365604	0.010113	0.100564	-0.02251	-0.12924	3	7	24	2.17
W-3	1.404182	0.006355	0.079718	0.016068	0.116371	3	7	24	2.17
W-3A	1.35918	0.002627	0.051252	-0.02893	-0.32595	3	7	24	2.17

TABLE A-3

PERCENTAGE POINTS OF THE MANY-ONE t STATISTICS
(For reference, see Chap. 2, Sec. 5)

(One-tailed) $d^{\alpha}_{k,\nu}$

	$\alpha = .05$									$\alpha = .01$								
ν \ k	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
5	2.02	2.44	2.68	2.85	2.98	3.08	3.16	3.24	3.30	3.37	3.90	4.21	4.43	4.60	4.73	4.85	4.94	5.03
6	1.94	2.34	2.56	2.71	2.83	2.92	3.00	3.07	3.12	3.14	3.61	3.88	4.07	4.21	4.33	4.43	4.51	4.59
7	1.89	2.27	2.48	2.62	2.73	2.82	2.89	2.95	3.01	3.00	3.42	3.66	3.83	3.96	4.07	4.15	4.23	4.30
8	1.86	2.22	2.42	2.55	2.66	2.74	2.81	2.87	2.92	2.90	3.29	3.51	3.67	3.79	3.88	3.96	4.03	4.09
9	1.83	2.18	2.37	2.50	2.60	2.68	2.75	2.81	2.86	2.82	3.19	3.40	3.55	3.66	3.75	3.82	3.89	3.94
10	1.81	2.15	2.34	2.47	2.56	2.64	2.70	2.76	2.81	2.76	3.11	3.31	3.45	3.56	3.64	3.71	3.78	3.83
11	1.80	2.13	2.31	2.44	2.53	2.60	2.67	2.72	2.77	2.72	3.06	3.25	3.38	3.48	3.56	3.63	3.69	3.74
12	1.78	2.11	2.29	2.41	2.50	2.58	2.64	2.69	2.74	2.68	3.01	3.19	3.32	3.42	3.50	3.56	3.62	3.67
13	1.77	2.09	2.27	2.39	2.48	2.55	2.61	2.66	2.71	2.65	2.97	3.15	3.27	3.37	3.44	3.51	3.56	3.61
14	1.76	2.08	2.25	2.37	2.46	2.53	2.59	2.64	2.69	2.62	2.94	3.11	3.23	3.32	3.40	3.46	3.51	3.56
15	1.75	2.07	2.24	2.36	2.44	2.51	2.57	2.62	2.67	2.60	2.91	3.08	3.20	3.29	3.36	3.42	3.47	3.52
16	1.75	2.06	2.23	2.34	2.43	2.50	2.56	2.61	2.65	2.58	2.88	3.05	3.17	3.26	3.33	3.39	3.44	3.48
17	1.74	2.05	2.22	2.33	2.42	2.49	2.54	2.59	2.64	2.57	2.86	3.03	3.14	3.23	3.30	3.36	3.41	3.45
18	1.73	2.04	2.21	2.32	2.41	2.48	2.53	2.58	2.62	2.55	2.84	3.01	3.12	3.21	3.27	3.33	3.38	3.42
19	1.73	2.03	2.20	2.31	2.40	2.47	2.52	2.57	2.61	2.54	2.83	2.99	3.10	3.18	3.25	3.31	3.36	3.40
20	1.72	2.03	2.19	2.30	2.39	2.46	2.51	2.56	2.60	2.53	2.81	2.97	3.08	3.17	3.23	3.29	3.34	3.38
24	1.71	2.01	2.17	2.28	2.36	2.43	2.48	2.53	2.57	2.49	2.77	2.92	3.03	3.11	3.17	3.22	3.27	3.31
30	1.70	1.99	2.15	2.25	2.33	2.40	2.45	2.50	2.54	2.46	2.72	2.87	2.97	3.05	3.11	3.16	3.21	3.24
40	1.68	1.97	2.13	2.23	2.31	2.37	2.42	2.47	2.51	2.42	2.68	2.82	2.92	2.99	3.05	3.10	3.14	3.18
60	1.67	1.95	2.10	2.21	2.28	2.35	2.39	2.44	2.48	2.39	2.64	2.78	2.87	2.94	3.00	3.04	3.08	3.12
120	1.66	1.93	2.08	2.18	2.26	2.32	2.37	2.41	2.45	2.36	2.60	2.73	2.82	2.89	2.94	2.99	3.03	3.06
∞	1.64	1.92	2.06	2.16	2.23	2.29	2.34	2.38	2.42	2.33	2.56	2.68	2.77	2.84	2.89	2.93	2.97	3.00

TABLE A-4
SUMMARY OF STATISTICAL RESULTS

POSITION	SAMPLE			Calc Ti	Crit *Ct*	NULL HYPOTHESIS	CONCLUSIONS
W-2	WATER	-	ALPHA	INTUITIVE		Not Rejected	Same population
W-3	WATER	-	ALPHA	INTUITIVE		Not Rejected	Same population
W-3A	WATER	-	ALPHA	INTUITIVE		Not Rejected	Same population
W-2	WATER	-	BETA	-0.51	2.19	Not Rejected	Same population
W-3	WATER	-	BETA	-0.63	2.19	Not Rejected	Same population
W-3A	WATER	-	BETA	-0.31	2.19	Not Rejected	Same population
W-2	SEDMT	-	ALPHA	0.02	2.17	Not Rejected	Same population
W-3	SEDMT	-	ALPHA	0 05	2.17	Not Rejected	Same population
W-3A	SEDMT	-	ALPHA	-0.08	2.17	Not Rejected	Same population
W-2	SEDMT	-	BETA	-0.12	2.17	Not Rejected	Same population
W-3	SEDMT	-	BETA	0.12	2.17	Not Rejected	Same population
W-3A	SEDMT	-	BETA	-0.33	2.17	Not Rejected	Same population

In each case it was found that the *many-one t* (Ti) statistic was significantly below the critical value of *t*; thus, the statistical inference is that the upstream and the downstream observations are not from different populations; e.g. there is no significant difference in radioactivity levels from the upstream reference to any of the downstream locations.

If the calculated values of *t* (Ti) would have been as large as the critical value, *Ct*, then the inference would have been that the downstream values would have been from a different (higher radioactivity) population than the upstream.

Reference The method and tables of critical values are described in R. G. Miller's SIMULTANEOUS STATISTICAL INFERENCE, Second Edition, 1985, pp76-81.

PART B Ground Water Levels

The following table presents data on the level of ground water in the sample wells. These well locations are given in Figure 1. Well # W-9 continued to have no water. The water table has remained rather constant through the seasons and over the three year period.

TABLE A-5

GROUND WATER LEVELS IN SAMPLE WELLS

Sample Well	Well Dimensions		Water Level, ft	
	Casing Length, ft	Casing to Ground	11/5/87	3/19/88
W-4A	250	1'-10"	2'-5"	1'-11"
W-8	23.5	1'-11"	*	22'-3"
W-9	15.0	0'-10"	*	*
W-11A	24.2	1'-7"	20'-8"	20'-6"
W-12	24.8	1'-7"	**	18'-9"
W-14	25.1	1'-7"	22'-10"	22'-9"

* No water in well
** No water sample could be taken

APPENDIX PART C

CORRECTION OF DATA ERRORS IN OCTOBER, 1987, PROGRESS REPORT

In the October Progress Report errors in data presentation were made in two tables, Table 3 and Table 6. Neither of these errors materially affected the results and conclusions presented at that time.

TABLE 6-A adds two units of data omitted from TABLE 3 of the earlier report. The added units are circled for easy identification.

TABLE 6-A
correcting TABLE 3, October 1987 PROGRESS REPORT

WATER ANALYSES COMPARISN, pC/L

	March 1987				May 1987			
ALPHA data	R S O		Teledyne		RSO		Teledyne	
River		% +/-		+/-		% +/-		+/-
W-1	< 6.27	5	2		15.07	33	< 2	
W-2	< 5.28	5	2		< 5.26	5	< 2	
W-3	< 9.88	5	2		8	56	< 2	
W-3A	< 6.6	5	2		< 4.98	33	< 2	
Sample Wells								
W-4A	< 6.667	5	2		< 6.246	5	< 2	
W-8	< 13.04	5	25	17	< 9.067	5	< 2	
W-9	no water				no water			
W-11A	< 11.68	5	3		< 7.319	5	< 3	
W-12	< 10.1	5	3		8.941	53	< 3	
W-14	< 11.01	5	4		30.76	30	< 3	
River BETA Data								
W-1	29.66	43	5.2	2.6	< 29.15	5	4.9	2.7
W-2	< 24.97	5	4	2.6	< 29.75	5	4.2	2.6
W-3	< 33.77	5	3		< 34.98	5	4.8	2.6
W-3A	< 22.56	5	6	2.7	< 29.15	5	< 4.0	
Sample Wells								
W-4A	30.36	44	2.8	1.2	< 34.98	5	3.6	2.6
W-8	58.3	25	74	11	< 36.07	5	9.4	3.2
W-9	no water				no water			
W-11A	< 31.45	5	6.1	3.2	< 30.05	5	< 4	
W-12	< 27.2	5	3.7	1.6	< 30.05	5	6	3
W-14	48.24	45	5.2	1.8	< 36.07	5	7.5	3.4

TABLE 7-7 presents the correction for TABLE 6, October 1987 Report. The error here was that a portion of the data reported as second quarter of 1987 was actually first quarter data. The corrected data is highlighted for ease of identification.

TABLE 7-A
Correcting Table 6, October 1987 Progress Report
COMPARISON OF SEDIMENT ANALYSIS IN SECOND QUARTER(1987), pC/gm

Sample Location	R S O	+ -	Teledyne	+ -	
for Alpha					
W-1	9.56	4.26	9.8	6	Upstream
W-2	6.22	3.7	11	6	
W-3	12.6	4.7	7	5.5	
W-4A	8.36	4.1	< 6		
for Beta					
W-1	15	7.17	19	2	Upstream
W-2	13.9	0.7	21	2	
W-3	19.3	7.3	18	2	
W-4A	13.9	0.7	19	2	

APPENDIX PART D

CALIBRATION OF MICRO R METER

Form IS-23

GP Instrument Services, Inc.

CALIBRATION CERTIFICATE

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION

Customer Name: Energy Impact Associates
Customer Address: P.O. Box 176
Monroeville, PA 15146

Customer P.O.#: EIA 2845-88
Work Order #: I-88-03-215

INSTRUMENT INFORMATION

Instrument Manufacturer: Ludlum
Model: 19 Serial Number: 23079
External Probe(s): Serial #:
Calibration Method: 137Cs s/n 107

INSTRUMENT CALIBRATION INFORMATION

	Instrument Range	Calibration Standard Value	Instrument Response Before Calib.	Instrument Response After Calib.	Comment
1	25	15 uR/hr		16 uR/hr	All Calibrations Btn. + & - 10%
2		20		19	
3					
4	50	15		16	
5		20		20	
6		40		36	
7					
8	250	50		55	
9		100		100	
10		200		180	
11					
12	500	100		110	
13		200		200	
14		400		370	
15					
16	5000	1,000		1,100	
17		2,000		2,000	
18		4,000		3,600	
19					
20					
21					
22					
23					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all of the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Bureau of Standards (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated by: James Christie (Signed)
Calibration Date: 03-08-88
Next Calibration Due: 03-08-89

I certify that the above information is correct:
Administrative Coordinator
03-08-88
Date

APPENDIX PART E

FENCE INSPECTION REPORT

Whittaker Corporation
Audit Report of Radioactive Material
Located Next to Greenville Metals
Greenville, Pennsylvania

Item Audited	Item Satisfactory	Correction	Comments
1. Gates Locked			
2. Fence Integrity (Chain Link)			
3. Signs on Fencing (Chain Link)			
4. Fence Integrity (Barbed Wire)			
5. Signs on Fencing (Barbed Wire)			

Distribution: L. Rouse (NRC)
T. Gerusky (DER)
A. Simmons (Whittaker)
G. Louttit (Whittaker)
A. Krause (EIA)
J. Wright (EIA)

Prepared by: _____

Date: _____

Form AJK - 5/7/86, Rev. 1, 4/23/87