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RADIOLOGICAL ANALYSIS OF SOIL SAMPLES - PADDY'S RUN DECEMBER 10, 1986

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Radiological Analysis of Soil Samples - Paddy's Run

Feed Materials Production Center
Fernald, Ohio

December 10, 1986

Dames & Moore

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1.0 BACKGROUND

The Dames & Moore July 1985 Task C Report (Reference 1), indentifies two sources of above-background levels of uranium in three off-site groundwater wells. These sources are:

- Groundwater recharge from water flowing into the Storm Sewer Outfall Ditch (SSOD) via the Storm Sewer Outfall from the FMPC Production Area.

- Groundwater recharge from water flowing into Paddy's Run (PR) from the Waste Pit Storage Area.

As part of this work, Dames & Moore also identified several short term actions which could be implemented to reduce the contribution of uranium to groundwater and/or mitigate potential impacts. One of these short-term actions was to perform a closely spaced radiological survey and sampling program of both the SSOD and PR. This survey (and related sediment sampling) would have as its objective the identification of sediments which may be acting as intermediate or secondary uranium sources for the groundwater.

In February 1986, such a radiological survey and sampling program was conducted on the Storm Sewer Outfall Ditch at the FMPC in order to identify those areas of soil containing elevated concentrations of uranium. Measurements of gamma radiation levels were made over the length of the SSOD from its confluence with Paddy's Run to the outfall pipe which discharges storm water runoff from the Plant Production Area. Alpha radiation measurements also were made at selected sampling locations. The results of this survey and sampling program are provided in Support Services - Conceptual Design Report (Reference 2) and the related Addendum Report (Reference 3).

In May 1986, a similar radiological survey and sampling program was conducted on Paddy's Run in order to identify areas of soil containing potentially elevated levels of uranium. Measurements of gamma radiation levels were made from the FMPC railroad bridge downstream in Paddy's Run to its confluence with the Great Miami River.

1.1 Survey Procedures

The technical approach used in the radiological survey consisted of first establishing distances along the approximate centerline of the stream bed using a 300 foot surveyor's tape. For each 5-foot interval along the centerline, four gamma measurements were made approximately 5 and 10 feet to the left and right of the center point. The frequency of measurements was statistically chosen to be sufficient to detect a circular anomaly of three feet with a 90% confidence level (Reference 2). At each measurement point, contact gamma measurements were taken and recorded. Field measurement data have been plotted in the form of an isopleth map. This map (Figure 1) identifies areas within Paddy's Run which contain elevated gamma activity. The map uses as its basis the 7 1/2 minute Shandon topographic quadrangle.

To mitigate the effects of gamma radiation originating from the K-65 tanks, shielded survey measurements were made (at a slightly greater grid spacing) along approximately 2400 feet of Paddy's Run. The area where shielded measurements were taken is shown as Zone A on Figure 1. Shielding consisted of two lead blankets and one 3/8 inch thick plywood sheathed lead plate.

Within Zone A of Figure 1A, unshielded gamma readings ranged from 20 uR/hr to 200 uR/hr. Some of the more elevated readings (greater than 20 uR/hr), especially in the reach of the stream closest to the K-65 tanks, have been related to shielding inefficiency. In order to

provide supporting data for shielded gamma survey measurements, a 1700 sediment sampling program for 1200 feet of this stretch of Paddy's Run was developed (Zone B). This program entailed taking a sample from the east and the west banks of Paddy's Run at approximately 25 foot intervals.

1.2 Soil Sampling Procedures

Soil samples were composited in such a way that analysis would be performed on one sample representing each bank for each 100 foot section of Paddy's Run.

A trowel was used to collect the sample and was washed with demineralized water and dried to reduce the cross-contamination potential between samples. The sample number and location was recorded and a label was prepared for each sample.

Approximately two kilograms of soil were drawn from an area of four inches in diameter down to four inches in depth. Samples were allowed to air dry for approximately 2 weeks. They then were composited on an equal weight basis, labeled, monitored and sent to the subcontracted laboratory (EAL, Richmond, CA) for analysis. In the field, sampling was biased to allow for the collection of the finer grained fraction of stream bank sediments.

Additionally, there were two locations within Paddy's Run where gamma activity exceeded 25 uR/hr which could not be attributed to the effects of the K-65 tanks. A soil sample was collected for radiological isotopic analysis at each of these two locations. Also, in two locations where gamma activity was similar to background, a soil sample was collected.

In all, a total of twenty-eight soil samples were analyzed. The sample locations are shown on Figure 1. All of the samples were analyzed for gross alpha, isotopic uranium, isotopic thorium, and Radium-226.

2.0 DISCUSSION OF ANALYTICAL RESULTS

The analytical results of sediment samples taken from Paddy's Run are shown on Table 1. The Paddy's Run samples fall into three categories:

- **Sediment samples taken from areas where elevated gamma radiation levels are believed to be due to localized sources in the soil.**

Two samples fall into this category. One of these samples (1PR-50E-SSOD) was taken from an area fifty feet upstream of the confluence of the SSOD with Paddy's Run. The second of these samples (4PR-595E-GMR) was taken from a point approximately six hundred feet upstream of the confluence of Paddy's Run with the Great Miami River. This sample represents the only point in the Dames & Moore survey where elevated concentrations of uraniferous materials in the sediment have been identified in an offsite location.

- **Sediment samples taken from areas where gamma activity levels are representative of most of the Paddy's Run sediment - i.e., similar to background.**

Two samples fall into this category. These samples (2PR-0W-SSOD and 3PR-20E-SSOD) were collected from locations in Paddy's Run within twenty feet of the confluence with the SSOD.

The gamma activity survey data for each of these four sampling locations are shown on Table 2. The two samples believed to be representative of the majority of Paddy's Run sediment (i.e., similar to background) had gamma radiation levels of 8 uR/hr and 9 uR/hr respectively. Gamma radiation levels in this range apparently are similar to background levels in Ohio (Reference 4). Since many points

of elevated uranium concentrations in sediment were identified in the SSOD (Reference 2 and 3), these two samples were collected close to its confluence. The purpose was to identify potentially elevated concentrations of uranium, thorium, or radium in sediments despite similar to background gamma survey results. From the laboratory data (Table 1), concentrations of uranium, thorium and radium in these two samples are indeed similar to background levels (Table 3).

- **Sediment samples taken from areas adjacent to the K-65 tank, a radiation source which might have masked potentially elevated gamma radiation levels in the stream sediment.**

The remaining twenty-four (24) samples listed in Table 1 fall into this the third category. As mentioned in Section 1.0, there were 2400 feet of stream where shielding was used to filter effects of the K-65 tank source. Stream sediment samples were taken from both the east and west banks of the stream in order to provide supporting data for shielded gamma survey measurements. The sample location can be deciphered from the sample ID shown in Table 1. For example, "PR-48E-SSOD" is the composited sample representing the points 4800 ft, 4825 ft, 4850 ft and 4875 ft upstream of the SSOD on the east bank of Paddy's Run. Several of these samples (eg., PR-48E-SSOD, PR-53E-SSOD, PR-55W-SSOD) indicate that there may be some above-background levels of uranium, thorium and/or radium in this portion of Paddy's Run.

3.0 CONCLUSIONS AND RECOMMENDATIONS

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From the results of the radiological survey and sampling program conducted in Paddy's Run, the following conclusions can now be drawn:

- With the exception of one sampling location, the radiological survey of Paddy's Run did not identify sediments with concentrations of uraniferous materials which appear to vary greatly from background concentrations. Therefore, although uranium has been detected in surface water runoff from the Waste Pit Storage Area (Reference 1), it does not appear to be concentrated in PR sediments.

- In one location on the east bank of Paddy's Run (approximately 600 feet upstream of its confluence with the Great Miami River) concentrations of thorium have been identified which appear to be greater than background concentrations.

- From the data gathered to date, the SSOD appears to be the primary pathway for elevated concentrations of uranium in offsite groundwater wells. Uranium-bearing liquids discharged to the SSOD are a primary source as evidenced by the uraniferous materials deposited in the banks of the SSOD (Reference 2). Those uranium bearing stream bank sediments of the SSOD also could act as a secondary source by the resuspension of soluble uranium during periods of high precipitation. WMCO has already implemented several remedial actions designed to prevent the discharge of uranium bearing liquids to the SSOD (e.g., the construction of the storm water detention basin).

In light of the information gathered to date and the conclusions described above, it is recommended that a remedial action plan be developed to address uranium bearing stream bank sediments within the SSOD.

The focus of this plan should be concentrated on uranium-bearing stream bank sediments in the Storm Sewer Outfall Ditch (SSOD). However it also should include other identified areas within PR that contain sediements which are potentially uranium-bearing. The main objectives of the plan would be to reconfirm the level and extent of elevated concentrations of uraniferous materials in both PR and SSOD stream bank sediments, to develop remedial action criteria, and to excavate contaminated soils. Each of these objectives are briefly described below:

Reconfirm Elevated Measurements - The locations which have been identified as having elevated levels of uraniferous materials in stream bank sediments should be verified. These locations would include the area near the confluence of Paddy's Run with the Great Miami River and locations in the Storm Sewer Outfall Ditch. In addition, the vertical extent of these elevated levels needs to be quantified. This quantification would be required to properly develop an approach for remedial action so that appropriate tools, equipment and resources can be selected to best meet the remedial action criteria.

It is recommended that a series of borings be hand augered to a depth of approximately 6 feet. Sediments collected from these borings should be analyzed for uraniferous materials in one (1) foot sections. These borings should be made in at least four (4) locations in the SSOD as well as the one location identified in Paddy's Run (4PR-595E-GMR). The SSOD locations would be chosen based on an analysis of previously reported survey and sampling studies of the SSOD (References 2 and 3).

Additionally both historic and recent sediment sampling data developed by WMCO/NLO should be evaluated in light of the objectives of the remedial action plan.

Develop Remedial Action Criteria - This task would entail a review of past and existing remedial action programs involving radiologically contaminated sediments, as well as guidelines and performance objectives outlined in the regulations promulgated by USDOE, USEPA, USNRC and other applicable agencies. Following such a review, a compendium of applicable regulations and guidelines would be provided and a performance objective would be recommended (e.g. dose criteria) from which remedial action criteria (e.g. threshold concentration limits) can be developed.

The development of remedial action criteria also should focus on the variation and statistical basis for what is considered regional background. This is needed to develop the threshold concentration above which soils/sediment are considered contaminated. Existing environmental sampling data should be reviewed and augmented as necessary to establish a statistically defensible data base of background concentrations of uraniferous materials in offsite locations where soil/sediment constituents could not be influenced by FMPC site operations.

Excavate Contaminated Soils

Consistent with the results of the tasks outlined above, these areas within PR and the SSOD identified as containing contaminated soils/sediment should be excavated and disposed in accordance with WMCO and DOE guidelines.

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4.0 REFERENCES

1) Dames & Moore, 1985. "Groundwater Study - Task C Report" Prepared by Dames & Moore for NLO, Inc., July, 1985.

2) Dames & Moore, 1986a. "Support Services - Conceptual Design Report" Prepared by Dames & Moore for Lockwood Greene Engineers, Inc., April, 1986.

3) Dames & Moore, 1986b. "Addendum Report - Conceptual Design Support Services - Feed Materials Production Center" Prepared by Dames & Moore for Lockwood Greene Engineers, Inc., July, 1986.

4) "State Background Radiation Levels: Results of Measurements Taken During 1975-1979", ORNL/TM-7343, Prepared by Myrick, T.E., Berven, B.A., Haywood, F.F. for USDOE/ORNL, Nov., 1981.

5) NCRP, 1975, Natural Background Radiation in the United States. NCRP Report No. 45.

TABLE 1: LABORATORY RESULTS OF RADIOLOGICAL ANALYSIS OF PADDY'S RUN SAMPLES
(Concentration in pCi/gram ± % error)

Sample I.D.	TMA/EAL No.	^{238}U	^{235}U	^{233}U	^{230}Th	^{232}Th	^{228}Th	^{226}Ra	Gross Alpha
PR-48E-SSOD	579-1	4.48 ± 5	0.12 ± 50	1.81 ± 8	0.693 ± 13	0.384 ± 17	0.414 ± 22	0.812 ± 7.7	-11 ± 73
PR-48W-SSOD	2	0.625 ± 12	0.039 ± 75	0.609 ± 12	0.989 ± 11	0.422 ± 16	0.429 ± 20	0.730 ± 7.1	5 ± 360
PR-49E-SSOD	3	1.09 ± 11	<0.03	1.00 ± 12	1.20 ± 10	0.694 ± 13	0.867 ± 12	0.943 ± 6.5	-4 ± 200
PR-49W-SSOD	4	0.658 ± 12	0.030 ± 67	0.366 ± 16	0.634 ± 14	0.269 ± 20	0.46 ± 22	0.711 ± 10.2	-11 ± 55
PR-50E-SSOD	5	1.06 ± 10	0.083 ± 38	0.848 ± 11	0.876 ± 19	0.59 ± 22	0.947 ± 16	1.354 ± 5.7	-17 ± 44
PR-50W-SSOD	6	0.584 ± 15	0.22 ± 35	0.502 ± 18	0.806 ± 15	0.34 ± 24	0.626 ± 19	0.489 ± 9.5	16 ± 41
PR-51E-SSOD	7	0.942 ± 11	0.11 ± 58	0.758 ± 13	1.08 ± 18	0.74 ± 21	0.90 ± 22	2.309 ± 4.0	-16 ± 47
PR-51W-SSOD	8	0.906 ± 11	0.054 ± 67	0.823 ± 12	0.929 ± 11	0.855 ± 12	0.892 ± 13	0.740 ± 8.2	12 ± 92
PR-52E-SSOD	9	1.56 ± 8	0.096 ± 30	1.60 ± 8	1.19 ± 12	0.593 ± 17	0.501 ± 18	0.256 ± 0.7	-6 ± 108
PR-53W-SSOD	10	0.628 ± 12	<0.03	0.716 ± 12	0.759 ± 16	0.594 ± 17	1.40 ± 13	0.741 ± 8.4	-14 ± 64
PR-54E-SSOD	11	0.794 ± 10	0.075 ± 50	0.778 ± 11	1.61 ± 11	0.547 ± 18	0.656 ± 19	0.796 ± 9.3	4 ± 225
PR-54W-SSOD	12	0.968 ± 11	0.032 ± 67	0.750 ± 12	1.68 ± 12	0.34 ± 24	0.875 ± 16	1.460 ± 5.1	10 ± 55
PR-55E-SSOD	13	0.373 ± 15	0.12 ± 28	0.549 ± 12	0.52 ± 31	0.46 ± 34	<0.4	0.380 ± 18.4	13 ± 96
PR-55W-SSOD	14	3.18 ± 6	0.15 ± 29	3.18 ± 6	2.09 ± 11	0.816 ± 16	1.22 ± 17	3.961 ± 1.6	6 ± 367
PR-56E-SSOD	15	2.12 ± 7	0.077 ± 70	1.26 ± 9	0.922 ± 20	0.744 ± 20	0.65 ± 24	0.934 ± 7.5	-5 ± 160
PR-56W-SSOD	16	0.794 ± 10	<0.10	0.783 ± 11	0.67 ± 25	0.57 ± 24	0.53 ± 27	0.575 ± 6.5	12 ± 100
PR-57E-SSOD	17	1.15 ± 9	<0.03	1.00 ± 10	1.6 ± 32	0.74 ± 35	1.4 ± 38	0.692 ± 8.8	-12 ± 100
PR-57W-SSOD	18	0.649 ± 12	<0.05	0.573 ± 14	0.966 ± 17	0.55 ± 23	0.691 ± 19	0.718 ± 10.9	11 ± 105
PR-58W-SSOD	19	0.868 ± 10	<0.02	0.875 ± 11	0.886 ± 19	0.803 ± 19	0.860 ± 20	0.630 ± 8.7	25 ± 32
PR-59E-SSOD	20	0.814 ± 10	0.028 ± 67	0.837 ± 11	1.45 ± 13	0.767 ± 17	1.11 ± 17	0.892 ± 7.5	1 ± 650
PR-59W-SSOD	21	0.618 ± 12	0.065 ± 43	0.603 ± 12	0.565 ± 20	0.826 ± 17	0.840 ± 19	0.635 ± 8.5	-26 ± 19
1PR-50E-SSOD	22	1.91 ± 7	0.19 ± 23	1.44 ± 8	3.07 ± 7	0.722 ± 14	0.690 ± 16	4.101 ± 2.6	-8 ± 81
2PR-OW-SSOO	23	0.664 ± 12	0.070 ± 50	0.636 ± 13	0.642 ± 17	0.481 ± 19	0.570 ± 19	0.742 ± 6.9	-7 ± 100
3PR-20E-SSOD	24	1.94 ± 8	0.088 ± 38	1.54 ± 9	1.41 ± 19	0.86 ± 24	0.64 ± 42	1.148 ± 7.5	-15 ± 77
4PR-595E-GMR	25	8.36 ± 5	0.328 ± 19	7.41 ± 5	266. ± 4	2.33 ± 10	0.950 ± 17	0.283 ± 0.9	244 ± 5
PR-52W-SSOD	26	0.448 ± 16	<0.02	0.547 ± 15	1.86 ± 10	0.30 ± 21	0.37 ± 23	0.606 ± 7.9	-3 ± 233
PR-53E-SSOD	27	0.864 ± 12	<0.14	0.778 ± 14	1.29 ± 12	0.29 ± 24	0.43 ± 22	4.064 ± 2.8	4 ± 75
PR-58E-SSOD	28	0.604 ± 12	0.072 ± 65	0.622 ± 12	0.865 ± 14	0.544 16	0.452 ± 20	0.580 ± 7.7	12 ± 29

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Table 2: PADDY'S RUN GAMMA SURVEY DATA

Sample I.D.	Gamma Survey(1) (uR/hr)	Alpha Survey(2) (cpm)
1PR-50E-SSOD	24	5
2PR-0W-SSOD	8	8
3PR-20E-SSOD	9	3
4PR-595E-GMR	44	34

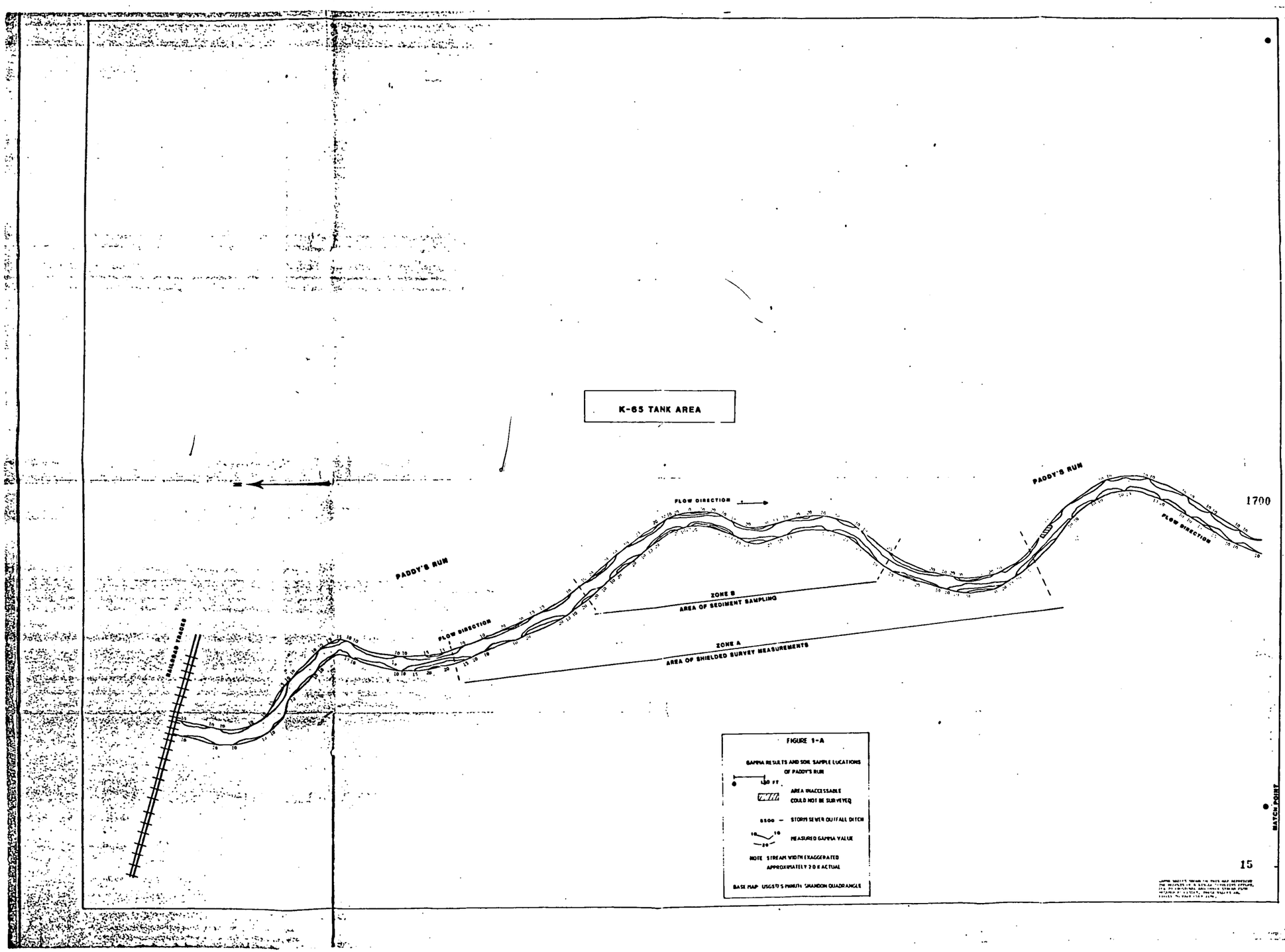
(1) Measurements taken before sampling

(2) Measurements taken after sampling

Table 3: Background Concentrations of Uranium and Thorium in Soil

Radionuclide	Background Concentration in Soil (pCi/g)
U-238	0.6
Th-232	1.0

Source: Reference 5



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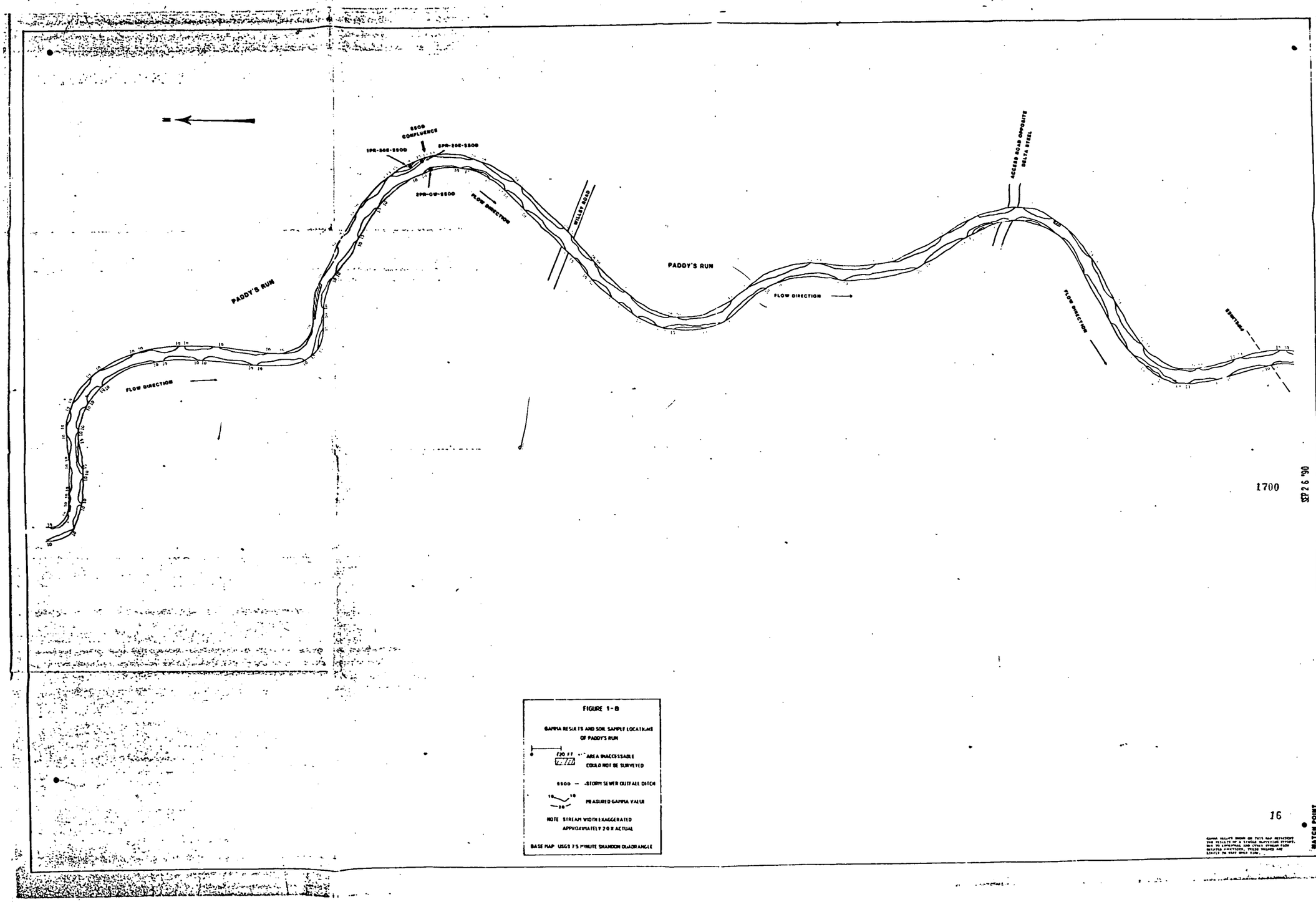
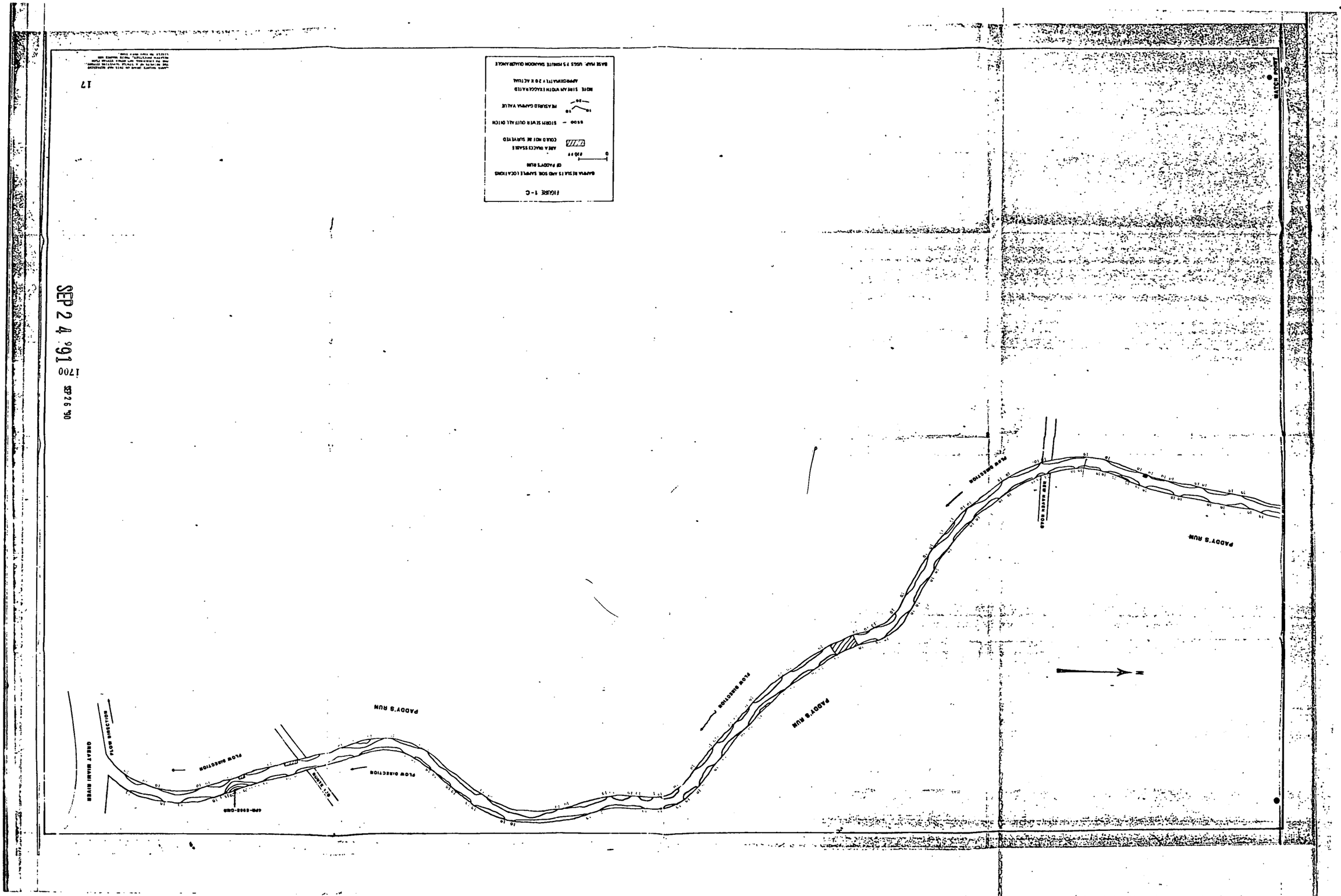

SSOB COMPLIENCE
1PR-SOE-SSOD
2PR-SOE-SSOD
2PR-OU-SSOD
FLOW DIRECTION
HILLEY ROAD
PADDY'S RUN
PADDY'S RUN
FLOW DIRECTION
ACCESS ROAD OPPOSITE DELTA STEEL
FLOW DIRECTION
FLOW DIRECTION
SENTINAL
FIGURE 1-B
GAMMA RESULTS AND SOIL SAMPLE LOCATIONS OF PADDY'S RUN
0
120 FT
AREA INACCESSABLE COULD NOT BE SURVEYED
SSOD - STORM SEWER OUTFALL DITCH
MEASURED GAMMA VALUE
NOTE STREAM WIDTH EXAGGERATED APPROXIMATELY 20 X ACTUAL
BASE MAP USGS 7.5 MINUTE SHANDON QUADRANGLE
1700
SEP 26 '90
SEP 24 '91
16
MATCH POINT



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SEP 26 '90
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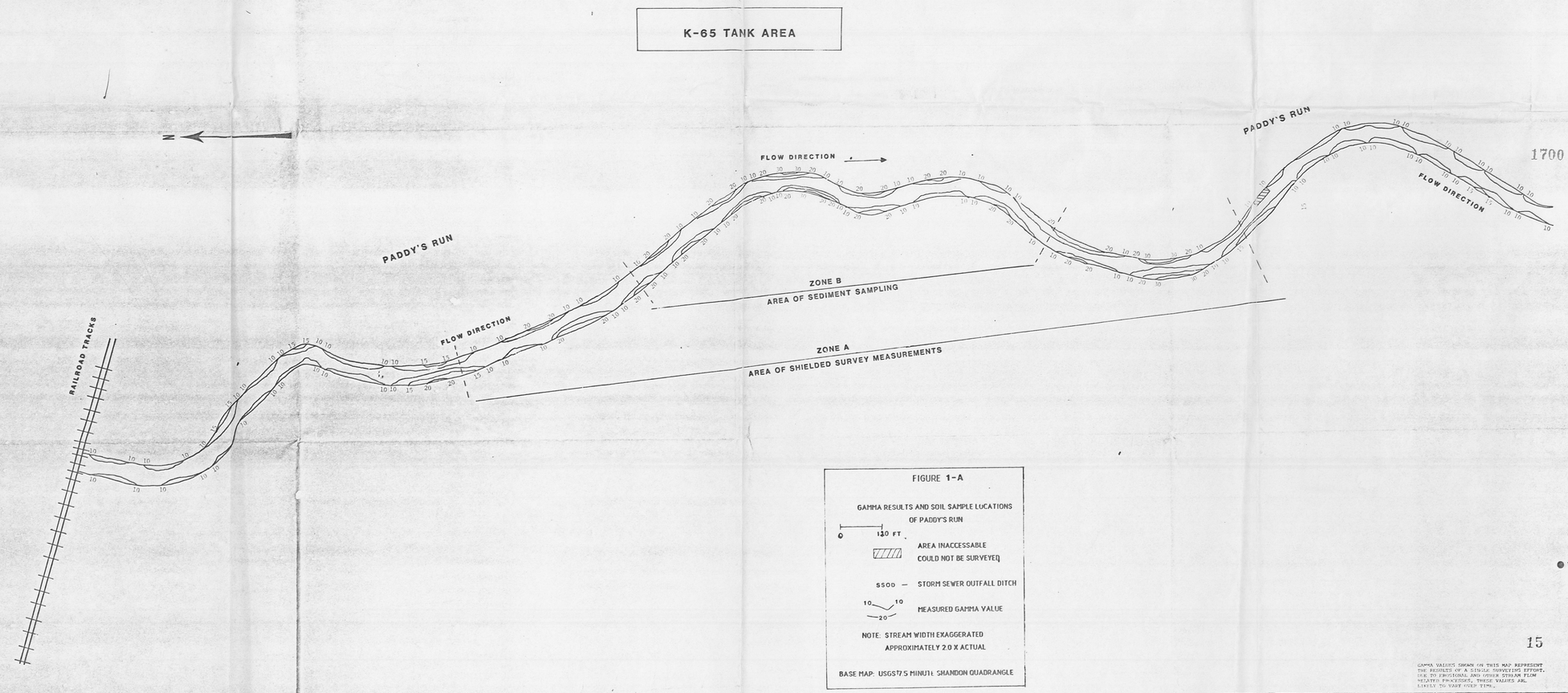

FIGURE 1-A

GAMMA RESULTS AND SOIL SAMPLE LOCATIONS OF PADDY'S RUN

0 120 FT

AREA INACCESSABLE COULD NOT BE SURVEYED

SSOD — STORM SEWER OUTFALL DITCH

10 10 20 MEASURED GAMMA VALUE

NOTE: STREAM WIDTH EXAGGERATED APPROXIMATELY 2.0 X ACTUAL

BASE MAP: USGS 7.5 MINUTE SHANDON QUADRANGLE

FIGURE 1-C

GAMMA RESULTS AND SOIL SAMPLE LOCATIONS OF PADDY'S RUN

0 — 20 FT

AREA INACCESSABLE COULD NOT BE SURVEYED

SSOD — STORM SEWER OUTFALL DITCH

10 10 20 — MEASURED GAMMA VALUE

NOTE: STREAM WIDTH EXAGGERATED APPROXIMATELY 2.0 X ACTUAL

BASE MAP: USGS 7.5 MINUTE SHANDON QUADRANGLE

GAMMA VALUES SHOWN ON THIS MAP REPRESENT THE RESULTS OF A SINGLE SURVEYING EFFORT. DUE TO EROSIONAL AND OTHER STREAM FLOW RELATED PROCESSES, THESE VALUES ARE LIKELY TO VARY OVER TIME.

SEP 26 '90
1700

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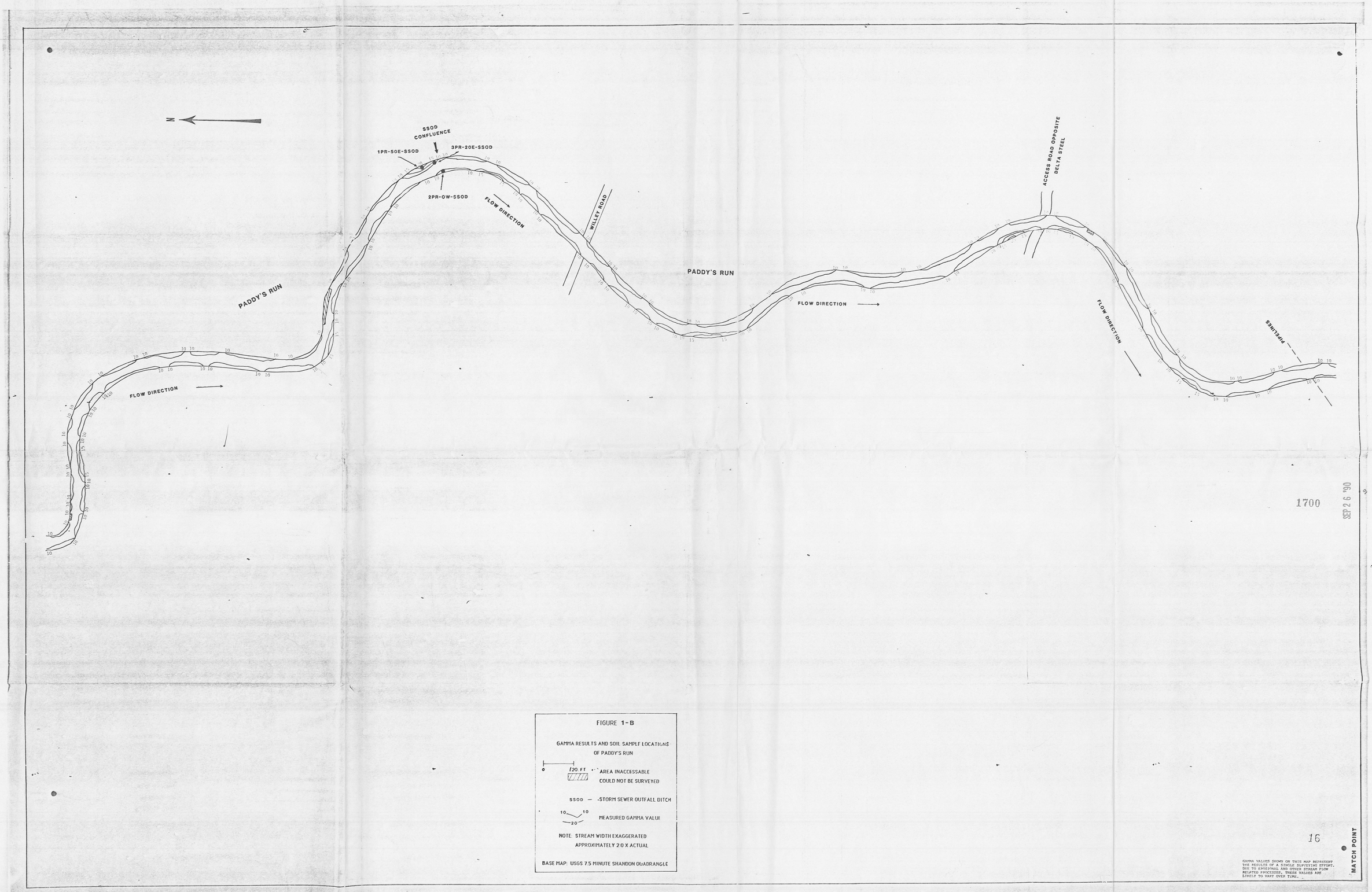

FIGURE 1-B

GAMMA RESULTS AND SOIL SAMPLE LOCATIONS OF PADDY'S RUN

0 — 120 FT

AREA INACCESSABLE COULD NOT BE SURVEYED

SSOD — STORM SEWER OUTFALL DITCH

10 10 20 — MEASURED GAMMA VALUE

NOTE: STREAM WIDTH EXAGGERATED APPROXIMATELY 2.0 X ACTUAL

BASE MAP: USGS 7.5 MINUTE SHANDON QUADRANGLE

GAMMA VALUES SHOWN ON THIS MAP REPRESENT THE RESULTS OF A SINGLE SURVEYING EFFORT. DUE TO EROSIONAL AND OTHER STREAM FLOW RELATED PROCESSES, THESE VALUES ARE LIKELY TO VARY OVER TIME.

1700

SEP 26 '90

16

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