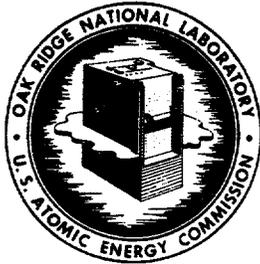


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*Anal. Report
Cameron*

(1960)



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THE DETECTION OF A LITHIUM ISOTOPE SEPARATION PLANT

A Completion Report

by

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June 1960

Analytical Chemistry Division
Oak Ridge National Laboratory

Operated for the

U. S. Atomic Energy Commission

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CONCLUSIONS

This laboratory was assigned the problem of detecting a lithium isotope separation plant by isotopic analysis of the air-borne and water-borne effluent.

It was demonstrated that the maximum distance a lithium isotope separation plant could be detected by analysis of the air-borne effluent is 25 miles. To achieve even a reasonable degree of confidence at distances greater than five miles from the plant, techniques which differentiate between air-borne effluent and the natural background must be employed.

The water-borne effluent from a lithium isotope separation plant is detectable at least 200 miles away by the increased concentration of lithium in the rivers, and at least 300 miles away by the change in the isotopic composition from natural lithium.

PART A - Air-borne Effluent

Introduction

The detection of a lithium isotope separation plant by change in the isotopic ratio of lithium in nearby vegetation has been investigated. This study was centered around the isotope separation plant at Oak Ridge.

Associated studies have been made on the variation of isotopic ratio of the lithium in vegetation near a lithium processing plant where no isotope separation is accomplished. Studies of the lithium in rain water near an isotope separation plant and a brief investigation of the change in lithium-rubidium ratio in soil near a lithium plant due to excessive lithium losses were also made.

In this report, analytical results are reported in smidgens (1 sm = 1 mg gram).

Summary

Previous studies have established that natural lithium minerals can vary in isotopic ratio (7/6) between 12.44 and 12.93.¹ Investigation of background lithium around the Foote Mineral Company's plant near Sunbright, Virginia, show variations of greater than 1% (12.39 to 12.55) are possible in a relatively small (80 square mile) area.

For the detection of a lithium isotope separation plant by isotopic analysis of the lithium in evergreen needles, one is limited to a radius of less than 25 miles for a large industrial facility comparable to Oak Ridge. To achieve even a reasonable degree of confidence at 5 miles, it is necessary to differentiate between the natural background and air-borne effluent. This can be done in several ways:

1. By washing the needles and comparing the isotopic ratio of the lithium in the wash solution with the isotopic ratio of the lithium in the washed needles, bark, or soil from that area. Washing the needles to remove lithium works equally well on fresh or air-dried needles.
2. Or, assuming some integration of isotopically altered lithium by the needles during the growing season, a comparison of the needles with either the bark or soil can be made. This technique is much less sensitive.

The collection of air-borne lithium in rain water was limited to a distance of 8 miles from the Y-12 plant. Oak leaves and pine needles were sampled at each water collection site. A large and inconsistent variation in isotopic ratio was found in the rain water. Except for one sample at 1.9 miles, the pine needles were in the range of normal lithium and viewed independently would not be indicative of a lithium isotope separation plant in the area.

1. Cameron, A. E., JACS, 77, 2731 (1955).

The oak leaf samples collected at the area showed a wide variation in isotopic ratio of lithium. There was no evidence of integration of the air-borne lithium in the leaf, but rather the leaf seems merely to collect some of the current losses.

A preliminary investigation of the lithium-rubidium ratio in soil was performed. Russian results² indicate a narrow range of lithium concentration in various types of soils and plants. The concentration of rubidium in soils also lies within narrow limits but there is an enrichment of rubidium in plants. The change in concentration of lithium in soils around Oak Ridge due to air-borne effluent does not alter the lithium-rubidium ratios significantly.

Experimental Techniques and Results

A conventional 60°, six-inch radius, first order focusing mass spectrometer was modified to collect the two lithium isotopes simultaneously. A ratio recording system was employed so a direct 6/7 ratio was observed. One hundred sm. samples were mounted on 2-56 stainless steel washers as lithium fluoride and a single rhenium filament was used both to evaporate the neutral molecules and to serve as a hot surface to form ions. All the samples were submitted to the operator as unknowns. Frequent checks on the accuracy were made by running laboratory standards as unknowns. It was shown experimentally that the equipment would reproduce to within 0.25% of the ratio. This precision was only required on samples that were in the range of natural lithium and was not necessary for many of the samples where an error of 1% in the ratio would not be significant.

A series of pine needle and bark samples were collected May 26, 1959, at distances of 1, 2, 5, and 10 miles radially northeast of the lithium plant in Oak Ridge. Table I is a summary of the lithium isotopic ratios found in this investigation. No washing of the samples to differentiate between background lithium and Oak Ridge effluent was attempted.

It is obvious that little, if any, air-borne lithium is associated with the bark of a tree. The lack of retention of lithium by bark has been demonstrated in the laboratory in an attempt to use bark as an ion exchange medium. Any anomalous isotope ratios in bark samples are probably due to particulate matter that has not been washed off by rain.

An isotopic analysis of the total needle sample shows a detectable variation from the normal isotopic ratio up to five miles from the plant. At 10 miles, no variation over background was found even though the total lithium content was about twice the expected amount.

2. Ivanov, D. N., Soil Science, 2, 32-45 (1954).

A second set of samples was collected on December 12, 1959. This group, collected at 1, 5, 10, 15, and 25 miles radially northeast of the lithium separation plant consisted of needles, bark, and soil. Half of each sample of needles was allowed to air dry for a few months in the laboratory. In order to differentiate between air-borne effluent and the natural background, the needles were washed in water with an ultrasonic generator. The wash solution was then filtered and an isotopic analysis was performed on the washed needles, the wash solution, and the filtered solids. The results are tabulated in Table II and compared with the soil and bark from the same site. It is interesting to note that the wash solution was enriched in the mass 6 isotope and the washed needles were enriched in the mass 7 isotope. This indicates some occlusion or absorption of air-borne lithium by the plant during the growing season. The washing technique, whether on fresh or air-dried samples, extends detection capability to 25 miles.

A further analysis of the data in Table II shows a close agreement between the lithium leached from the soil and the bark at 5, 10, 15, and 25 miles. At 1 mile, the isotopic ratio of the lithium in the uppermost layer of the soil may be altered due to the plant effluent. The isotopic ratio of the solids from the wash solution and the dissolved soil samples were included in the study but no interpretation is pertinent.

Table III is a summary of the leaf, bark, and needle samples collected in October 1958, near the Foote Mineral Company's plant at Sunbright, Virginia. The variation in isotopic ratio of the lithium found at this location, where no isotope separation is accomplished, illustrates the necessity of differentiating between air-borne plant effluent and natural background before an interpretation can be made of a routine analysis.

In May 1958, rain water collectors were placed around Oak Ridge at ten different locations. Three series of samples were collected during the four month period. At each location, one pine needle and one oak leaf sample were taken when the rain water collectors were first placed. Samples of oak leaves were also taken at the end of each rain water collection period.

Table IV lists the data for the rain water samples. It is apparent that lithium of altered isotopic ratio can be detected in rain water up to at least 8 miles. There is no agreement between the isotopic ratio of the lithium in the rain water at different locations, which is additional evidence of the inconsistent nature of the air-borne losses from the Oak Ridge plant. The collection of larger rain water samples may be coupled with ion exchange techniques to concentrate the lithium to extend the distance so that it could be a useful clandestine method for detection of a lithium separation plant but it is doubtful if the range would ever be as much as 25 miles.

Table V lists the data for the oak leaf and pine needle samples collected at the same location as the rain water samples. The samples were not washed and accordingly represent the natural background plus accumulated air-borne

material. The majority of these samples were within the range of natural lithium but were not representative of the known isotopic ratios of lithium in soil around Oak Ridge.

The ratio of total lithium to total rubidium in soils, reported by the Russians to lie within very narrow limits, was investigated to determine if the effluent from the Oak Ridge plant was enough to change the ratio significantly. Table VI lists the results of this study. No significance can be attached to this ratio for the purpose of detection of a lithium plant.

Conclusions

It has been experimentally demonstrated that the inherent difficulties in detecting a lithium isotope separation plant by isotopic analysis of lithium in vegetation, i.e., the variation of the lithium 7/6 ratio in nature, the abundance of lithium in soils and vegetation, the solubility of lithium effluent and negligible occlusion or absorption in foliage indicate the small probability of detecting a lithium isotope separation facility by analyzing foreign vegetation samples without other reasons for suspecting the area.

TABLE I

Analytical Results from the May 26, 1959
Bark and Vegetation Samples Near Oak Ridge

<u>Distance From Plant (Miles)</u>	<u>Type</u>	<u>Conc. sm/gm</u>	<u>Lithium 7/6</u>
1	Needles	564	13.23
1	Bark	334	12.46
2	Needles	558	13.74
2	Bark	524	12.48
5	Needles	649	12.76
5	Bark	1,585	(12.52)* 12.53
10	Needles	309	(12.51)* 12.48
10	Bark	1,467	12.49

*Duplicate runs.

TABLE II

Analytical Results from the December 12, 1959 Bark, Vegetation, and Soil Samples Near Oak Ridge

Distance From Plant (Miles)	Washed Needles		Wash	Solids	Leached Soil	Bark		Wash From Dried Needles	Dissolved Soil
	Lithium Conc. sm/gm.	Lithium T/6 Ratio				Lithium Conc. sm/gm.	Lithium T/6 Ratio		
1	406	12.82	9.17	12.15	12.21	1,010	12.45	12.41*	-
5	129	12.54	12.12	12.27	12.47	455	12.42	12.19	-
10	155	12.58	12.47	12.45	12.47	516	12.45	12.32	12.48
15	159	12.49	12.21	12.44	12.45	819	12.46	11.70	12.53
25	89	12.56	12.36	12.44	12.53	314	12.51	12.36	12.47

*This sample was not part of original - collected next day at same location. Also, this sample had partly decayed when washed.

Miscellaneous

W. Ridge (3.5 miles)	- Needles	12.35
	- Wash	11.07
Fort Loudon (12 miles)	- Needles	12.45
	- Wash	12.15

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TABLE III

Analytical Results from October 1958

Bark and Vegetation Samples Near Sunbright, Virginia

<u>Sample Number</u>	<u>Type</u>	<u>Location (Miles from Plant)</u>	<u>Lithium Conc. sm/gm.</u>	<u>Lithium Ratio 7/6</u>
312	Bark	5 S	401	12.50
313	Needles	"	102	12.45
314	Leaves	"	252	12.42
315	Bark	5 E	649	12.44
316	Needles	"	219	12.50
317	Leaves	"	490	12.41
318	Cedar	"	488	12.55
319*	Moss	"	9,607	12.50
320	Bark	2 E	1,228	12.41
321	Cedar	"	846	12.43
322	Leaves	"	822	12.48
323	Bark	2 S	1,126	12.41
324	Needles	"	2,407	12.42
325	Leaves	"	1,060	12.43
326	Bark	2 W	1,636	12.39
327	Needles	"	8,715	12.39
328	Leaves	"	5,830	12.52
329	Bark	5 W	586	12.53
330	Needles	"	5,564	12.43
331	Leaves	"	3,170	12.50
332	Bark	5 N	224	12.49
333	Needles	"	289	12.41
334	Leaves	"	342	12.46

*Moss sample included some soil from ground.

TABLE IV

Analytical Results from Rain Collecting Experiment Near Oak Ridge

<u>Sample Number</u>	<u>Type Sample</u>	<u>Distance and Direction From Y-12 Plant</u>	<u>Sampling Period</u>	<u>Total Li, Sm</u>	<u>Lithium Ratio 7/6</u>
200 A	Water	1.7-SSE	5-8-58 - 6-10-58	480	13.79
B	"		6-10-58 - 8-5-58	530	14.16
C	"		8-5-58 - 9-10-58	470	10.02
203 A	"	3.1-WSW	5-8-58 - 6-10-58	1,013	12.90
B	"		6-10-58 - 8-10-58	508	12.95
C	"		8-5-58 - 9-10-58	473	11.85
206 A	"	1.9-NE	5-8-58 - 6-10-58	1,425	12.36
B	"		6-10-58 - 8-5-58	1,908	15.34
C	"		8-5-58 - 9-10-58	1,201	15.67
209 A	"	8-SW	5-8-58 - 6-10-58	438	12.38
B	"		6-10-58 - 8-5-58	510	12.71
C	"		8-5-58 - 9-10-58	375	12.30
212 A	"	7.2-WSW	5-8-58 - 6-10-58	656	11.68
B	"		6-10-58 - 8-5-58	1,917	12.69
C	"		8-5-58 - 9-10-58	435	12.93
215 A	"	3.5-WNW	5-8-58 - 6-10-58	475	12.50
B	"		6-10-58 - 8-5-58	698	12.58
C	"		8-5-58 - 9-10-58	484	14.12
218 A	"	4.9-NE	5-8-58 - 6-10-58	1,425	12.56
B	"		6-10-58 - 8-5-58	3,208	13.51
C	"		8-5-58 - 9-10-58	650	14.08
221 A	"	5.4-NNE	5-8-58 - 6-10-58	925	12.27
B	"		6-10-58 - 8-5-58	2,050	13.48
C	"		8-5-58 - 9-10-58	600	13.18
224 A	"	6.8-W	5-8-58 - 6-10-58	525	12.24
B	"		6-10-58 - 8-5-58	675	12.41
C	"		8-5-58 - 9-10-58	300	12.85
*227 A	"	2-NNE	5-8-58 - 6-10-58	1,531	12.12
B	"		6-10-58 - 8-5-58	2,531	13.19

*Sampler located on housetop in Woodland section of Oak Ridge.

TABLE V

Analytical Results from Vegetation Samples Near Oak Ridge

<u>Sample Number</u>	<u>Type Sample</u>	<u>Distance and Direction From Y-12 Plant</u>	<u>Sampling Date</u>	<u>Li Conc. sm/gm</u>	<u>Li Ratio 7/6</u>
201	Pine Needles	1.7-SSE	5-8-58	136	12.38
202 A	Oak Leaves	"	5-8-58	42	12.39
B	"	"	6-10-58	44	12.53
C	"	"	8-5-58	115	12.23
D	"	"	9-10-58	76	12.61
204	Pine Needles	3.1-WSW	5-8-58	122	12.45
205 A	Oak Leaves	"	5-8-58	86	12.59
B	"	"	6-10-58	239	12.50
C	"	"	8-5-58	94	12.30
D	"	"	9-10-58	224	12.58
207	Pine Needles	1.9-NE	5-8-58	371	11.70
208 A	Oak Leaves	"	5-8-58	187	11.95
B	"	"	6-10-58	196	12.11
C	"	"	8-5-58	300	12.48
D	"	"	9-10-58	424	12.23
210	Pine Needles	8-SW	5-8-58	150	12.41
211 A	Oak Leaves	"	5-8-58	22	12.39
B	"	"	6-10-58	96	12.51
C	"	"	8-5-58	117	12.33
D	"	"	9-10-58	240	12.33
213	Pine Needles	7.2-WSW	5-8-58	515	12.45
214 A	Oak Leaves	"	5-8-58	53	12.44
B	"	"	6-10-58	125	12.24
C	"	"	8-5-58	143	12.27
D	"	"	9-10-58	137	12.48
216	Pine Needles	3.5-WNW	5-8-58	375	12.64
217 A	Oak Leaves	"	5-8-58	111	12.63
B	"	"	6-10-58	229	12.45
C	"	"	8-5-58	219	12.39
D	"	"	9-10-58	356	12.32
219	Pine Needles	4.9-NE	5-8-58	278	12.39

TABLE V (Continued)

Analytical Results from Vegetation Samples Near Oak Ridge

<u>Sample Number</u>	<u>Type Sample</u>	<u>Distance and Direction From Y-12 Plant</u>	<u>Sampling Date</u>	<u>Li Conc. sm/gm</u>	<u>Li Ratio 7/6</u>
220 A	Oak Leaves	4.9-NE	5-8-58	81	12.63
B	"	"	6-10-58	167	12.54
C	"	"	8-5-58	359	12.50
D	"	"	9-10-58	446	12.62
222	Pine Needles	5.4-NNE	5-8-58	287	12.41
223 A	Oak Leaves	"	5-8-58	40	12.54
B	"	"	6-10-58	236	12.48
C	"	"	8-5-58	246	12.69
D	"	"	9-10-58	394	12.54
225	Pine Needles	6.8-W	5-8-58	416	12.56
226 A	Oak Leaves	"	5-8-58	167	12.52
B	"	"	6-10-58	198	12.44
C	"	"	8-5-58	227	12.47
D	"	"	9-10-58	482	12.20

TABLE VI

Rubidium-Lithium Ratio in Soils Near Oak Ridge

<u>Laboratory Sample No.</u>	<u>Distance And Direction From Y-12 Plant</u>	<u>Rb/Li.</u>
701	1-NE	1.84
704	5-NE	1.30
707	10-NE	4.80
710	15-NE	2.81
713	25-NE	3.20

PART B - Water-borne Effluent

Introduction

In November 1958, the water of a portion of the Tennessee Valley Authority drainage area was sampled in order to determine the concentration and isotopic composition of the lithium. There were two reasons for doing this: (1) to observe the contribution of a commercial lithium plant, where no isotope separation is performed, to the total lithium concentration; and (2) to observe the contribution to total lithium concentration and change in isotopic composition due to the Oak Ridge separations plant.

In March 1959, the study was repeated to confirm the November 1958 results. Because foreign water samples are easily compromised and difficult to obtain, consideration has been given to taking advantage of natural integrators which are associated with rivers.

Summary

It has been established that lithium from a processing plant such as the Foote Mineral Company's plant at Sunbright, Virginia, can be traced several hundred miles in river water merely by a knowledge of the lithium concentration and flow rates of the water system. Typical background concentrations of lithium in river water (0.3 sm/ml - 2.0 sm/ml) were increased to as much as 90 sm/ml near the plant and were still greater than the normal background concentration 200 miles away.

It has further been demonstrated that the effluent from a lithium isotope separation plant alters the isotopic composition of the lithium in the river water farther than 300 miles away. It is entirely possible to locate a lithium isotope separations plant from a series of water samples and do this successfully in the presence of excessive amounts of normal lithium in the water.

A four week survey of the concentration and isotopic ratio of the lithium in Poplar Creek illustrated the wide variation in effluent from the Oak Ridge separations plant.

An investigation of fish and driftwood, as well as vegetation in which the root system obviously was near water that contained isotopically altered lithium, indicated these techniques are much less sensitive than an analysis of the raw water.

Experimental Techniques and Results

The isotopic analyses of the lithium samples were made on a 60° six-inch radius mass spectrometer. A single collector was used and a magnetic scanning technique was used to alternately detect the ion beams of interest. The amplified signal was "bucked down" with precision put and take decade

resistors. The 50 sm. samples of lithium iodide were mounted on a triple filament source similar to that described by Inghram³, or a double filament source developed by A. E. Cameron, in which the ionizing surface was a coil of tungsten wire. A few of the samples were run on the ratio recording spectrometer previously described.

The area that was sampled and each sampling site are shown on the map in Appendix I. The lithium concentration and the lithium 7/6 ratio are given at those sampling sites that are included on the map.

Table I is a compilation of the data on all the samples taken in November 1958. Some of the samples listed in Table I do not appear on the map because these are not pertinent to the experiment except to show the normal concentration and isotopic composition where no separations plant is involved.

In March 1959, the sampling was repeated. Table II is a compilation of the data from the samples taken in March 1959. It is notable that the same trend was found but different concentrations and isotopic ratios were found. This is to be expected since the effluent from the plant showed a wide variation.

From Tables I and II, it is obvious that the Oak Ridge lithium isotope separations plant can be accurately located from a series of water samples. It is possible to calculate the contribution to the lithium concentration in the rivers by the Oak Ridge facility if the flow rates and, therefore, the dilution is known. Accordingly, it is then possible to calculate the concentration of lithium at any point downstream knowing the flow rates. The close agreement between the theoretical and experimental values for the dilution, as shown in Table III, supports the original calculation for estimating the water-borne effluent losses from Oak Ridge. Figure I is a plot of the data presented in Table III and illustrates the addition of a considerable quantity of lithium between Norris and Watts Bar. Although the concentration below Norris is low, there is a big difference in quantity because of the large increase in volume and flow after the Clinch River spills into the Tennessee River. The calculated amount that Oak Ridge must contribute, based on the preceding arguments, is 15 pounds of lithium per hour.

The most important aspect of the survey is the greatly altered isotopic composition of the lithium in the river after the Oak Ridge contribution. Figure II is a plot of the data of Table I and illustrates the distances which the abnormal isotopic ratio persist, at least 300 miles downstream.

3. Inghram, M. G., and Chupka, W. A., Rev. Sci. Inst. 24, No. 7, (518-520) 1957.

The wide variation in quantity and isotopic ratio of the Oak Ridge water-borne effluent are shown in Table IV. For this four week survey, it appears losses are a mixture of Li^7 tails, Li^6 product, and normal feed material. It is notable though, and logically so, that there is less care in handling of the tail-end material.

Table V lists the data obtained on driftwood, leaves, and fish, which could act as natural integrators of the isotopically altered lithium. Indications of a lithium isotope separation plant may be obtained from such samples but the results are inconclusive.

Conclusion

It is apparent that the most effective way to detect a lithium isotope separations plant is by the water-borne effluent. In doing so, it is possible to take advantage of the physical and chemical properties of lithium that limit the usefulness of analyzing vegetation samples.

TABLE I

Analytical Results from the November 1958 Water Samples

<u>Sample Number</u>	<u>Date</u>	<u>Sampling Site</u>	<u>Li Conc. sm/ml</u>	<u>Li 7/6 Ratio</u>
310	10-19-58	Clinch River above Stock Creek spillage near Clinchport, Virginia	2.0	12.70
311	10-19-58	Clinch River below Stock Creek spillage near Clinchport, Virginia	90	12.43
346	11-18-58	Clinch River 10 miles east of Tazewell, Tennessee	73	12.34
347	11-18-58	Powell River 4 miles east of Harrogate, Tennessee	2.1	12.58
345	11-18-58	Below Norris Dam	11	12.58
348	11-20-58	Below Fort Loudon Dam	0.5	13.11
349	11-20-58	Below Watts Bar Dam	6.1	17.90
350	11-20-58	Hiwassee River 16 miles preceding spillage into Tennessee River	0.3	12.85
351	11-20-58	Below Chickamauga Dam	4.5	15.63
352	11-20-58	Below Hales Bar Dam	3.7	15.25
245	7-17-58	Kentucky Lake near Paris, Tennessee	0.6	13.58

TABLE II

Analytical Results from the March 19, 1959 Water Samples

<u>Sample Number</u>	<u>Sampling Site</u>	<u>Li Conc. sm/ml</u>	<u>Li 7/6 Ratio</u>
518	Clinch River 10 miles east of Tazewell, Tennessee	33	12.47
515	Powell River 4 miles east of Harrogate, Tennessee	2.1	12.58
524	Below Norris Dam	9.9	12.44
535	Below Fort Loudon Dam	0.4	12.81
531	Below Watts Bar Dam	3.38	15.93
529	Hiwassee River 16 miles preceding spillage into Tennessee River	0.3	12.81
527	Below Chickamauga Dam	2.45	15.43

TABLE III

Experimental and Theoretical Results Using TVA Flow Data to Calculate
Theoretical Lithium Concentration from Dilution

November 1958 Flow Data

<u>Flow-Rate Checking Site</u>	<u>Flow l/sec.</u>	<u>Experimental Li Conc. sm/ml.</u>	<u>Theoretical Li Conc. sm/ml.</u>
Near Clinchport	6,230	90	-
Tazewell	7,930	73	71
Norris	137,330	11	6.1
Watts Bar	617,300	6.1	2.7
Chickamauga	900,450	4.5	1.82
Hales Bar	827,000	3.7	1.96

TABLE IV

The Determination of Lithium in the East Fork of Poplar Creek

A Four Week Survey

<u>Sample Code</u>	<u>Date Sampled</u>	<u>Li Conc. sm/ml.</u>	<u>Li 7/6 Ratio</u>
24	10-21-57	1,550	-
26	10-22-57	1,850	-
27	10-23-57	1,060	14.30
28	10-24-57	1,550	11.89
29	10-25-57	1,000	12.67
30	10-26-57	4,000	17.21
31	10-27-57	970	-
32	10-28-57	1,300	-
33	10-29-57	1,050	10.81
34	10-30-57	2,200	-
35	10-31-57	2,170	12.95
36	11-1-57	910	-
37	11-2-57	1,060	16.21
38	11-3-57	1,810	-
39	11-4-57	2,620	14.33
40	11-5-57	1,870	-
41	11-6-57	1,310	11.45
50	11-7-57	1,730	-
51	11-8-57	1,050	-
52	11-9-57	910	-
53	11-10-57	1,300	-
54	11-11-57	900	-
55	11-12-57	12,500	20.95
56	11-13-57	1,430	-
57	11-14-57	650	-
58	11-15-57	380	-
62	11-16-57	70 (heavy rain)	11.82
63	11-17-57	240	-

TABLE V

Some Analytical Results of Natural Integrators

Sample A - Driftwood, Poplar Creek, about 10 miles from plant perimeter. Sample buried in creek bed with only a small piece projecting into water.

Sample B - Driftwood, Watts Bar Lake, about 30 miles from plant perimeter.

Sample C - Leaves from weeds. Same location as Sample B.

Sample D - Leaves from willow. Same location as Sample B.

<u>Sample</u>	<u>Li Conc. sm/gm.</u>	<u>7/6 Ratio</u>
A	4,980	12.85
B	1,006	12.93
C	194	12.55
D	51	12.58

Fish from Watts Bar and Norris Lake - Lithium 7/6 Ratio

	<u>Head and Scales</u>	<u>Fillet</u>	<u>Entrails</u>
Watts Bar	13.06	12.65	12.82
Norris	-	12.46	12.42

FIGURE I. The Effect of the Y-12 Plant Effluent on the Downstream Dilution of Lithium

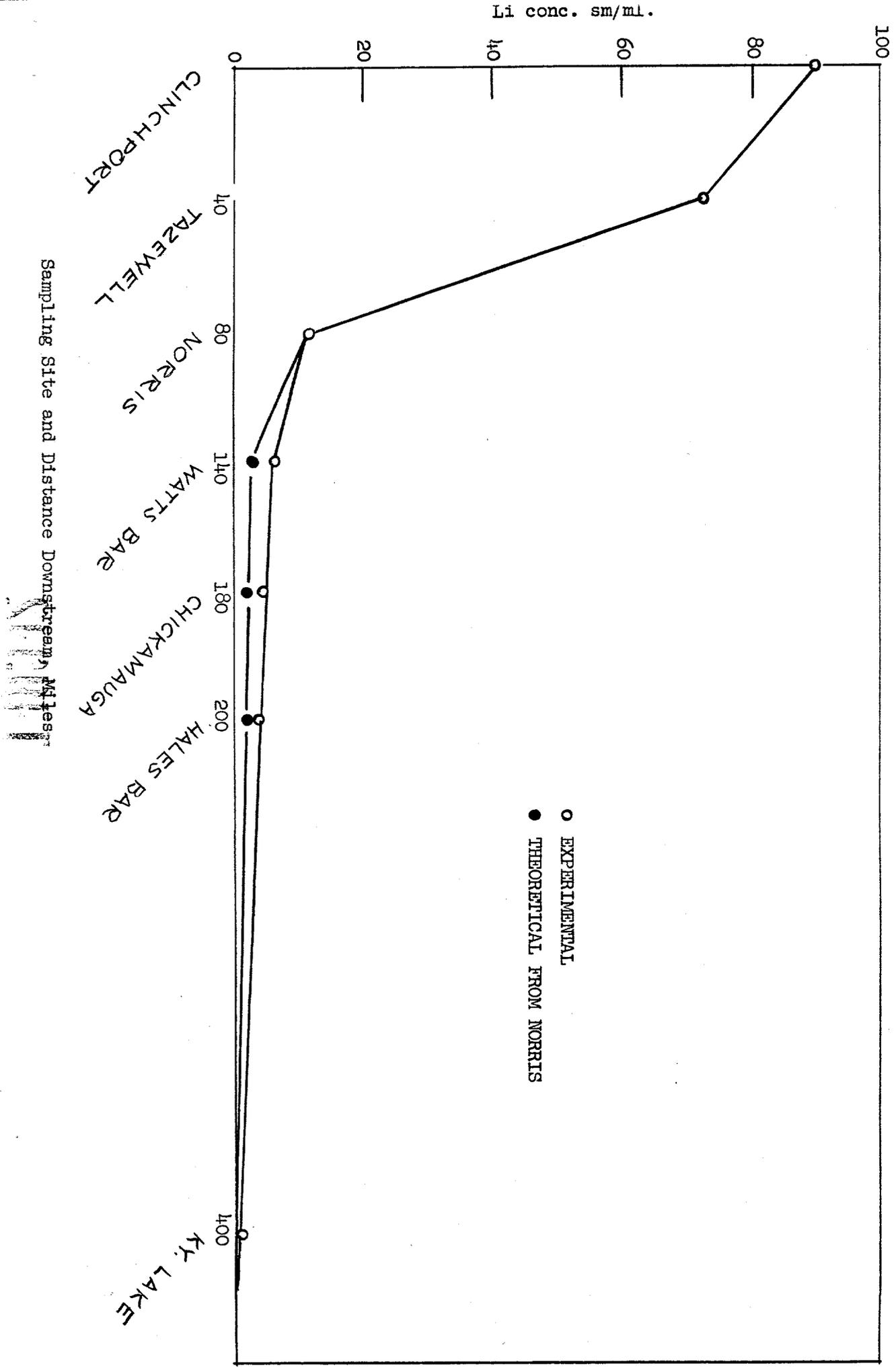
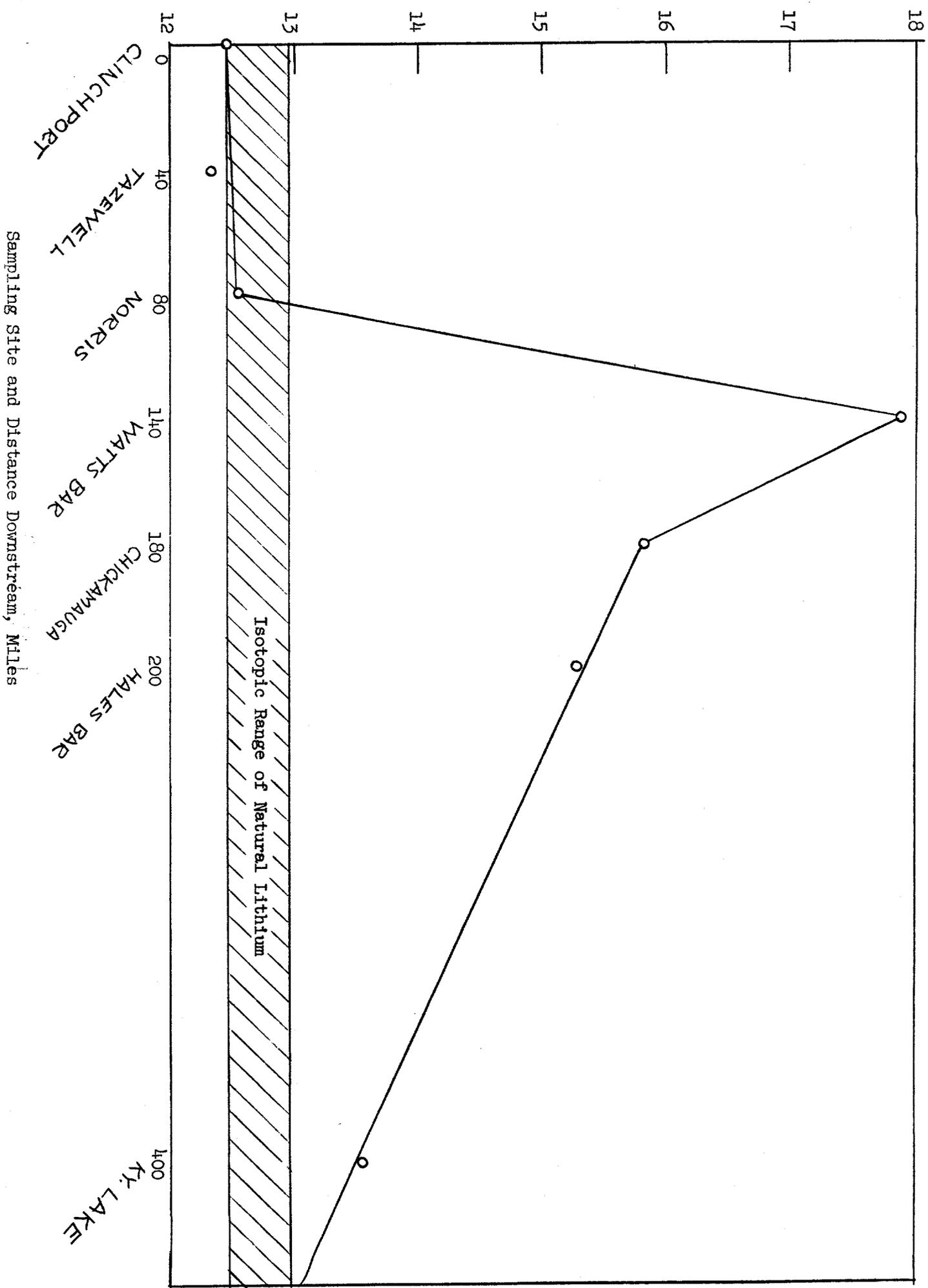
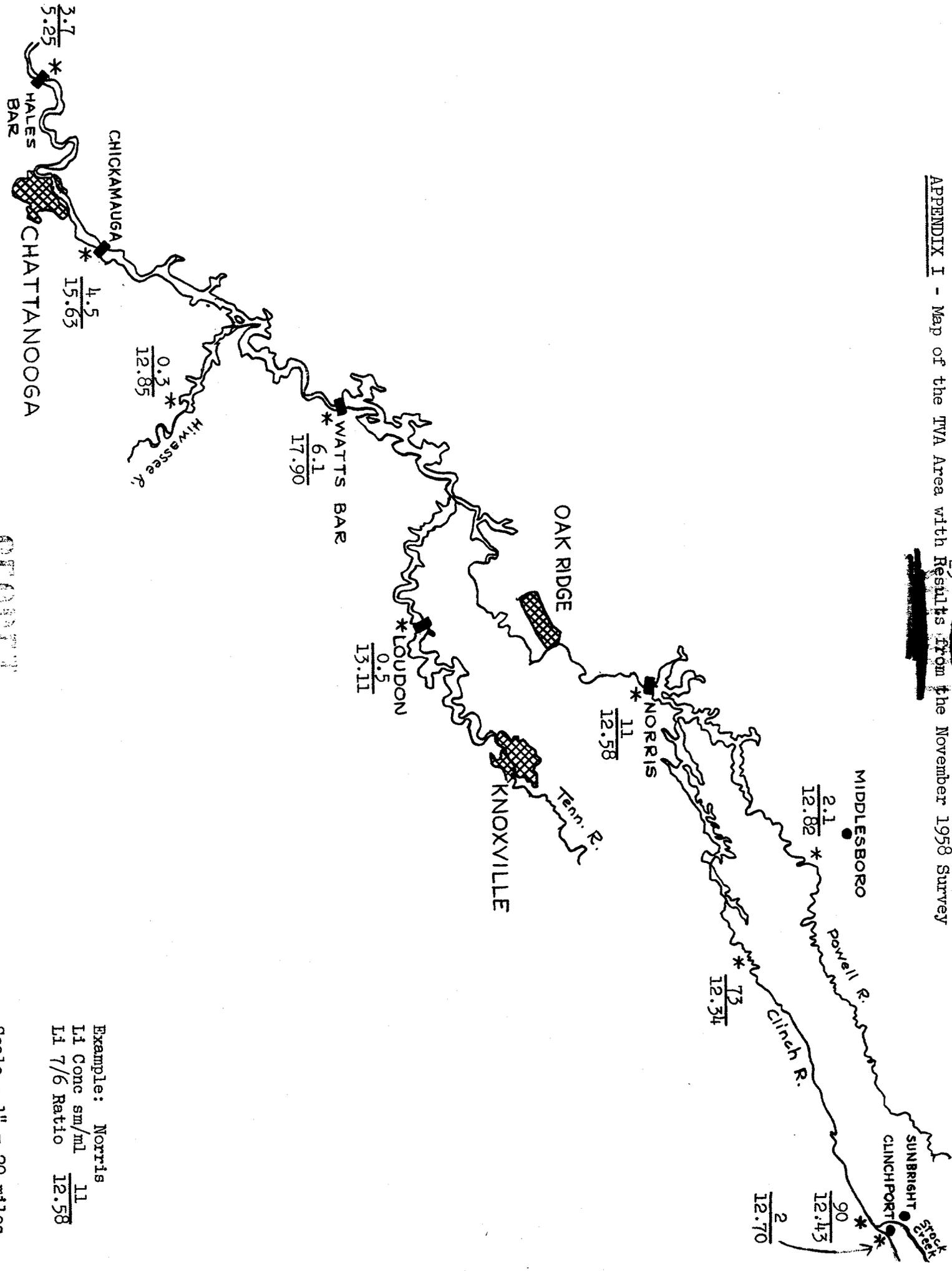


FIGURE II. The Effect of the Y-12 Plant Effluent on the Isotopic Composition of Lithium



Sampling Site and Distance Downstream, Miles

APPENDIX I - Map of the TVA Area with Results from the November 1958 Survey



SPOTT

Example: Norris
 L1 Conc sm/ml $\frac{11}{12.58}$
 L1 7/6 Ratio

Scale - 1" = 20 miles

APPENDIX II

Determination of Lithium in K-25 Plant Water

<u>Code</u>	<u>Date</u>	<u>Source</u>	<u>Li Conc. sm/ml.</u>
042	11-5-57	K-892 make-up from Clinch River	60
043		K-892-H Recycle	60
044		K-801-B make-up from Poplar Creek	11.5
059	11-15-57	Make-up, Clinch River	134
060		K-802-G Recycle	138
061		Make-up, Poplar Creek	78
064	11-20-57	Make-up, Clinch River	75
065		Recycle	80
066		Make-up, Poplar Creek	10
067	11-29-57	Make-up, Clinch River	65
068		Recycle	66
069		Make-up, Poplar Creek	20
075	12-5-57	Make-up, Clinch River	68
076		Recycle	74
077		Make-up, Poplar Creek	18
080	12-12-57	Make-up, Clinch (K-892)	67
081		Recycle K-892-H	68
082		Make-up, Poplar Creek (K-802)	13
083		Raw H ₂ O, Clinch (K-892)	15
084*	12-26-57	Make-up, K-892-H (K-33 treated)	21 *084 and
085		K-892-H Recycle	77 086 were
086		Raw Poplar Creek	63 probably
087		Raw Clinch River	20 mixed by
			sampler.
096	1-9-58	Treated make-up K-33	33
097		Recycle K-33	79
098		Raw Poplar Creek	190
099		Raw Clinch River	38
101	1-9-58	Recycle K-25	255
102		Recycle K-27	63
103		Recycle K-29	56
104		Recycle K-31	88
105	1-15-58	Treated make-up (K-33)	133
106		Recycle (K-33)	183
107		Raw Poplar Creek	290
108		Raw Clinch River	108

APPENDIX II (Continued)

Determination of Lithium in K-25 Plant Water

<u>Code</u>	<u>Date</u>	<u>Source</u>	<u>Li Conc. sm/ml.</u>
109	1-22-58	Treated make-up (K-33)	24
110		Recycle (K-33)	136
111		Raw Poplar Creek	512
112		Raw Clinch River	30
122	1-28-58	Treated make-up (K-33)	14
123		Recycle (K-33)	130
124		Raw Poplar Creek	138
125		Raw Clinch River	15

Remarks: The purpose of taking these samples was to get some idea of the amount of lithium being sent air-borne by the tremendous amount of H₂O evaporated daily at the K-25 Plant. The results were rather disappointing but did show a considerable amount of Li present in all the water.