Investigation of Laura Spring in the Raven Run Watershed, Fayette County, Kentucky

By

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September 1998

Purpose of Study

This study was undertaken to delineate the recharge area of a spring used as a household supply. The spring is called Laura Spring by the owner, Mr. Richard Levine, 5675 Kiddville Lane, Lexington, and is designated 9000-1949 in the Division of Water's groundwater data base.

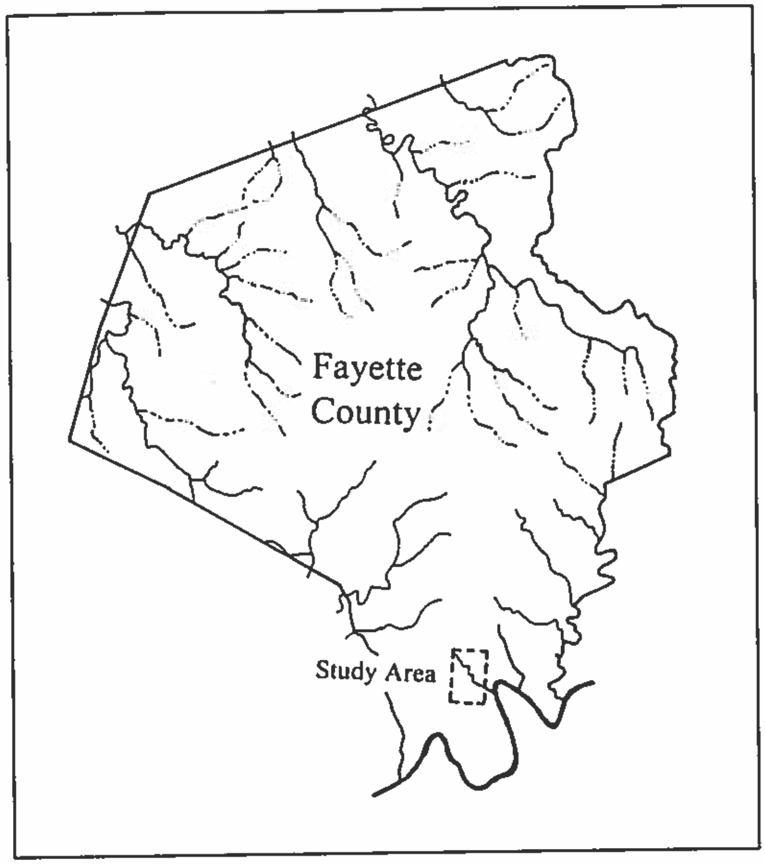


Figure 1: Location of Raven Run Study Area

Geologic Setting

Laura Spring, and the other springs and dye injection points involved in the study, are located on Raven Run Creek and its tributaries in Fayette County, Kentucky (Figure 1). This is an area of deeply dissected drainage adjacent to the Kentucky River in the Inner Bluegrass karst region. Raven Run Creek and tributaries are entrenched in a gorge 300 feet below the surrounding peneplain.

The upland surface is underlain by the Grier and Curdsville members of the Lexington Limestone. The Raven Run gorge is developed in the High Bridge Group of limestones and dolomites. The springs are located just above and below the contact between the Oregon dolomite and the Camp Nelson limestone and dolomite. Stress relief fracturing along the margins of the stream gorges is believed to have a significant role in local patterns of groundwater movement.

Water Quality Analysis

Laura Spring is used for domestic purposes by the Levine family including bathing and dishwashing, although drinking water is obtained in bottled form. The spring has been modified by construction of a small 5 by 3 feet covered concrete reservoir; water is pumped uphill through a buried water line.

At the request of Mr. Levine, grab samples of the spring water were collected on 17 March 1998 for analysis of multiple parameters including fecal coliform bacteria, dissolved metals, pesticides, and nutrients. Coliform samples were collected both at the spring source and at the kitchen tap. All other parameters were sampled from the source only.

Laboratory analysis reported a fecal coliform count of 40 and 35 colonies per 100 ml from the source and the kitchen tap, respectively. This suggested potential contamination of the groundwater aquifer supplying Laura Spring. All other parameters were within acceptable ranges for drinking water quality (See Appendix 1 for analytical reports).

Methodology

Based on the results of the surface investigations described below, two separate dye injections were conducted at an interval of four weeks, using two discrete injection points and a different dye for each trace. Fluorescein dye was used in the first trace, and Rhodamine WT for the second. Table 1 provides a characterization of all receptor sites used in both traces; see Figure 4 for locations.

The land surface above Laura Spring was investigated for possible injection sites. The point chosen for injection was an enlarged fissure or "grike" located about 300 feet from the Levine residence on the Martin property, on the uphill slope away from Laura spring. The grike is about ten feet long, one foot wide, and at least six feet deep. The owner has in the past made efforts to fill the grike with loose rock placed at one end, but continued erosion has kept the feature open beneath the rock fill. Soil erosion is aligned with the grike; it is not forming a depression but instead collapsing along the length. This feature is located near a cluster of trees and a utility pole almost directly in line with the power lines that cross through the property. Martin reports a filled-in pond above this. Also above this grike, to the northwest, is a

STUDY ID#	KENTUCKY SPRING ID#	NAME	DESCRIPTION	EST. FLOW (CFS)
1	9000-2455	Cave Spring	Perennial spring discharges at edge and slightly above surface stream, upper tributary to Raven Run. Receptor placed 2 feet from spring in direct flow.	1.5 (high) .5 (low)
2	N/A	Waterfall Spring	Intermittent spring discharges from beneath talus on slope about 40 feet above surface stream, upper tributary to Raven Run. Dropped from study due to cessation of flow at time of trace.	0.1 (high) 0.0 (low)
3	9000-2457	Deadfall Spring	Seasonal spring discharges from beneath talus on slope about 40 feet above surface stream, upper tributary to Raven Run. Receptor placed on ledge just above surface stream. During period of trace, flow had reduced to trickle barely sufficient for purpose.	0.05 (high) 0.01 (low)
4	N/A	N/A	Surface stream, upper tributary to Raven Run. About 100 feet above junction with Raven Run.	6.0 (high) 1.0 (low)
5	9000-1949	Laura Spring	Perennial spring on Raven Run, used as domestic water source, discharge point modified by enclosure. Receptor placed to receive overflow from spring box.	0.5 (high) 0.3 (low)
6	9000-2458	Undercut Spring	Perennial spring on Raven Run about 150 feet downstream from Laura Spring. Discharge from bedding plane in undercut slightly above level of surface stream.	0.3 (high) 0.2 (low)
7	N/A	N/A	Surface stream. Raven Run just above major series of cataracts and before junction with another surface tributary but about 50 feet downstream from a three foot high waterfall. Placed in chute between large flat rock and stream bank.	12.0 (high) 2.5 (low)
8	N/A	N/A	Surface stream, lower tributary to Raven Run. Above cataracts, about 100 feet above junction with Raven Run, next to leaning tree.	6.0 (high) 1.5 (low)
9	9000-2459	Powerline Spring	Seasonal spring discharges from hillside above upper tributary to Raven Run; named for powerlines directly overhead. Receptor placed in flow across ledge above stream.	0.05 (high) 0.01 (low)
10	N/A	N/A	Surface stream, tributary to tributary of Raven Run. Beneath 2-foot waterfall located about 50 feet back from junction.	1.5 (high) 0.2 (low)
11	9000-2456	Martin Cave Spring	Seasonal overflow spring, flow discharges from beneath talus pile below low cave opening. Spring channel splits into three forks that merge with surface stream; receptor placed in middle fork just above junction with surface stream.	??? (high) 0.05 (low)

Table 1: Characteristics of Receptor Sites

shallow grassy swale that ends in two or more tiny swallets. No evidence can be seen of water flow into either the grike or into the swallets. To the south is a series of small dry sinks with no visible inflow.

The gorge of Raven Run and the tributary streams surrounding the planned injection point were surveyed for springs on 8 May 1998 following a period of moderate to heavy rains. Numerous springs were observed discharging from just above the level of the surface streams or from points on the slope 30 to 50 feet above the stream. Many of the springs were later determined to be seasonal or intermittent, ceasing flow during drier weather conditions. Laura Spring (#5) and Undercut Spring (#6) on Raven Run and Cave Spring (#1) on the upper tributary were the most significant, perennial springs located for the study. Activated charcoal dye receptors were placed at five springs and at three surface stream locations at this time to establish background conditions prior to the actual trace. Subsequently, Waterfall Spring (#2) was eliminated from the study for lack of flow and Powerline Spring (#9) and an additional surface stream location (#10) were added.

Fluorescein dye, 2 ounces in solution, was injected into the upland grike on 12 May 1998. Prior to injection, approximately 10 gallons of water were directed into the grike through a water hose. After injection, the dye was flushed with approximately 360 additional gallons of water, at a rate of approximately 2 gpm for 180 minutes. Receptors were retrieved and replaced on May 19 and retrieved and not replaced on May 29.

Investigation of the tributary above Cave Spring during base flow conditions revealed that nearly the entire flow of the tributary stream discharges from Cave Spring. The surface stream bed above Cave Spring was dry except for a trickle that represented discharge from Martin Cave Spring (#11) located about 75 feet upstream from Cave Spring. The relative position of Martin Cave Spring suggested an overflow route for the flow to Cave Spring (note that Cave Spring is a misnomer as there is no cave opening at this spring; Martin Cave Spring, however, has a low opening about three feet high and eight feet wide). Discharge at Martin Cave Spring is from beneath a talus pile at the entrance. The surface stream bed upstream from Martin Cave Spring, during base flow conditions, remains dry for approximately 500 feet until flow is again encountered. The flow in the surface stream sinks into fractures in the limestone bedrock of the stream bed; no open swallet was observed.

On 8 June 1998, dye receptors were placed at Cave Spring and at Martin Cave Spring and 0.5 cup of a 20% solution of Rhodamine WT was added to the flow of the tributary stream about ten feet above where the stream sinks into bedrock fractures. Receptors were retrieved on 15 June 1998 and not replaced.

For each trace, dye was eluted from collected receptors using so-called "Smart" solution, consisting of 5:3:2 ratio of 1-propanol, deionized water, and ammonium hydroxide. The elutant was evaluated with a Shimadzu spectrofluorophotometer to determine the magnitude of spectral peaks for Fluorescein and Rhodamine, if present.

Results

The receptors collected prior to introduction of Fluorescein on 12 May 1998 showed no sign of any background dye that might interfere with the trace, except for Waterfall Tributary where a slight possible background was evident. Following dye injection into the grike, receptors collected on 19 May 1998 indicated extremely positive results for Deadfall Spring (#3); very positive for Powerline Spring (#9) and surface stream water in the upper tributary of Raven Run (#4); and positive for Laura Spring (#5), Undercut Spring (#6) and the waters of Raven Run (#7). Fluorescein was not detected in the waters of the lower tributary of Raven Run (#8, #10), nor at Cave Spring (#1). Similar results followed examination of the receptors collected on 29 May 1998, although the positives were ambiguous for Laura Spring and the waters of Raven Run. These results are summarized in Table 2, and selected plots from the Shimadzu are shown in Figure 2.

ID#	NAME	5/8	5/19	5/29
1	Cave Spring	-	-	-
3	Deadfall Spring	-	+++	++
4	Upper Tributary	-	++	+
5	Laura Spring	-	+	?
6	Undercut Spring	-	+	+
7	Raven Run	-	+	?
8	Lower Tributary	-	-	-
9	Powerline Spring	-	++	+
10	Waterfall Tributary	B	B	B

Table 2: Summary of Results of Fluorescein Trace

Receptors collected on 15 June 1998 after injection of Rhodamine dye into the upper tributary where it sinks into bedrock fractures gave extremely positive results for Cave Spring (#1) and very positive for Martin Cave Spring (#11). Although receptors were not placed at any other sites for this trace, unexpected visual evidence of a strong positive to Laura Spring was provided by Mr. Levine who reported pink water in his bathroom following dye injection. Results are summarized in Table 3, and selected Shimadzu plots are shown in Figure 3 (following page).

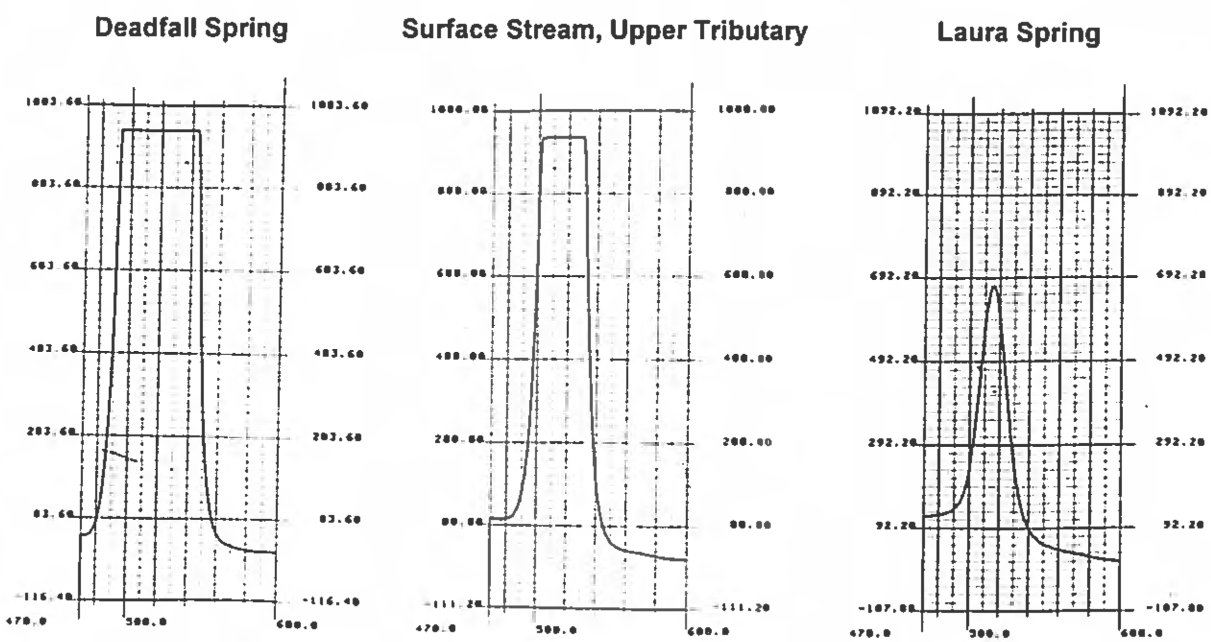
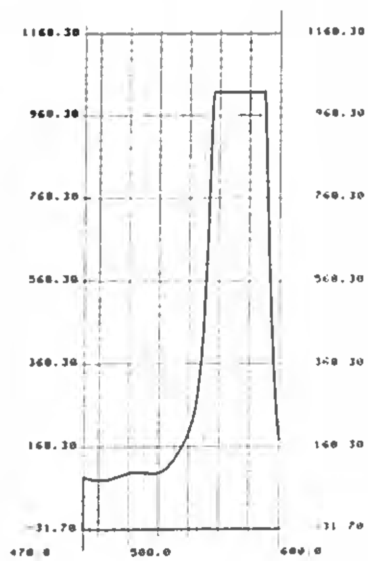


Figure 2: Graphs of Spectral Peaks from Fluorescein Trace
Note: Truncated spikes shown for Deadfall Spring and the Upper Tributary result from use of the high-sensitivity setting on the Shimadzu.

ID#	NAME	6/15
1	Cave Spring	+++
11	Martin Cave Spring	++
5	Laura Spring	+++ Visual

Table 3: Summary of Results of Rhodamine Trace

Cave Spring



Martin Cave Spring

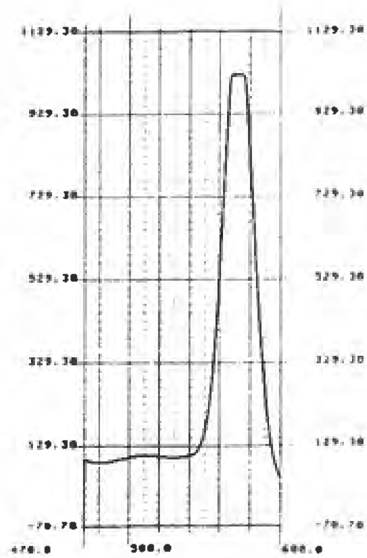


Figure 3: Graphs of Spectral Peaks from Rhodamine Trace

Note: Truncated spikes shown result from use of the high-sensitivity setting on the Shimadzu

Interpretation of Results

The Fluorescein trace resulted in detection of dye at numerous sites over an arc of about 90 degrees from the injection point. These results led to the initial conclusion that groundwater movement from the uplands to the gorge of Raven Run and its tributary in the vicinity of the Levine property tends to follow a widespread pattern of dispersal from multiple points along an arc, rather than simple linear flow. The second trace, using Rhodamine, was intended only to confirm a predicted link between Cave Spring and the point further up the tributary where flow sinks into fractures. The Rhodamine trace was not expected to reveal additional insights about flow pathways from upland to gorge. Critical information was nevertheless provided in a wholly unexpected manner. The property owner's visual confirmation of Rhodamine in Laura Spring revises conclusions drawn from the results of the Fluorescein injection.

The presence of Rhodamine dye in Laura Spring indicates that leakage must be occurring through the bed of the tributary stream at some unknown location. Surface water is therefore likely to be a significant component of the flow from Laura Spring. In light of this revelation, the upland groundwater dispersal hypothesis based upon the Fluorescein trace must be revised. It now appears likely that the positive trace for Fluorescein to Laura Spring does not indicate a direct connection to the upland grike, but also represents leakage of surface flow into the stream bed. The mild positive for Fluorescein at Laura Spring probably results from dye discharged from Deadfall and Powerline springs into the tributary that leaked through the stream bed and was then transported to Laura Spring. This indicates bed leakage for both traces occurred between Powerline Spring and Laura Spring.

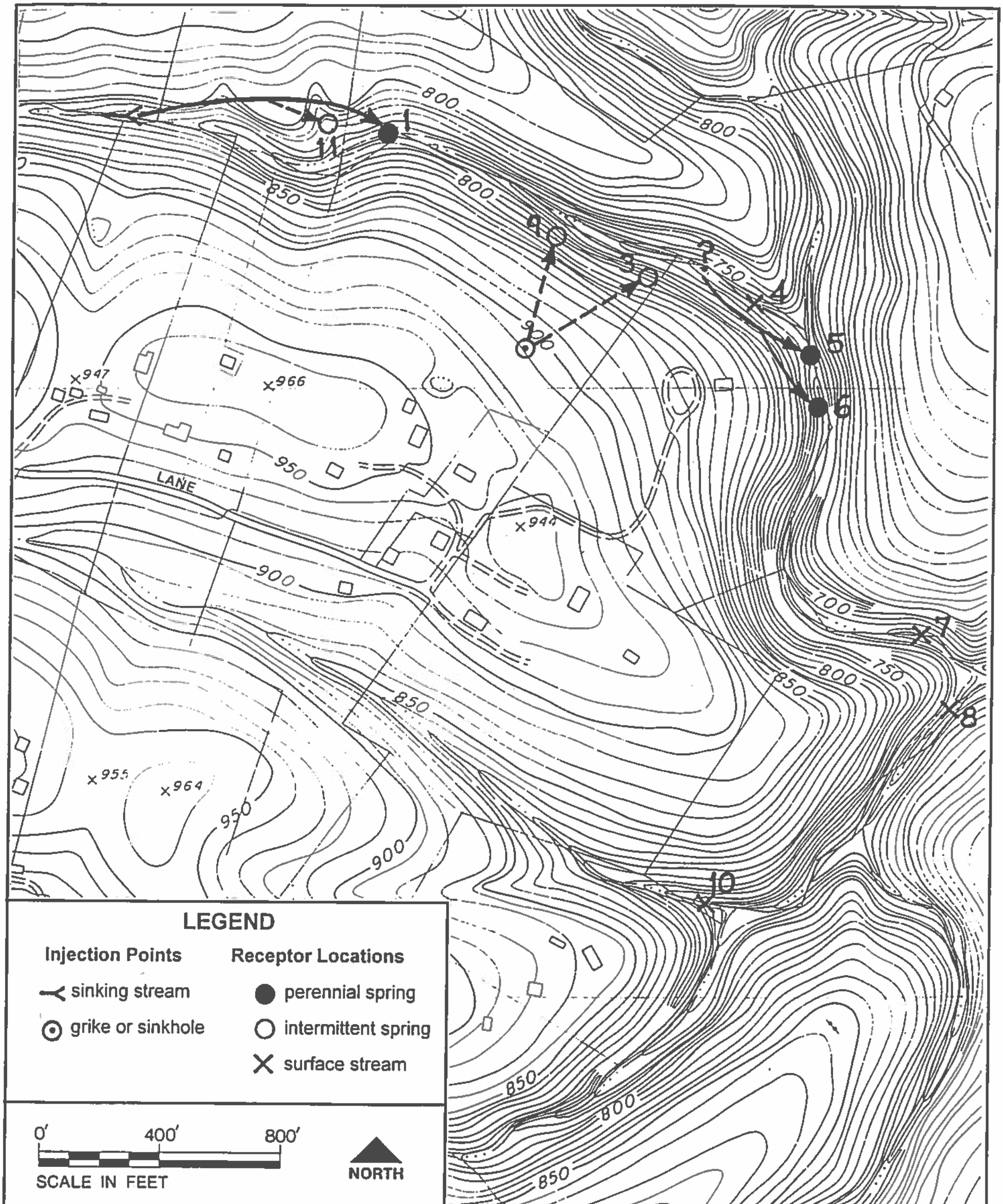


Figure 4: Map of Raven Run study area showing injection points, dye receptor locations, and positive traces obtained during moderate flow conditions.

Figure 4 shows the final interpretation of the results of the two dye traces. Strong positives for Fluorescein at Powerline (#9) and Deadfall (#3) springs indicate a direct (more or less) pathway from the upland grike. Strong positives for Rhodamine at Martin Cave Spring (#11) and Cave Spring (#1) indicate that Cave Spring is a resurgence for the sinking stream further up the tributary valley and that Martin Cave Spring is a higher-level overflow route. Fluorescein recovery from Laura (#5) and Undercut (#6) springs downstream from Powerline and Deadfall springs, when combined with the visual Rhodamine dye confirmation from Laura Spring, indicate that the discharge from Laura and Undercut Springs is partly or entirely derived from diversion of surface water flowing in the upper tributary stream. Because Fluorescein dye was recovered, this points to an area of leakage between Powerline Spring and Laura Spring.

An important procedural conclusion to be drawn from this study is that the unexpected is always possible and more receptor sites are better than few. The Rhodamine trace was originally considered to be incidental to the primary investigation, merely to confirm the predicted source of Cave Spring's flow from the upstream diversion of surface flow, so no receptors were placed below Cave Spring. Deeper reflection on this situation prior to the Rhodamine trace might have anticipated the probability that bed leakage may occur in more than one location and hence more than one spring may be affected. If Mr. Levine, who was not aware that a Rhodamine trace was intended, had not been curious as to why water in his house pumped from Laura Spring had a faint pink tinge, interpretation of groundwater dispersal from upland to gorge would have been based solely on the Fluorescein results. Thus the assumption of a straight-line connection between the upland and Laura Spring would be completely erroneous. This account should serve as an object lesson to anyone undertaking to trace groundwater flow in karst.

I would like to acknowledge the assistance of Joseph A. Ray, Division of Water, in the planning and evaluation of this study. Assistance with collection of water samples was provided by Peter T. Goodman.

Appendix 1: Results of Water Quality Analysis

LABORATORY ANALYSIS

03/19/98

APR 6 1998

KENVIRONS

452 Versailles Road Frankfort,KY 40601
Phone (502)695-4357 Fax (502)695-4363

DR. RICHARD LEVINE
5675 KIDDVILLE LANE
LEXINGTON, KY 40515

ATTN:

SAMPLE IDENTIFICATION :
LAURA'S SPRNG (AT SOURCE)

PROJECT NO.: 98057
LAB. NUMBER: 112861
DATE RECEIVED: 03/17/98
DATE SAMPLED: 03/17/98
SAMPLED BY: CLIENT

FIELD DATA:

PARAMETER NAME	LAB RESULT	PQL/MDL	UNITS	DATE	ANALYST	METHOD
COLIFORM FECAL	40	0	/100ML	03/17/98	KJS	9222D

ANALYSIS PER EPA SW-846 & EPA METHODS

SUBMITTED John F. [signature]

DATE 3/19/98

4/-/9/ 2:24

257-9000

LABORATORY ANALYSIS

03/19/98

606-257-1437

KENVIRONS

452 Versailles Road Frankfort,KY 40601
Phone (502)695-4357 Fax (502)695-4363

DR. RICHARD LEVINE
5675 KIDDVILLE LANE
LEXINGTON, KY 40515

ATTN:

SAMPLE IDENTIFICATION :
LAURA'S SPRNG (COLD TAP)

PROJECT NO.: 98057
LAB. NUMBER: 112862
DATE RECEIVED: 03/17/98
DATE SAMPLED: 03/17/98
SAMPLED BY: CLIENT

FIELD DATA:

PARAMETER NAME	LAB RESULT	PQL/MDL	UNITS	DATE	ANALYST	METHOD
COLIFORM-FECAL	35	0.	/100ML	03/17/98	KJS	9222D

ANALYSIS PER: EPA SW-846 & EPA METHODS

SUBMITTED John F. Hill DATE 3/19/98

JAMES E. BICKFORD
SECRETARY

PAUL E. PATTON
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL SERVICES
CENTRALIZED LABORATORY FACILITY
100 SOWER BLVD STE 104
FRANKFORT KY 40601-8272

June 2, 1998

Division of Environmental Services
Report Number: A39-00341
Sample Number: 9800839

To: Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Re: Groundwater Monitoring Network

Attn: James Webb

AKGWA Number: 9000-1949

County: Fayette

Facility:

Collected by: Peter Goodman — **Date:** 03/17/98 **Time:** 1330

Delivered by: James Webb — **Date:** 03/18/98 **Time:** 1018

Received by: Scott Bryan — **Date:** 03/18/98 **Time:** 1018

Sample Matrix: Water

Collection Method: Grab

Sample Identification: Laura's Spring

REPORT OF ANALYSIS

CAS NUMBER	TOTAL CONSTITUENTS	CONCENTRATION
	Alkalinity	175 mg/L
	CBOD-5	ND @ 2 mg/L
16887-00-6	Chloride	4.95 mg/L
	Conductivity	401 µmho
16984-48-8	Fluoride	0.305 mg/L
	pH	7.89 S.U.
	Total Suspended Solids	2 mg/L
	Total Dissolved Solids	237 mg/L
14808-79-8	Sulfate	18.0 mg/L
7440-44-0	Organic Carbon	1.30 mg/L
	Ammonia-Nitrogen	ND @ 0.05 mg/L
	Total Kjeldhal Nitrogen	ND @ 0.05 mg/L
14797-55-8	Nitrate	0.288 mg/L
	Phosphorus, ortho	ND @ 0.019 mg/L
	Phosphorus, total	0.182 mg/L
77-47-4	1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene	ND @ 0.000040 mg/L
118-74-1	Hexachlorobenzene	ND @ 0.000010 mg/L
319-84-6	Hexachlorocyclohexane,alpha isomer	ND @ 0.000010 mg/L
319-85-7	Hexachlorocyclohexane,beta isomer	ND @ 0.000010 mg/L
58-89-9	Hexachlorocyclohexane,gamma isomer	ND @ 0.000010 mg/L
319-86-8	Hexachlorocyclohexane,delta isomer	ND @ 0.000010 mg/L

CAS NUMBER	TOTAL CONSTITUENTS	CONCENTRATION
76-44-8	Heptachlor	ND @ 0.000010 mg/L
309-00-2	Aldrin	ND @ 0.000010 mg/L
2921-88-2	Chlorpyrifos	ND @ 0.000010 mg/L
1024-57-3	Heptachlor epoxide	ND @ 0.000010 mg/L
27304-13-8	Oxychlordane	ND @ 0.000010 mg/L
5103-74-2	trans-Chlordane	ND @ 0.000010 mg/L
5103-71-9	cis-Chlordane	ND @ 0.000010 mg/L
39765-80-5	trans-Nonachlor	ND @ 0.000010 mg/L
56534-02-2	alpha-Chlordene	ND @ 0.000010 mg/L
3734-48-3	Chlordene	ND @ 0.000010 mg/L
	gamma-Chlordene	ND @ 0.000010 mg/L
5103-73-1	cis-Nonachlor	ND @ 0.000010 mg/L
12789-03-6	Technical Chlordane	ND @ 0.000010 mg/L
3424-82-6	o,p'-DDE	ND @ 0.000010 mg/L
72-55-9	p,p'-DDE	ND @ 0.000010 mg/L
60-57-1	Dieldrin	ND @ 0.000010 mg/L
72-20-8	Endrin	ND @ 0.000010 mg/L
53-19-0	o,p'-DDD	ND @ 0.000010 mg/L
72-54-8	p,p'-DDD	ND @ 0.000010 mg/L
789-02-6	o,p'-DDT	ND @ 0.000010 mg/L
50-29-3	p,p'-DDT	ND @ 0.000010 mg/L
8017-34-3	Total DDT	ND @ 0.000010 mg/L
72-43-5	Methoxychlor	ND @ 0.000010 mg/L
2385-85-5	Mirex	ND @ 0.000010 mg/L
959-98-8	Endosulfan I	ND @ 0.000010 mg/L
33213-65-9	Endosulfan II	ND @ 0.000010 mg/L
1031-07-8	Endosulfan sulfate	ND @ 0.000010 mg/L
7421-93-4	Endrin aldehyde	ND @ 0.000010 mg/L
53494-70-5	Endrin ketone	ND @ 0.000010 mg/L
8001-35-2	Toxaphene	ND @ 0.000100 mg/L
62-73-7	Dichlorvos	ND @ 0.000050 mg/L
759-94-4	S-Ethyldiisopropyl thiocarbamate (EPTC)	ND @ 0.000050 mg/L
2008-41-5	S-Ethyldiisobutyl thiocarbamate (Butylate)	ND @ 0.000050 mg/L
7786-34-7	Mevinphos	ND @ 0.000050 mg/L
1929-77-7	Vernolate (S-Propyldipropylthiocarbamate)	ND @ 0.000050 mg/L
30560-19-1	Acephate	ND @ 0.000400 mg/L
1114-71-2	Pebulate	ND @ 0.000050 mg/L
2212-67-1	Molinate	ND @ 0.000050 mg/L
34014-18-1	Tebuthiuron	ND @ 0.000400 mg/L
1918-16-7	Propachlor	ND @ 0.000050 mg/L
13194-48-4	Ethoprop	ND @ 0.000050 mg/L
1134-23-2	Cycloate	ND @ 0.000050 mg/L
101-21-3	Chlorpropham	ND @ 0.000050 mg/L
1582-09-8	Trifluralin	ND @ 0.000050 mg/L
1861-40-1	Benfluralin (Benefin)	ND @ 0.000050 mg/L
6190-65-4	Atrazine desethyl	ND @ 0.000050 mg/L
1610-17-9	Atraton	ND @ 0.000050 mg/L
1610-18-0	Prometon	ND @ 0.000050 mg/L
122-34-9	Simazine	ND @ 0.000050 mg/L
1912-24-9	Atrazine	ND @ 0.000050 mg/L

CAS NUMBER	TOTAL CONSTITUENTS	CONCENTRATION
139-40-2	Propazine	ND @ 0.000050 mg/L
26399-36-0	Profluralin (Tolban)	ND @ 0.000050 mg/L
13071-79-9	Terbufos	ND @ 0.000050 mg/L
333-41-5	Diazinon	ND @ 0.000050 mg/L
944-22-9	Fonofos	ND @ 0.000050 mg/L
23950-58-5	Pronamide	ND @ 0.000050 mg/L
298-04-4	Disulfoton	ND @ 0.000050 mg/L
79538-32-2	Tefluthrin	ND @ 0.000050 mg/L
5902-51-2	Terbacil	ND @ 0.000100 mg/L
34256-82-1	Acetochlor	ND @ 0.000050 mg/L
15972-60-8	Alachlor	ND @ 0.000050 mg/L
21087-64-9	Metribuzin	ND @ 0.000050 mg/L
1014-70-6	Simetryn	ND @ 0.000050 mg/L
834-12-8	Ametryn	ND @ 0.000050 mg/L
7287-19-6	Prometryn	ND @ 0.000050 mg/L
298-00-0	Methyl parathion	ND @ 0.000050 mg/L
886-50-0	Terbutryn	ND @ 0.000050 mg/L
121-75-5	Malathion	ND @ 0.000050 mg/L
314-40-9	Bromacil	ND @ 0.000050 mg/L
51218-45-2	Metolachlor	ND @ 0.000050 mg/L
43121-43-3	Triadimefon	ND @ 0.000050 mg/L
56-38-2	Parathion	ND @ 0.000050 mg/L
21725-46-2	Cyanazine	ND @ 0.000050 mg/L
113-48-4	MGK 264	ND @ 0.000050 mg/L
957-51-7	Diphenamide	ND @ 0.000200 mg/L
33820-53-0	Isopropalin (Paarlan)	ND @ 0.000200 mg/L
40487-42-1	Pendimethalin (Prowl)	ND @ 0.000050 mg/L
23184-66-9	Butachlor	ND @ 0.000050 mg/L
22248-79-9	Stirofos	ND @ 0.000050 mg/L
15299-99-7	Napropamide	ND @ 0.000050 mg/L
22224-92-6	Fenamiphos (Nemacur)	ND @ 0.000800 mg/L
19666-30-9	Oxadiazone	ND @ 0.000050 mg/L
150-50-5	Merphos (Folex)	ND @ 0.000050 mg/L
42874-03-3	Oxyflurfen (Goal)	ND @ 0.000050 mg/L
5234-68-4	Carboxin	ND @ 0.000050 mg/L
27314-13-2	Norflurazon	ND @ 0.000050 mg/L
51235-04-2	Hexazinone	ND @ 0.000050 mg/L
12674-11-2	Aroclor 1016	ND @ 0.000100 mg/L
11104-28-2	Aroclor 1221	ND @ 0.000100 mg/L
11141-16-5	Aroclor 1232	ND @ 0.000100 mg/L
53469-21-9	Aroclor 1242	ND @ 0.000100 mg/L
12672-29-6	Aroclor 1248	ND @ 0.000100 mg/L
11097-69-1	Aroclor 1254	ND @ 0.000100 mg/L
11096-82-5	Aroclor 1260	ND @ 0.000100 mg/L
1336-36-3	Aroclor 1262	ND @ 0.000100 mg/L
11100-14-4	Aroclor 1268	ND @ 0.000100 mg/L

CAS NUMBER	DISSOLVED CONSTITUENTS	CONCENTRATION
7429-90-5	Aluminum	ND @ 0.104 mg/L
7440-36-0	Antimony	ND @ 0.045 mg/L

CAS NUMBER	DISSOLVED CONSTITUENTS	CONCENTRATION
7440-39-3	Barium	0.009 mg/L
7440-41-7	Beryllium	ND @ 0.002 mg/L
7440-70-2	Calcium	77.1 mg/L
7440-48-4	Cobalt	ND @ 0.017 mg/L
7439-89-6	Iron	ND @ 0.007 mg/L
7439-95-4	Magnesium	4.79 mg/L
7439-96-5	Manganese	ND @ 0.005 mg/L
7439-98-7	Molybdenum	ND @ 0.013 mg/L
7440-02-0	Nickel	0.027 mg/L
7440-09-7	Potassium	0.664 mg/L
7440-22-4	Silver	ND @ 0.006 mg/L
7440-23-5	Sodium	2.76 mg/L
7440-24-6	Strontium	0.103 mg/L
7440-31-5	Tin	ND @ 0.016 mg/L
7440-62-2	Vanadium	ND @ 0.012 mg/L
7440-66-6	Zinc	ND @ 0.003 mg/L
7440-38-2	Arsenic	ND @ 0.002 mg/L
7440-43-9	Cadmium	ND @ 0.001 mg/L
7440-47-3	Chromium	ND @ 0.001 mg/L
7440-50-8	Copper	ND @ 0.001 mg/L
7439-92-1	Lead	ND @ 0.002 mg/L
7439-97-6	Mercury	ND @ 0.00005 mg/L
7782-49-2	Selenium	ND @ 0.002 mg/L
7440-28-0	Thallium	ND @ 0.002 mg/L

ND = Not Detected

This report has been prepared and reviewed by personnel within the Division of Environmental Services. It has been approved for release.

William E. Davis

William E. Davis, Director
Division of Environmental Services