Fall 2006

F-CHEC Cistern Survey Results

Fernald Community Health Effects Committee

Introduction

The Fernald Community Health Effects (F-CHEC) Cistern Use and Maintenance Survey was conducted to compile information about the historical and current use and maintenance patterns of Fernald area residents with cisterns. Cisterns represent an unstudied route of potential exposure to waterborne contaminants for area residents. These water sources for refilling cisterns, whether rainwater, on- and off-site wells, river access, etc. are common sources of water for cisterns; all represent potential sources of exposure to chemical and radiological contaminants. Many of these exposure routes have been researched. However, contaminants collected in rainwater as runoff from roofs has not been studied. The potential for airborne contaminants from the Fernald site to collect on rooftops and drain into cisterns during rain events warrants investigation.

The Fernald Medical Monitoring Program (FMMP) collected information about the presence of cisterns on the properties of participants and later developed a questionnaire to collect additional information about how participants used and maintained their cisterns. Ms. Emma-Jane Fennell, an MS student at the University of Cincinnati in the Department of Environmental Health used the survey to conduct her thesis entitled Patterns of Cistern Drinking Water Use in a Semi-Rural Community for Exposure Assessment (2003). Surveys were sent to six hundred and eleven FMMP participants living within the two-mile exposure domain. (See the F-CHEC Water Quality Database for reference information about this thesis.)

F-CHEC decided to conduct a comparable survey of area residents not participating in the medical monitoring program. F-CHEC modified the survey instrument. (See the attached timeline RE: the founding of F-CHEC and the conduct of this project for details about the conduct of the cistern survey, including publicity activities, processing procedures and quality control practices.) F-CHEC members distributed copies of the surveys with return envelopes to local establishments like senior centers, churches, township meeting places, etc. This proved to be an ineffective method of enlisting survey participation. Forty-three surveys were returned; three were not included in the analysis as the address was outside the five-mile exposure domain.

Surveys were also mailed to FMMP participants who did not participate in the initial survey mailing to households within the two-mile exposure domain. Eight hundred surveys were mailed to randomly selected FMMP participants with a cistern within the three- to five-mile radius of the Fernald facility. Three hundred and fifteen surveys were returned; two records were not included in the analysis as the address was indeterminate or outside the five-mile exposure domain.

The results presented here are for three hundred and fifty-three survey respondents. The data indicate that:

- a majority of respondents relied on their cistern as a major source of drinking water;
- rain water was the most common source of water used to refill cisterns;
- rainwater was commonly used during the production years to refill cisterns;
- filters and shut-off valves were reported used by less than half the respondents; and
- although most respondents reported cleaning or treating their cistern, many could not recall the frequency of these practices.

The survey is limited by respondent recall. The surveys were mailed to the oldest living relative of the household where the cistern had been reported. Respondents were asked to recall details about the cistern and maintenance practices that date back many years. Some surveys were completed by adults who were children at the time the family lived on the property with the cistern. In addition, it's apparent respondents had problems understanding some of the questions which negatively impacted the number of respondents answering these questions. Nonetheless, the data indicate that if airborne contaminants from the site were deposited on area rooftops, rainwater used to refill cisterns may have been a viable route of exposure to these dusts/particulates. These data can help researchers better assess that exposure potential and estimate risks.

Demographic Characteristics (DEMO)

Distance from the Site: Three hundred and fifty-three (353) individuals completed the survey. Sixty-six respondents (19%) lived on properties in Butler County; two hundred and eighty-seven (81%) respondents lived on properties in Hamilton County. Table DEMO-1 shows the location of the respondents by county mile radius from the Fernald plant.

Table DEMO-1: County and Mile Radius from Fernald Plant of Survey Respondents

County	Mile Radius from Fernald Plant				
	1	2	3	4	5
Butler	-	-	15 (4%)	23 (7%)	28 (8%)
Hamilton	2 (1%)	10 (3%)	88 (25%)	98 (28%)	89 (25%)
Total Number of Respondents	2 (1%)	10 (3%)	103 (29%)	121 (35%)	117 (33%)

See Appendix B for a complete listing of survey respondents by county-mile-segment and Appendix C for a map depicting the county-mile-segment for the five-mile exposure domain.

Duration of Residence: The Fernald facility operated between 1952 and 1989. (See Table WD-3: Time Periods of the Fernald Uranium Processing Plant in the Well Database Description for a timeline of production milestones and dates of off-site contamination.) Three hundred and fifteen (88%) of the respondents lived at their residence with a cistern for some period during the production years. The average length of residence was seventeen years. Table DEMO-2 presents the move-in and move-out dates by decade for the survey respondents.

[See Q2 & Q3 on the Cistern Use & Maintenance Questionnaire]

Table DEMO-2: Period of Residence on Property with Cistern of Survey Respondents

Begin Date of Residence	End Date of Residence						Total
	1950s	1960s	1970s	1980s	1990s	2000s	
1950s (and earlier)	22	37	45	5	26	1	137
1960s	-	13	32	27	30	8	110
1970s	-	-	13	16	27	4	60
1980s	-	-	-	8	12	8	28
1990s	-	-	-	-	5	12	17
2000s	-	-	-	-	-	1	1
Total	**22**	**50**	**90**	**56**	**100**	**34**	**352**

Number of Respondents Not Answering Question = 1

Water Sources (WS)

Cistern on Property: Three hundred and thirty respondents (93%) indicated the cistern was present on the property when they moved to the residence. Table WS-1 shows these data.

[See Q4 on the Cistern Use & Maintenance Questionnaire]

Table WS-1: Presence of Cistern on Property

Cistern Present When Moved to Property	Number of Responses (%)
No	22 (6%)
Yes	329 (93%)
Don't Know	1 (<1%)
Total Number of Respondents	352

Number of Respondents Not Answering Q4 = 1

Primary Sources of Drinking Water: Cistern water was the primary source of drinking water for three hundred and twenty-two (%) survey respondents. Table WS-2 lists the primary sources of drinking water identified by the respondents.

[See Q6 on the Cistern Use & Maintenance Questionnaire]

Table WS-2: Primary Sources of Drinking Water

Primary Source of Drinking Water	Number of Responses (%)
Municipal Water Company	11 (3%)
Well Water	39 (11%)
Cistern Water	321 (91%)
Bottled Water	10 (3%)
Other	1 (<1%)
Don't Know	1 (<1%)

NOTE: Some respondents indicated more than one primary source of drinking water.

Number Respondents Not Answering Q6 = 0

Secondary Sources of Drinking Water: Cistern and well water were reported most frequently as secondary sources of drinking water. One hundred thirty-nine (39%) respondents answered this question. (The responses shown here are independent of responses to Q7, Did you use a second source for your drinking water?) Thirty-six (26%) respondents identified cisterns as their secondary source of drinking water; thirty-two (23%) identified well water. Table WS-3 lists the secondary sources of water identified by the survey respondents.

[See Q8 on the Cistern Use & Maintenance Questionnaire]

Table WS-3: Secondary Sources of Drinking Water

Secondary Source of Drinking Water	Number of Responses (%)
Municipal Water Company	13 (9%)
Well Water	32 (23%)
Cistern Water	36 (26%)
Bottled Water	23 (17%)
Don't Know	2 (1%)
Not Applicable	49 (34%)
Total Number of Respondents	139

NOTE: Some respondents indicated more than one primary source of drinking water.

Number of Respondents Not Answering Q8 = 214.

First Use of Cistern for Drinking Water: Most of the respondents (292 or 83%) started using their cisterns for drinking water during the Fernald production years (1952-1989). Table WS-4 shows the decade in which the index cistern was first used for drinking. [Index cistern refers to the cistern on the property referenced in the survey.]

[See Q9 on the Cistern Use & Maintenance Questionnaire]

Table WS-4: First Year of Cistern Use by Decade

First Year Cistern Used for Drinking Water	Number of Responses (%)
Before 1950	22 (6%)
1950s	108 (31%)
1960s	99 (29%)
1970s	62 (18%)
1980s	22 (6%)
After 1990	15 (4%)
Never	11 (3%)
Don't Know	7 (2%)
Total Number of Respondents	346

Number of Respondents Not Answering Q9 = 7

Current Use of Cistern: Most (58%) of the respondents no longer live at the property with the index cistern. However, among the respondents still living on the property with the cistern, eighty (23%) respondents still use their cistern for some purpose. Table WS-5 depicts respondent's current use of the index cistern.

[See Q10 on the Cistern Use & Maintenance Questionnaire]

Table WS-5: Current Cistern Use by Survey Respondents

Currently Use Cistern	Number of Responses (%)
No longer live at address	205 (58%)
No	65 (19%)
Yes	80 (23%)
Don't Know	1 (<1%)
Total Number of Respondents	351

Number of Respondents Not Answering Q10 = 2

Cistern Usage (CU)

Current Cistern Uses: Respondents reported currently using cistern water for many purposes. Sixty-one (76%) respondents currently use their cistern water for cooking and fifty-three (66%) for drinking. Table CU-1 presents the current uses of cistern water reported by survey respondents.

[See Q11 on Cistern Use & Maintenance Questionnaire]

Table CU-1: Current Indoor & Outdoor Uses of Cistern Water

Current Uses of Cistern Water	Number of Responses (%)
Cooking	61 (76%)
Drinking Water	53 (66%)
Laundry	69 (86%)
Gardens - Vegetable/Fruit	49 (61%)
Gardens - Flower/Shrub	69 (86%)
Showers & Baths	72 (90%)
Other*	13 (16%)
Not Applicable	1 (1%)
Total Number of Respondents**	80

NOTE: Some respondents indicated more than one current use of their cistern water.

Other*: 4/13 reported indoor uses and 9/13 reported outdoor uses.

Total Number of Respondents**: 80 survey respondents answered this question, corresponding to the 80 people who answered YES to Q10: Are you currently using the cistern as a source of water for any purpose?

Number of Respondents Not Answering Q11 = 0

Previous Cistern Uses: Respondents no longer using cistern water reported previously using cistern water for many purposes. Respondents most commonly reported previously using their cistern water for showers/baths (n=253), cooking (n=250), laundry (n=248) and drinking (n=244). Table CU-2 presents the previous uses of cistern water reported by survey respondents.

[See Q12 on Cistern Use & Maintenance Questionnaire]

Table CU-2: Previous Indoor & Outdoor Uses of Cistern Water

Previous Uses of Cistern Water	Number of Responses (%)
Cooking	250 (95%)
Drinking Water	244 (92%)
Laundry	248 (94%)
Gardens - Vegetable/Fruit	192 (74%)
Gardens - Flower/Shrub	196 (74%)
Showers & Baths	253 (96%)
Other*	38 (14%)
Not Applicable	7 (3%)
Total Number of Respondents**	264

NOTE: Some respondents indicated previously using their cistern for more than one use.

Other*: 3/38 reported indoor uses and 12/38 reported outdoor uses.

Total # Respondents**: 264 survey respondents answered this question, roughly equivalent to the 270 people who answered NO LONGER LIVE AT ADDRESS or NO to Q10: Are you currently using the cistern as a source of water for any purpose?

Number of Respondents Not Answering Q12 = 6

Months of Cistern Use: Most respondents reported using cistern water throughout the months of the year for drinking water. Ninety-nine percent (n=323) of the respondents answering Q13 reported using their cistern for drinking water more than six months in a year. Watering edible gardens was more seasonal, with maximum usage during the spring and summer months. Only thirty-two percent (n=81) of the respondents answering Q13 reported using their cistern to water their gardens for more than six months in year. Table CU-3 presents select types of cistern use by calendar months.

[See Q13 on Cistern Use & Maintenance Questionnaire]

Table CU-3: Use of Cistern for Drinking and Watering Edible Gardens by Calendar Month

Months of Use	Type of Cistern Water Usage	
	Drinking Water	Garden - Vegetable/Fruit
January	322	63
February	322	63
March	322	75
April	323	127
May	322	207
June	321	245
July	321	250
August	323	242
September	323	174
October	324	85
November	322	62
December	322	61
Total Number of Respondents	325	251

Number of Respondents Not Answering Q13 = 28

Number of Respondents Not Answering Q13 = 102

Percent Drinking Water from Cistern: Two hundred and eighty-five (83%) respondents reported that, on average, 75-100% of their drinking water came from the cistern. Table CU-4 presents the average percent usage of cistern water for drinking.

[See Q14 on Cistern Use & Maintenance Questionnaire]

Table CU-4: Average Percent Drinking Water from Cistern

Average Percent of Drinking Water from Cistern	Number of Responses (%)
None	19 (6%)
Less than 10%	5 (1%)
10 - 25%	2 (1%)
25 - 50%	10 (3%)
50 - 75%	16 (5%)
75 - 100%	285 (83%)
Don't Know	7 (2%)
Total Number of Respondents	344

Number of Respondents Not Answering Q14 = 9

Cistern Water Sources (CWS)

Sources Used to Refill Cisterns: Rainwater was the most common source of water used to refill the cistern; 319 respondents (91%) indicated they used rainwater off the roof to refill their cistern. Survey respondents indicated that off-site sources of water also were frequently used to refill cisterns. Table CWS-1lists the sources of water used to refill cisterns.

[See Q15 on Cistern Use & Maintenance Questionnaire]

Table CWS-1: Sources of Water Used to Refill Cisterns

Source of Water to Refill Cistern	Number of Responses
Rainwater Off the Roof	319
On-Site Well Water	22
Off-Site Well Water	159
Great Miami River	7
Paddy's Run Creek	2
Dealer (Water Hauler)	132
Other Local Sources	26
Don't Know	20
Total Number of Respondents	352

NOTE: Some respondents indicated more than one source of water to refill cistern.

Number of Respondents Not Answering Q15 = 1

Duration of Use of Refill Source: Survey respondents reported using the different sources of water to refill their cisterns, on average, a comparable duration of time, ranging between fifteen and eighteen years. Table CWS-2 presents the average number and range of years each source was used to refill respondent's cisterns.

[See Q15 on Cistern Use & Maintenance Questionnaire]

Table CWS-2: Average Duration of Use of Select Water Sources to Refill Cisterns

Source of Water to Refill Cistern	Number of Respondents	Average Number of Years	Range in Years
Rainwater Off the Roof	186	18	1 - 49
On-Site Well Water	14	15	1 - 55
Off-Site Well Water	101	16	1 - 55
Great Miami River	3	23	14 - 41
Paddy's Run Creek	1	14	14 - 14
Dealer (Water Hauler)	56	18	1 - 45
Other Local Sources	16	17	1 - 44
Total Number of Respondents	211	-	-

NOTE: Some respondents indicated more than one source of water to refill cistern.

Number of Respondents Not Answering YEARS REFILLED in Q15 = 141 (Based on responses to sources of refills in Q15.)

Decade of First Use of Refill Source: Reported use of rainwater, off-site wells and water haulers to refill cisterns peaked in the 1960s and continued to decline in the following decades. Table CWS-3 presents the decades of first use of select sources of water used to refill cisterns.

[See Q15 on Cistern Use & Maintenance Questionnaire]

Table CWS-3: Source of Water to refill Cistern by Decade of First Use

Source of Water to Refill Cistern	Cistern Refill Start Date					
	Before 1950	1950-1959	1960-1969	1970-1979	1980-1989	After 1990
Rainwater Off the Roof	17	62	73	40	16	7
On-Site Well Water	3	5	4	1	3	-
Off-Site Well Water	5	30	34	24	13	4
Great Miami River	-	3	1	1	-	-
Paddy's Run Creek	-	1	-	-	-	-
Dealer (Water Hauler)	4	19	20	10	5	8
Other Local Sources	-	5	4	4	2	2

NOTE: Some respondents indicated more than one source of water to refill cistern.

Historical Use of Rainwater to Refill Cisterns: Eighty-two percent (152/186) of the respondents reported their cistern was refilled with rainwater during the years of operation of the Fernald facility, 1952-1989. Twenty-one respondents reported refilling their cisterns prior to the opening of the plant in 1952. Table CWS-4 present the begin and end dates of cistern refills using rainwater.

[See Q15 on Cistern Use & Maintenance Questionnaire]

Table CWS-4: Historical Use of Rainwater to Refill Cisterns by Decades

Begin Date of Refills	Last Date of Refills from Rainwater						Total
	1950s	1960s	1970s	1980s	1990s	2000s	
1950s (and earlier)	9	24	24	3	1	4	65
1960s		5	18	22	4	15	64
1970s			9	10	9	12	40
1980s				4	6	3	13
1990s					1	3	4
Total	9	29	51	39	21	37	186

Water Haulers: Nineteen respondents reported using more than one dealer to haul in water. Table CWS-5 presents the names of the water haulers identified by the survey respondents.

[See Q15 on Cistern Use & Maintenance Questionnaire]

Table CWS-5: Water Haulers Used to Refill Cisterns

Water Hauler	Number of Responses
City	4
Daniles	2
Fagaly	2
Hall	2
Henry	13
Ingle	6
Jerry	3
Ron	4
Ross - OH	4
Schunk	13
Sloneker	13
Suder	4
Ted & Ron	7
Topper	18
Ulrich	3
Miscellaneous*	11
Don't Know	23

NOTE: Some respondents indicated more than one water hauler

Miscellaneous: Assorted water haulers identified by one respondent each

Sources of Off-Site Wells: Respondents identified numerous off-site wells used to refill cisterns. Millville (n=2), Okeana (n=5), Ross (n=66) and Springdale Road (Colerain) (n=15) accounted for 65% (88/135) of the off-site well locations identified. All these well sites were within the five-mile exposure domain. Ross is located in the two-mile radius of the site in Butler County. Table CWS-6 lists the locations of off-site wells used to refill cisterns.

NOTE: Per the F-CHEC members of the Research Team, these data are questionable as Cleves, Fairfield, Harrison and Miamitown (37/135) generally represent municipal sources of water, not wells. For instance, individuals and water haulers often accessed hydrants in Cleves and Miamitown for water.

[See Q16 on Cistern Use & Maintenance Questionnaire]

Table CWS-6: Locations of Off-Site Wells Used to Refill Cisterns

Location of Off-Site Wells Used to Refill Cisterns	Number of Responses
Cleves	3
Fairfield	2
Harrison	12
Miamitown	20
Millville	2
Okeana	5
Ross	65
Springdale Rd. (Colerain)	15
Other	10
Don't Know	143
Not Applicable	52
Total Number of Respondents	305

NOTE: Some respondents indicated more than one off-site well used to refill cistern.

Number of Respondents Not Answering Q16 = 48

Gallons of Water per Refill: Survey respondents estimated the number of gallons to refill their cisterns from each source. Among the respondents using well water to refill their cisterns, thirty percent (25/82) reported using more than two thousand gallons of water from this source to refill their cistern. Among the respondents using other local sources to refill their cisterns, fifty-two percent (26/50) reported using more than two thousand gallons of water from this source to refill their cistern. Table CWS-7 presents the estimated number of gallons per cistern refill by the source of the refill water.

[See Q17 on Cistern Use & Maintenance Questionnaire]

Table CWS-7: Gallons of Water per Refill by Source of Refill Water

Source of Water to Refill Cistern	Gallons Per Refill				Total Number of Respondents
	Less than 1000 Gallons	1000-1999 Gallons	2000-2999 Gallons	More than 3000 Gallons	
Well Water	10	47	18	7	82
Great Miami River	-	1	1	1	3
Paddy's Run Creek	-	1	1	-	2
Other Local Sources	6	18	24	2	50
Don't Know	-	-	-	-	121
Not Applicable	-	-	-	-	31

NOTE: Some respondents indicated more than one off-site well used to refill cistern.

Number of Respondents Not Answering Any Part of Q17 = 25

Number of Cistern Refills per Year: Survey respondents reported the frequency of refills each year by source of water. Twenty-nine percent of the cisterns refilled with well water (32/110) were refilled more than twelve times per year. Twenty-four percent of the cisterns refilled from other local sources (17/71) were refilled more than twelve times per year. Table CWS-8 shows the estimated number of refills per year by the source of the refill water.

[See Q17 on Cistern Use & Maintenance Questionnaire]

Table CWS-8: Number of Cistern Refills per Year by Source of Refill Water

Source of Water to Refill Cistern	Number of Refills Per Year (Refills/Yr)		
	Less than 6 Refills/Yr	6-12 Refills/Yr	More than 12 Refills/Yr
Well Water	41	37	32
Great Miami River	-	-	5
Paddy's Run Creek	1	1	-
Other Local Sources	30	24	17

NOTE: Some respondents indicated more than one source of water used to refill cistern.

Number of Respondents Not Answering Any Part of Q17 = 25

Cistern Refills Exceeding Twelve per Year: Among respondents reporting more than twelve refills per year, twenty-four (53%) reported refilling their cisterns twice a month; eleven (24%) reported refilling their cisterns four times per month. Table CWS-9 shows the average number of cistern refills per month for these respondents.

[See Q18 on Cistern Use & Maintenance Questionnaire]

Table CWS-9: Survey Respondents Reporting More than Twelve Cistern Refills per Year

Average Number of Refills Per Month Among Respondents Reporting More than 12 Cistern Refills per Year	Number of Responses
2	24
3	6
4	11
5	2
12	1
20	1
Total Number of Respondents	45

Number of Respondents Not Answering Q18 = 16 (Based on responses to Q17.)

Cistern Maintenance (CM)

Cistern Filter: Less than one-half (148/350) of the respondents reported a filter on their cistern; sixteen percent did not recall whether or not a filter was present on their cistern. Table CM-1 presents the responses to this survey question.

[See Q19 on Cistern Use & Maintenance Questionnaire]

Table CM-1: Reported Presence of Filter on Cistern

Filter on Cistern?	Number of Responses
No	147 (42%)
Yes	148 (42%)
Don't Know	55 (16%)
Total Number of Respondents	350

Number of Respondents Not Answering Q19 = 3

Type of Cistern Filter: Survey respondents identified several filter types. Table CM-2 lists the filter types reported by the survey respondents.

[See Q20 on Cistern Use & Maintenance Questionnaire]

Table CM-2: Types of Cistern Filters

Type of Filter on Cistern	Number of Responses
Cartridge	29
Charcoal / Sand	19
Cinder Block	27
Other	25
Don't Know	93
Not Applicable	49
Total Number of Respondents	241

Number of Respondents Not Answering Q20 = 112

Cistern Shut-Off Valve: Less than one-third (106/349) of the respondents reported the existence of a shut-off valve on their cistern. Shut-off valves were used to divert rainwater off the roof from the cistern for a period of time, allowing time for the rainwater to clean the roof of debris before filling the cistern. The shut-off valve was manually operated. Table CM-3 presents the number of survey respondents reporting the existence of a shut-off valve on their cistern.

[See Q21 on Cistern Use & Maintenance Questionnaire]

CM-3: Reported Presence of a Shut-Off Valve on the Cistern

Shut-Off Valve on Cistern?	Number of Responses
No	186 (53%)
Yes	106 (30%)
Don't Know	49 (14%)
Not Applicable	8 (2%)
Total Number of Respondents	349

Number of Respondents Not Answering Q21 = 4

Year of Last Use of Shut-Off Valve: Among the respondents reporting the existence of a shut-off valve on the index cistern, forty-seven percent were last used in 1989 or before and fifty-three percent were last used in 1990 or later.

[See Q22 on Cistern Use & Maintenance Questionnaire]

Table CM-4: Reported Last Date (Decade) Shut-Off Valve Used

Last Date Shut-Off Valve Used	Number of Responses
1950 - 1959	3
1960 - 1969	6
1970 - 1979	11
1980 - 1989	5
After 1990	28
Total Number of Respondents*	53

Total Number of Respondents*: 53 survey respondents answered this question which is one half of the 106 people who answered YES to Q21: Did you use a switch (valve) on the down spouts that could be turned off...?

Number of Respondents Not Answering Q22 = 53 (Based on responses to Q21.)

Frequency of Usage of Shut-Off Valve: Among the respondents reporting a shut-off valve on the cistern, seventy-six percent (78/103) reported using it with some frequency (more frequent than ALMOST NEVER). Table CM-5

[See Q23 on Cistern Use & Maintenance Questionnaire]

Table CM-5: Estimated Usage of Cistern Shut-Off Valve

Estimated Usage of Shut-Off Valve	Number of Responses
Almost Always	34
Sometimes	44
Almost Never	16
Don't Know	9
Total Number of Respondents*	103

Total Number of Respondents*: 103 survey respondents answered this question which is 97% of the 106 people who answered YES to Q21: Did you use a switch (valve) on the down spouts that could be turned off...?

Number of Respondents Not Answering Q23 = 3 (Based on responses to Q21.)

Duration of Use of Valve: Among respondents reporting using the shut-off valve, the duration varied considerably. Table CM-6 presents the duration of time survey respondents estimated the shut-off valve was operated when used.

[See Q24 on Cistern Use & Maintenance Questionnaire]

Table CM-6: Estimated Number of Minutes Shut-Off Valve Operated per Use

Number of Minutes Shut-Off Valve Used	Number of Responses
Less than 5 minutes	1
5 - 9 minutes	5
10 - 15 minutes	21
More than 15 minutes	17
Total Number of Respondents*	44

Total Number of Respondents*: 44 survey respondents answered this question which is 42% of the 106 people who answered YES to Q21: Did you use a switch (valve) on the down spouts that could be turned off...?

Number of Respondents Not Answering Q24 = 62 (Based on responses to Q21.)

Condition of Cistern: Most respondents (224/348) reported treating or cleaning their cistern. Approximately one-third (122/348) indicated the cistern had been sealed or covered; many didn't know or skipped the question. Respondents seemed confused by the question about dumping materials in the cistern; sixty-five percent (100/348) answered DON'T KNOW or skipped this part of the question. Table CM-7 presents the survey respondents' practice of select cistern maintenance and storage practices.

[See Q25 on Cistern Use & Maintenance Questionnaire]

Table CM-7: Condition of Cistern

Condition of Cistern	Number of Responses		
	No	Yes	Don't Know
Materials Dumped	112	11	100
Treated or Cleaned	30	224	76
Access Sealed/Covered	73	122	75

Number of Respondents Not Answering Any Part of Q25 = 5

Frequency of Treating Cistern: Among survey respondents who reported treating their cistern, nineteen percent (40/212) indicated it was treated quarterly or more frequently; forty-three percent (91/212) indicated it was treated at least yearly. Table CM-8 presents the reported frequency of cistern treatments.

[See Q26 on Cistern Use & Maintenance Questionnaire]

Table CM-8: Frequency of Treating Cistern

Respondents Reporting Treating their Cistern	
Frequency of Cistern Treatment	**Number of Responses**
Monthly	18
Every Two Months	10
Quarterly	12
Twice per Year	25
Yearly	26
Never	57
Don't Know	48
Not Applicable	16
Total Number of Respondents*	212

Total Number of Respondents*: 212 survey respondents answered this question which is 95% of the 224 people who answered YES to TREATING or CLEANING their cistern in Q25: Have any of the following been done to this cistern?

Number of Respondents Not Answering Q26 = 12 (Based on responses to Q25.)

Frequency of Cistern Cleaning: Among respondents who reported cleaning their cistern, thirty-one percent (67/218) indicated it was cleaned at least every other year; thirty-two percent (69/218) indicated it was cleaned ever 2-5 years. Table CM-9 shows the frequency of cistern cleaning.

[See Q27 on Cistern Use & Maintenance Questionnaire]

Table CM-9: Frequency of Cistern Cleaning

Respondents Reporting Cleaning their Cistern	
Frequency of Cistern Cleaning	**Number of Responses**
Yearly	44
Alternating Years	23
2-5 Years	69
6-10 Years	27
10+ Years	19
Never	7
Don't Know	28
Not Applicable	1
Total Number of Respondents*	218

Total Number of Respondents*: 218 survey respondents answered this question which is 97% of the 224 people who answered YES to TREATING or CLEANING their cistern in Q25: Have any of the following been done to this cistern?

Number of Respondents Not Answering Q27 = 6 (Based on responses to Q25.)

Products Used to Treat/Clean Cisterns: Bleach was the most commonly reported product used to treat and clean the cisterns. Table CM-10 presents the products identified by survey respondents to treat and/or clean their cistern.

[See Q29 and Q30 on Cistern Use & Maintenance Questionnaire]

Table CM-10: Products Used to Treat and/or Clean Cisterns

Products Used to Treat / Clean Cisterns	Number of Responses	
	Treatment	Cleaning
Bleach	88	69
Vinegar	2	-
Non-Chemical	-	10
Other	1	2
Don't Know	1	1
Not Applicable	5	9
Total Number of Respondents	213	214

Number of Respondents Not Answering Q29 RE treatment = 11 (Based on responses to Q25)

Number of Respondents Not Answering Q30 RE: cleaning = 10 (Based on responses to Q25)

Cistern Status (CS)

Presence of Cistern: Fifty-eight percent of the respondents (202/349) indicated that the cistern was still present at the house at the time of the cistern survey; twenty-eight percent (99/349) reported they didn't know if the cistern was still on the property. Table CS-1 presents survey respondent's answers to this question.

[See Q31 on Cistern Use & Maintenance Questionnaire]

Table CS-1: Survey Respondents Reporting Index Cistern Is Still Present on Property

Cistern Still Present at the House?	Number of Responses
No	48
Yes	202
Don't Know	99
Not Applicable	8
Total Number of Respondents	349

Number of Respondents Not Answering Q31 = 4

Shape of Cistern: Eighty-one percent of the survey respondents indicated that their cistern was square or rectangular in shape. Only six percent of the respondents reporting not recalling the cistern shape. Table CS-2 presents the number of survey respondents reporting different cistern shapes.

[See Q32 on Cistern Use & Maintenance Questionnaire]

Table CS-2: Shapes of Cisterns

Shape of Cistern	Number of Responses (%)
Round / Oval	44 (13%)
Square / Rectangular	282 (81%)
Don't Know	22 (6%)
Total Number of Respondents	348

Number of Respondents Not Answering Q32 = 5

Cistern Dimensions: Survey respondents estimated the dimensions and overflow capacity of their cisterns. As many as one hundred sixty-three survey respondents (47%) didn't recall the dimensions of their cistern. Table CS-3 presents the estimated length and width (in feet) of the index cisterns and the overflow depth.

[See Q33 on Cistern Use & Maintenance Questionnaire]

Table CS-3: Cistern Dimensions

Cistern Dimensions (in feet)	Number of Responses	Descriptive Statistics		
		Average	Standard Deviation	Range
Length	196	17	7	3 - 45
Width	200	11	7	4 - 100
Overflow Depth	118	8	6	1 - 70
Depth	154	8	3	3 - 30
Don't Know	163	-	-	-
Total Number of Respondents	345	-	-	-

Number of Respondents Not Answering Q33 = 8

Cistern Capacity: One hundred and twenty-seven (37%) survey respondents estimated the capacity of their cisterns; the average was 8,000 gallons (median=6,000 gallons). However, sixty-three percent answered DON'T KNOW to the question. Table CS-4 presents the estimated average capacity of the cisterns and the range in gallons.

[See Q34 on Cistern Use & Maintenance Questionnaire]

Table CS-4: Approximate Capacity (in Gallons) of Index Cisterns

Capacity of Cisterns	Number of Responses	Approximate Cistern Size (in gallons)	
		Average	Range
Size of Cistern in Gallons	127	8000	6-34,000
Don't Know	217	-	-
Total Number of Respondents	344	-	-

Number of Respondents Not Answering Q34 = 9

Cistern Testing: Very few respondents (5%) indicated that their cistern had been tested for chemical or radiological contaminants. However, thirty-three percent did not know whether their cistern had been tested. Table CS-5 presents respondent's recollections about whether their cistern had been tested.

[See Q35 on Cistern Use & Maintenance Questionnaire]

Table CS-5: Survey Respondents Reporting Index Cistern Tested for Chemical/Radiological Contaminants

Cistern Tested for Chemical/Radiological Contaminants	Number of Responses (%)
No	217 (63%)
Yes	16 (5%)
Don't Know	113 (33%)
Total Number of Respondents	346

Number of Respondents Not Answering Q35 = 7

Among the respondents who reported that their cistern had been tested, two were tested in the 1960s, two in the 1980s and one in the 1990s; eleven respondents did not indicate the date of the test. Three respondents indicated that a county laboratory had conducted the test; one respondent recorded a private laboratory.

The F-CHEC members of the Research Team caution readers about the results for this question. There has been considerable confusion among residents about cistern testing. The local health departments tested water for potability, looking for biological contamination; these laboratories were not equipped to test for chemical or biological contamination.

Appendix A

Copy of the F-CHEC Cistern Use & Maintenance Questionnaire

Cistern Use & Maintenance Questionnaire

Fernald Community Health Effects Committee (F-CHEC) Revised 7-23-03

The purpose of this questionnaire is to determine how Fernald area residents use and maintain their home cisterns both today and in the past This survey is for area residents who did not complete the cistern survey administered by the Fernald Medical Monitoring Program. Please complete a questionnaire for each Fernald area residence where you lived between 1952 and 2002. If you need additional copies of the questionnaire, please call 513-558-0854.

1. Address of residence: _____
   Street Number Street Name

   _____
   City Zip Code

NOTE: Address information is needed to ensure that all households with cisterns have been surveyed.

2. How long did you live at this address: ___ ___ years

3. What years did you live at this address? _____ _____
   Move In Date Move Out Date

4. Was a cistern present on the property when you moved to this address?
   ☐ No ☐ Yes ☐ Don't Know

5. If the cistern was not present when you moved to this address, when was the cistern installed?
   1 9 ___ ___ ☐ Never ☐ Don't Know

6. What was the primary source of your drinking water?
   ☐ Municipal Water Company ☐ Well Water
   ☐ Cistern Water ☐ Bottled Water
   ☐ Other, *please specify*: _____ ☐ Don't Know

Please Note: Completion of this self-administered questionnaire constitutes informed consent.

7. Did you use a second source for your drinking water?

☐ No ☐ Yes ☐ Don't Know

8. If you did use a second source for drinking water, what was it?

☐ Municipal Water Company ☐ Well Water

☐ Cistern Water ☐ Bottled Water

☐ Other, *please specify*: _____ ☐ Don't Know

☐ Not Applicable

9. In what year did you first use this cistern as a drinking water source?

__ __ __ __ (year) ☐ Never ☐ Don't Know

10. Are you currently using the cistern as a source of water for any purpose?

☐ No longer live at this address ☐ No ☐ Yes ☐ Don't Know

11. If yes, for what purposes are you using the cistern water? (*Please ✓ all that apply*.)

☐ Cooking ☐ Drinking Water ☐ Laundry

☐ Gardens - vegetable/fruit ☐ Gardens - flower/shrub ☐ Not Applicable

☐ Showers & baths ☐ Other, *please specify*: _____

12. If you no longer use the cistern, for what purposes did you use the cistern water? Please indicate the approximate period you used the cistern for these purposes.

	Begin Use Date	End Use Date
☐ Cooking	__ __ __ __	__ __ __ __
☐ Drinking Water	__ __ __ __	__ __ __ __
☐ Laundry	__ __ __ __	__ __ __ __
☐ Gardens - vegetable/fruit	__ __ __ __	__ __ __ __
☐ Gardens - flower/shrub	__ __ __ __	__ __ __ __
☐ Showers & baths	__ __ __ __	__ __ __ __
☐ Other	__ __ __ __	__ __ __ __

Please specify: _____

☐ Not Applicable

13. Over the time that you used the cistern, during what months of the year was the cistern used for the following purposes? (Please circle all the months that apply.)

Drinking Water Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Garden(s) vegetable/fruit Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

14. On average, what percent of your drinking water at this residence came from a cistern?

☐ None ☐ Less than 10% ☐ 10 - 25% ☐ 25 - 50%

☐ 50 - 75% ☐ 75 - 100% ☐ Don't Know

15. What was the source of water used to refill the cistern? (*Please ✓all that apply.)* Please specify the years when the cistern was refilled from each source.

	Years Refilled
☐ Rainwater off the roof	__ __ __ __ - __ __ __ __
☐ Well water - private well on property	__ __ __ __ - __ __ __ __
☐ Well water - water truck from off-site well	__ __ __ __ - __ __ __ __
☐ Great Miami River	__ __ __ __ - __ __ __ __
Please specify where along the river: _____	
☐ Paddy's Run Creek	__ __ __ __ - __ __ __ __
☐ Dealer	__ __ __ __ - __ __ __ __
Please specify the dealer: _____	
☐ Other local sources	__ __ __ __ - __ __ __ __
Please specify: _____	
☐ Don't Know	

16. If well water was trucked in from an off-site well to fill the cistern, what was the location(s) of the off-site well(s)?

_____ _____ _____

☐ Don't Know ☐ Not Applicable

17. Please indicate the approximate quantity and circle the frequency of the re-fillings.

	Quantity of Each Re-Fill	Frequency of Refills Per Year
Well Water	___ gallons	1 2 3 4 5 6 7 8 9 10 11 12 More Than 12
Great Miami River	___ gallons	1 2 3 4 5 6 7 8 9 10 11 12 More Than 12
Paddy's Run Creek	___ gallons	1 2 3 4 5 6 7 8 9 10 11 12 More Than 12
Other local sources	___ gallons	1 2 3 4 5 6 7 8 9 10 11 12 More Than 12

☐ Don't Know ☐ Not Applicable

Please Note: Completion of this self-administered questionnaire constitutes informed consent.

18. If more than 12 refills per year, what was the average number of refills per month? Please circle the average number of refills per month.

2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19 20

☐ Don't Know ☐ Not Applicable

19. Is there or was there a filter on the cistern?

☐ No ☐ Yes ☐ Don't Know

20. What type of filter was on the cistern?

_____ ☐ Don't Know ☐ Not Applicable

21. Some cisterns are equipped with a shut-off valve which can be used to divert rainfall away from or into the cistern. This shut-off valve was sometimes used to allow the initial rain to wash off the roof before beginning to collect the rainwater in the cistern. Did you use a switch (valve) on the down spouts that could be turned on so the initial rainfall on the roof did not enter the cistern?

☐ No ☐ Yes ☐ Don't Know ☐ Not Applicable

22. If you had a switch, about when was the switch (valve) last used?

___ ___ ___ ___ (year) ☐ Don't Know ☐ Not Applicable

23. If you had a switch, how often was it used?

☐ Almost always used it ☐ Sometimes used it

☐ Almost never used it ☐ Don't Know ☐ Not Applicable

24. If you used a switch, for about how many minutes would you use it each time?

___ ___ minutes ☐ Don't Know ☐ Not Applicable

25. Have any of the following been done to this cistern? *(Please ✓ all that apply.)*

Materials dumped	☐ No	☐ Yes	☐ Don't Know
Treated or cleaned	☐ No	☐ Yes	☐ Don't Know
Access sealed or covered	☐ No	☐ Yes	☐ Don't Know

26. How frequently was the cistern water treated?

☐ Monthly ☐ Every two months ☐ Quarterly ☐ Twice per year

☐ Yearly ☐ Never ☐ Don't Know ☐ Not Applicable

27. How frequently was the cistern cleaned?

☐ Yearly ☐ Alternating years ☐ 2-5 years ☐ 6-10 years

☐ 10+ years ☐ Never ☐ Don't Know ☐ Not Applicable

28. When was the last time the cistern water was treated and/or the cistern cleaned?

Last treatment __ __ __ __ ☐ Don't Know ☐ Not Applicable

Last cleaning __ __ __ __ ☐ Don't Know ☐ Not Applicable

29. What chemicals/products were used to treat the cistern water?

_____ _____ _____

☐ Don't Know ☐ Not Applicable

30. What chemicals/products were used to clean the cistern?

_____ _____ _____

☐ Don't Know ☐ Not Applicable

31. Is the cistern still present at the house?

☐ No ☐ Yes ☐ Don't Know

32. What is/was the shape of the cistern?

☐ Round or oval ☐ Square or rectangular ☐ Don't Know

33. What is/was the approximate size of the cistern in feet?

Length: __ __ feet Width: __ __ feet

Overflow depth __ __ feet Depth __ __ feet ☐ Don't Know

34. What is/was the approximate size of the cistern in gallons?

Gallons: ___ ___ ☐ Don't Know

35. Has the cistern water ever been tested for chemical and/or radiologic contaminants?

☐ No ☐ Yes ☐ Don't Know

35. If the cistern has been tested, who conducted the test and when?

Testing Company: _____ Date: __ __ __ __

☐ Don't Know ☐ Not Applicable

Thank you for taking the time to answer this questionnaire. The results of the survey will be communicated to area residents. If we have questions about your responses, may we contact you? ☐ No ☐ Yes If yes, please tell us your name and phone number.

Your Name: _____ Phone No: _____

REMEMBER: Your responses to this survey are confidential information.

Please return this questionnaire in the stamped envelope by DATE.
If you know of someone who has lived in the Fernald area and used a cistern, please ask them to participate by calling 513-558-0854.

Additional copies of the questionnaire are available by calling 513-558-0854.

Thank you for your time and effort in completing this questionnaire!

Fernald Community Health Effects Committee (F-CHEC)
Sue Verkamp, President

Environmental Health Foundation
University of Cincinnati
M. Kathryn Brown, Ph.D.
Susan Pinney, Ph.D.

Appendix B

Number of Respondents by County, Mile from FMPC & Segment Code

County, Mile from FMPC and Segment Code of Survey Respondents

Mile	Butler County		Hamilton County	
	Segment	# Respondents	Segment	# Respondents
1	-	-	04	2
2	-	-	08	3
			10	6
			11	1
3	10	3	14	1
	11	5	15	17
	12	3	16	8
	13	1	17	17
	14	2	18	15
	18	3	19	9
			20	5
			21	12
			22	1
			23	2
			24	1
4	19	1	25	4
	21	1	26	19
	22	2	27	7
	23	6	28	7
	24	8	29	11
	25	3	30	9
	26	2	31	10
			32	16
			33	1
			34	4
			36	1
			37	3
			38	6

County, Mile from FMPC and Segment Code of Survey Respondents

Mile	Butler County		Hamilton County	
	Segment	# Respondents	Segment	# Respondents
5	31	2	39	6
	32	2	40	1
	33	3	41	7
	34	3	42	10
	36	10	43	6
	37	6	44	2
	38	1	45	12
	42	1	46	5
			47	11
			48	9
			49	6
			50	10
			51	3
			55	1
TOTAL		**66**		**287**

Appendix C

Map of Fernald Five-Mile Exposure Domain

U.S.G.S. COMPOSITE BASE MAP
PLAN OF FMPC PERIPHERAL LAND AND SEGMENT MAP DESIGNATION PLAN FOR FERNALD SETTLEMENT FUND

POLITICAL SUBDIVISION OVERLAY

SANTORO ENGINEERING COMPANY
1501 CINCINNATI - BATAVIA ROAD
BATAVIA, OHIO 45103
(513) 732-2561
FAX 732-2936

SCALE: 1" = 2000'
DATE: 4-27-90
REVISIONS: 8-28-90

B-01 B-02 B-03 B-04 B-05 B-06 B-07 B-08 B-09 B-10 B-11 B-12 B-13 B-14 B-15 B-16 B-17 B-18 B-19 B-20 B-21 B-22 B-23 B-24 B-25 B-26 B-27 B-28 B-29 B-30 B-31 B-32 B-33 B-34 B-35 B-36 B-37 B-38 B-39 B-40 B-41 B-42 B-43 B-44 B-45

H-01 H-02 H-03 H-04 H-05 H-06 H-07 H-08 H-09 H-10 H-11 H-12 H-13 H-14 H-15 H-16 H-17 H-18 H-19 H-20 H-21 H-22 H-23 H-24 H-25 H-26 H-27 H-28 H-29 H-30 H-31 H-32 H-33 H-34 H-35 H-36 H-37 H-38 H-39 H-40 H-41 H-42 H-43 H-44 H-45 H-46 H-47 H-48 H-49 H-50 H-51 H-52 H-53 H-54 H-55

MORGAN TOWNSHIP
ROSS TOWNSHIP
FAIRFIELD TWP.
CITY OF FAIRFIELD
BUTLER COUNTY
HAMILTON COUNTY
HARRISON TOWNSHIP
CROSBY TOWNSHIP
COLERAIN TOWNSHIP
VILLAGE OF HARRISON
WHITEWATER TOWNSHIP
U S RESERVATION DEPARTMENT OF ENERGY FMPC SITE
ONE MILE
TWO MILES
THREE MILES
FOUR MILES
FIVE MILES