

UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

Civil Action  
No. 82-1672-S

SKINNER, D. J.  
and a Jury

ANNE ANDERSON, ET AL

V.

W. R. GRACE & CO., ET AL

Sixty-Seventh Day of Trial

APPEARANCES:

Schlichtmann, Conway & Crowley (by Jan Richard Schlichtmann, Esq., Kevin P. Conway, Esq., and William J. Crowley, III, Esq.) on behalf of the Plaintiffs.

Charles R. Nesson, Esquire, on behalf of the Plaintiffs.

Herlihy & O'Brien (by Thomas M. Kiley, Esq.) on behalf of the Plaintiffs.

Hale & Dorr (by Jerome P. Facher, Esq., Neil Jacobs, Esq., Donald R. Frederico, Esq., and Deborah P. Fawcett, Esq.) on behalf of Beatrice Foods.

Foley, Hoag & Eliot (by Michael B. Keating, Esq., Sandra Lynch, Esq., William Cheeseman, Esq., and Marc K. Temin, Esq.) on behalf of W. R. Grace & Co.

Courtroom No. 6  
Federal Building  
Boston, MA 02109  
9:00 a.m., Tuesday  
June 24, 1986

Marie L. Cloonan  
Court Reporter  
1690 U.S.P.O. & Courthouse  
Boston, MA 02109

1 THE COURT: Good morning, ladies and gentlemen  
2 Good morning, counsel.

3 We are ready to proceed with further testimony

4 JOHN GUSWA, Resumed

5 DIRECT EXAMINATION CONTINUED, By Mr. Keating

6 Q Yesterday I asked you if you had an opinion whether  
7 chemicals in the groundwater at the Cryovac site could have  
8 reached Wells G and H before they closed in May of 1979.  
9 Do you recall that?

10 A Yes, I do.

11 Q And your opinion was that the chemicals could not have  
12 reached the well field before May of 1979?

13 A That's correct.

14 Q And I reviewed with you yesterday various types of  
15 information which you took into consideration in forming  
16 your opinion.

17 A Yes.

18 Q And this morning I would like to ask you some further  
19 questions about the remainder of the information that you  
20 took into consideration in forming your opinion.

21 Now, you said at the end of the day yesterday  
22 that you had prepared water level maps that were useful to  
23 you in the formation of your opinion?

24 A That's correct.

25 Q Would you come over to the jury area and show the jury

1 the water level maps that you prepared?

2 A Yes.

3 Q Before you describe the water level map, Dr. Guswa,  
4 which is G-850, did you also cause to be made a photograph  
5 of this area and have entered on the photograph the information  
6 contained on the water level map?

7 A The photograph was prepared by someone else. We took  
8 advantage of the photograph and showed the same information  
9 that's on our water table map with the topographic map as  
10 a base, showed the same information on the aerial photograph  
11 for a different point of reference. They both illustrate  
12 the same principles that I'll be talking about. Some people  
13 might relate to a map, others might relate to a photograph  
14 better.

15 MR. KEATING: The photograph, for the record,  
16 is G-950A.

17 Q Okay, will you describe for the jury what information  
18 is reflected on the water level variation map and how that is  
19 also a matter you took into account in the formation of your  
20 opinion?

21 A Yes.

22 The water table map, or water level map, is  
23 prepared on the basis of water level measurements made in  
24 wells throughout a regional area. In this case, the area  
25 for which there were numerous water level measurements was

1 the area between Olympia Avenue and Salem Street and extended  
2 from the Beatrice site to the Cryovac plant. These wells  
3 were installed by EPA through their contracts with E&E and NUS  
4 as part of their investigation of the Aberjona River. The  
5 wells were installed also by Geoenvironmental Consultants as  
6 part of their work on behalf of W.R. Grace, and wells were  
7 installed on the Beatrice property by both Weston Geophysical  
8 and Woodward-Clyde.

9 And the purpose of making -- The reason for  
10 making a water level map that covers an area like this is to  
11 get an understanding of groundwater flow directions and other  
12 general information that we can make as we interpret the  
13 water level contours. The basic principles that are  
14 incorporated into a water level map are that we measure  
15 water levels in the well. These water levels, as I had  
16 mentioned yesterday, but in case it wasn't clear, these are  
17 actually a measure of potential energy of the groundwater  
18 flow system. We will refer to them now just as water levels.  
19 If we have wells in the ground at different locations, we  
20 have different water levels in those wells, and groundwater  
21 moves from a higher water level to a lower water level.  
22 It's actually moving from a higher energy state to a lower  
23 energy state. And the loss of energy is really just the  
24 loss due to the friction of the water as it moves through the  
25 ground. But it is easier to describe if we just refer to it  
as water levels.

1 A Now, there are probably over a hundred wells on this map  
2 indicated on this map. And many of these wells are what is  
3 referred to as cluster wells; that is, for example, S91, which  
4 is located here at -- between G and H, are actually four --  
5 S92 is actually four individual wells located on the edge  
6 of that river: The shallow well, a medium well, an intermediate  
7 depth and deep well. They are open and measure the water  
8 levels in different portions of the aquifer.

9 To prepare a water table map, we are actually  
10 measuring -- we are including water levels from one particular  
11 well for this water table map.

12 Q One particular well among the cluster?

13 A In each cluster.

14 And for these particular maps, that well that  
15 is included in this map is the well which is open in the  
16 unconsolidated deposits, the sand and gravel. In the cases  
17 where, for a cluster, there is one well on in those materials,  
18 for example, G-01, there is a low shallow well in ground rain  
19 deposits and two deep wells in the bedrock. For this we're  
20 using the shallow well, the unconsolidated material.

21 As we get into the center of the valley where  
22 we have multiple levels, we chose the well opposite where  
23 at the same elevation at the center value of it, at approximately  
24 a depth of 80 feet below the land surface.

25 Q The map and the photograph here are reflections of

1 water table elevations without pumping?

2 A That is correct.

3 Q Without the pumping of G and H?

4 A These water levels were measured on the morning of  
5 December 4th by many people, and they represent the non-  
6 pumping conditions in Wells G and H when not pumping at that  
7 time.

8 Q Why do you choose to measure water levels when you have  
9 the available data at the same level as the depth of Wells  
10 G and H, Dr. Guswa?

11 A Well, there are two things I would like to talk about  
12 regarding that. The first is the groundwater flow system is  
13 three-dimensional. The map is two. We restrict ourselves  
14 to choosing one of the wells at the different depths. It is  
15 not critical for the pre-pumping water level which well we  
16 actually chose because the variation of the differences in  
17 water levels at the cluster was very small under non-pumping  
18 conditions.

19 We will see later, however, during pumping  
20 conditions, there is a difference in the elevation of -- a  
21 significant difference in the elevation of water levels in  
22 the ground, depending upon how deep those wells are located  
23 within the ground.

24 Q Differences within a cluster?

25 A Within a cluster.

1                   And that reflects the response of the aquifer  
2 to the pumping of the wells themselves. Just as we have  
3 variations in water levels in wells that are spaced apart  
4 laterally, and interpret groundwater flow direction on the  
5 basis of that, we also see there are vertical differences in  
6 water levels during the pumping conditions, and that gives  
7 us information about groundwater flow direction in the vertical  
8 direction.

9                   Just so there is clearer understanding, these  
10 wells are unconsolidated material wells, represent the water  
11 level, and they represent water levels about the same eleva-  
12 tions as the pumping well.

13 Q       What do the contour lines tell us, Dr. Guswa, the lines  
14 that you see? Just explain to the jury what the contour lines  
15 are, what the arrows reflect on either of the two illustra-  
16 tions.

17 A       Yes. So we measure water level and we plot that eleva-  
18 tion, that water elevation on our map. And in fact, on this  
19 map the water elevations that were measured that correspond  
20 to this are included on that map. Then we draw lines.  
21 It is sort of a useful tool for us to draw lines that connect  
22 or basically connect lines of equal water elevation; we call  
23 these groundwater contour lines. And they represent, as I  
24 said, lines of equal water elevation, are equal energy within  
25 the groundwater flow system.

1                    Now, this map has several contour lines shown  
2 on it, most of which are at five foot increments. For  
3 instance, at the Cryovac plant, which is located up here,  
4 we have a water level measurement in Well G-8 which is an  
5 elevation of 95 feet, and as we move down toward the center  
6 of the valley, we go from 95 to 85, to 75 at the front of the  
7 property, and we move at five foot increments down toward the  
8 center of the valley.

9                    Within the center of the valley, we have  
10 included water levels. The contour lines are not five foot  
11 increments and this should be made clear. They're actually  
12 one foot increments because the gradients or the differences  
13 in water elevations between two adjacent wells are smaller  
14 in the center of the valley than they are on the edge of the  
15 property.

16                    And if we were only to show five foot water  
17 level contours, we would have one contour here at 45 foot  
18 elevation, and we would have no contours shown on this map.  
19 But to show, to understand the groundwater flow direction, we  
20 have included, or I included the one foot contours in the  
21 center of the valley.

22 Q                What do the contour lines tell you, if anything, about  
23 the permeability of the material that is reflected, that they  
24 are shown to be part of?

25 A                There are two general types of information we get from

1 water table maps or water level contour maps. The first is  
2 an indication of the groundwater flow direction on a regional  
3 scale. By that I mean this map gives a two-dimensional  
4 representation of the flow. It does not tell us anything  
5 really about the vertical up and down movement that the water  
6 might be taking as it moves, but it does tell us the general  
7 direction of groundwater flow from the Cryovac plant. The  
8 general direction is from the plant down toward the Aberjona  
9 River Valley. But in addition to that general information,  
10 we can also get a relative indication of the permeability,  
11 an indication of the relative permeability of the material in  
12 the ground.

13 For instance, in areas where you have shallow  
14 gradients or very small water level differences, and I think  
15 actually someone has testified to this fact, that is an  
16 indication of a, indirect indication, the water transmitting  
17 properties of that property are sufficiently high such that  
18 it does not take a lot of energy to move the water through  
19 that portion of the ground.

20 Conversely, where we see, and we make our water  
21 table maps and look at them and see closely spaced water table  
22 contours, that is an indirect indication of relatively low  
23 permeability because it takes a lot of energy. It is acting  
24 as if it were a dam. The low permeability is backing the  
25 water up behind it and acting as a dam and restricting the

1 flow of water through the zones.

2 Q Now, that would cause an elevation difference of five  
3 foot or what you have here within a short -- within a small  
4 area, is that the dam theory that you --

5 A Correct.

6 Q -- referred to?

7 A Yes.

8 In low permeability, it takes higher energy to  
9 push the water through. You can think of a pipe, an open  
10 pipe, we are trying to push water through. You can push it  
11 through easily. If you fill that pipe with sand or with clay  
12 and try to push the same water through at the same rate, you  
13 would have to use more energy to push it through. And that  
14 energy is reflected in the change of elevation of the water  
15 contours.

16 Q Would it also have the consequence of backing up, just  
17 to use your hypothetical of the pipe, would it have the conse-  
18 quence of backing up the water as you were trying to force it  
19 through the pipe? In other words, giving the sharper gradients  
20 you just described?

21 A Yes, it does.

22 But again, to make it clear, this is one of the  
23 analyses we make qualitatively. It is not an absolute. You  
24 can't make a direct measurement of permeability because there  
25 are other factors that affect that. But it is a qualitative

1 interpretation we make and that is one of the reasons we make  
2 the map.

3 Q What can you tell us about the groundwater flow direction  
4 before the wells were pumping that is shown in either one of  
5 your illustrations, Mr. Guswa, this general groundwater flow  
6 direction?

7 A We have a general rule that we follow when we interpret  
8 water level maps; that is groundwater flows at right angles  
9 to the contour lines. And the physical reason for that is the  
10 is the shortest path to reduce, to get rid of the energy,  
11 to give you the maximum reduction of energy, there is a  
12 physical basis for that. We translated that to the simple  
13 state: Groundwater flows at right angle to contour lines.

14 Now, if we talk a different type of problem  
15 where we're interested in the microscopic, we don't apply  
16 that rule. In a regional analysis as this, that is the general  
17 rule we follow. We can see that -- I have a couple of stickers  
18 I would like to put on to show where G and H are.

19

20

21

22

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25

C-1  
1 (Witness placing stickers on the map.)

2 That is not too bright, is it?

3 Q Those stickers represent what, Dr. Guswa, G and H?

4 A I placed the stickers on top of the locations of Well G  
5 and Well H.

6 Q Okay.

7 A This is the pumphouse that used to be at Well H. It  
8 has since been knocked down. That is where I am putting  
9 this sticker.

10 And the pumphouse for Well G, I believe, is  
11 right in there (indicating). Those are the approximate  
12 locations of Wells G and H.

13 Now, if we look at our water level map, either  
14 on a topographic basis or aerial photograph, I have drawn  
15 the arrows on the topographic basis. The groundwater, if  
16 you follow the basic right angle rule, from the eastern side  
17 of the value groundwater flowing in a generally westward  
18 direction but curves down as it approaches the Aberjona  
19 River.

20 From the northwest, a groundwater flow and  
21 arrows which indicates there is groundwater flow from the  
22 north basically parallel to the Aberjona River and moving  
23 down past Wells G and H on the western side of the river. We  
24 follow the right-angle rule and show there is groundwater  
25 flowing to the east and to the south into the Aberjona

C-2  
1 River Valley.

2 At the time this map was prepared, there was  
3 on the Riley plant, there was in operation and they were  
4 using water as part of their process, so there is a little  
5 cone of depression or influence of the pumping well;  
6 therefore, we see this arrow indicates there is groundwater  
7 flowing into that, from the west into the area of influence  
8 of that pumping well.

9 Q Are you able to tell us what this little circle is to  
10 the right of that?

11 A No, I can't. There are two water levels that are both  
12 above a 43-foot elevation, and I've tried several different  
13 ways of drawing a contour that would include that information,  
14 and this is the -- I'll say the least objectionable way of  
15 drawing it. There appears to be a little groundwater mound  
16 that either is, in fact, a groundwater mound or it may, in  
17 fact, reflect a land-serving elevation or measuring elevation.  
18 It is not of any major significance in this interpretation,  
19 but those water levels are above 43-foot elevation and I  
20 contoured them that way.

21 THE COURT: Excuse me, where is the river?

22 THE WITNESS: The river from the center path  
23 of the river is shown on the map here, and on the photograph  
24 is shown through here, but at the time of the test, this  
25 whole area was underwater so it was really a marshy area,

1 and the channel was not defined.

2 THE COURT: Where is it with respect to the  
3 two little circles down below there, the mound?

4 THE WITNESS: The river comes through here  
5 and goes in this direction.

6 Q Do you want to draw it on there?

7 A Yes. (Drawing the river on the topographic map.)

8 Q Maybe you could draw more.

9 A I will draw the whole thing.

10 THE COURT: Is there a split channel there?  
11 Is there a place where the channel splits?

12 THE WITNESS: Yes.

13 THE COURT: Could you indicate that?

14 THE WITNESS: Although not shown clearly on  
15 this topographic map, it is shown clearly on the aerial  
16 photograph (indicating). Here is the -- We should have some  
17 tape. There is a split right here, the channel here, and  
18 there is a channel that goes up that way, and a channel that  
19 goes that way. That is characteristic of the flow of  
20 surface water in that area. There are anastomosing of  
21 river channels, the things are moving back and forth just  
22 like this.

23 Now, there is another possibility, but I will  
24 only raise it because it is a possibility. When I was  
25 looking at this, I realized this is also adjacent to the

1 sewer line that runs through here. If the sewer were leaking,  
2 that might be a source of water that would give the mound.  
3 I have no other information that would suggest that is  
4 actually occurring. But as I am trying to explain this water  
5 table mound, I have to think about all the different alterna-  
6 tives. I have not reached a conclusion yet as to what the  
7 real reason is.

8 Q Does the map, 950, tell us anything about the direction  
9 of flow on the Cryovac site, on the external part of the  
10 Cryovac site?

11 A Yes, it does.

12 Q Could you point that out to the jury?

13 A This is the Cryovac site (indicating).

14 Again, it is this area here. We can see  
15 that water levels are highest back behind this building.  
16 There is what we call a groundwater divider or groundwater  
17 mound basically in the middle of the Cryovac plant. And the  
18 groundwater on the eastern side of this line is flowing  
19 toward the east, toward the southeast, and on the western  
20 side of the line is flowing to the west and toward the  
21 Aberjona River.

22 Q The line being a line that runs roughly parallel to the  
23 eastern end of the warehouse and going up parallel to  
24 Washington Street to the end of the property?

25 A Yes, and this is Well -- (indicating).

1           This is not only true for this period of  
2 time, but we prepared as part of our  
3 working analysis, we prepared water level tables for the  
4 Cryovac plant for a period of time, and that divide is  
5 consistent. On the eastern side of the property groundwater  
6 flow is toward the east, and on the western side, it is  
7 toward the west. It approximately splits the plant in half.

8       Q     Is there any significance to the size of the flow  
9 direction arrows that are on Exhibit 950, Dr. Guswa, the  
10 document next to you?

11       A     Yes, there is a significance to that. One of the first  
12 things I thought about when I was beginning to analyze this  
13 problem was just to compare how much groundwater can actually  
14 be moving through the Cryovac plant toward the Aberjona River  
15 Valley. Beause since we have a groundwater divide on the  
16 plant, we can draw a line that says there is no groundwater  
17 inflow from this direction, because groundwater is flowing  
18 to the east on the eastern side of the plant. So the only  
19 source of groundwater within this square or rectangular area  
20 here is infiltration of rainfall, and that is the only  
21 source of water that would flow from the groundwater from  
22 the plant, in addition to whatever water was used in the  
23 normal operation.

24       Q     That is the only source of water going in a southwesterly  
25 direction toward the Aberjona River area?