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

Fifty-Ninth 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., Wednesday
June 11, 1986

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

And then after 88 the planks had stopped, but I tried to nevertheless walk across the rest of the river valley in an effort to get onto the other side, but I couldn't do it because the other channel was flowing and I couldn't get across that.

Q When you say "the other channel," you're referring to the portion of the river on the left-hand side of the chart with the dark blue?

A If I can get up and just show.

Q Yes.

A What I had done was I was over here at Cluster 89, and I was measuring wells at this cluster and also in the river, the bed wells that I marked 3 and 4 over here. I then walked across here to 88, and I had to use the planks because the ground was still wet from all these hallmarks. I then tried to get across here. I thought I'd be able to get to this side of the river and just walk down this side and observe what was going on.

However, I thought I could make it because in January the ground was sort of frozen and I was trying to walk from ice patch to ice patch and keep on top of the hallmark so I wouldn't slip in. I got to the channel here, which had some ice on it, but it was free-flowing and it wasn't frozen and I couldn't get any further across. So I had to go back.

Q Now, we've had the testimony from various people as to the normal flow of the groundwater under usual conditions in thi valley on the east side of the river and on the west side of the river. What is your opinion as to the normal flow, the usual flow of groundwater not under pumping stresses of any kind?

A Under natural conditions, groundwater tends to flow from the upper parts of the valley, which are generally north, down towards the south: and groundwater will tend to flow in a southerly direction and into the stream or into the river and then out of the system.

Q I believe you're talking about on the Riley site?

A Yes.

Q Now, have you also studied the effect of the Riley pumping wells --

A Yes, I have.

Q -- on this?

And is that an important aspect of understanding the system?

A Yes, it's very important.

Q And during the historic period, was it your understanding that the Riley wells were pumping during the week at I think approximately 350,000 gallons per minute?

MR. SCHLICHTMANN: Objection, your Honor. Leading.

MR. FACHER: What is your --

THE COURT: Objection is sustained.

Q What data with respect to the Riley well do you rely on in reaching any conclusions about the Riley well?

A Well, again, the Riley well was pumping during the 30-day test and its pumpage would have an effect on groundwater flow in the area. What I wanted to do was make sure that if I was going to compare the results of that test back to the period during 1964 to '79, that the Riley well was also going to be pumping in a similar way, and what I determined is that the pumpage pattern that we observe now is the same pattern that we had during the 1964 to '79 period.

Q And if there were any contaminants on the Riley site, would the Riley well draw in those contaminants when it was -- Riley wells draw in those contaminants when they were pumping?

A Yes. Well, the Riley well itself has its own cone of depression and any contaminants that would be in your groundwater around that Riley property would be pumped out of the ground by the Riley well.

Q And to what extent, that is, how far would the -- would that effect take place? How far on the property?

A That effect would extend up north, probably north of -- if I can indicate on the map?

Q Yes.

A It would extend up north. This is Cluster 6. I would say somewhere north of Cluster 6 interim here, the area between

6 and 11.

Q Now, is there a normal fluctuation of water levels in the valley annually?

A Yes. Over a year there is a seasonal fluctuation.

Q What's the range, do you know?

A Well, the seasonal fluctuation depends on precipitation and --

Q You better hold it up a second.

(Pause due to outside noise.)

Q Why don't we try it again if you can move closer to the mike.

What are the seasonal fluctuations?

A The seasonal fluctuations range between five and ten feet.

Q I take it the summer months would have the lowest levels?

A The lowest levels usually occur in August.

Q In August.

Now, you mentioned yesterday that as a result of pumping Wells G and H you determined that there had been a reversal of gradients from the normal flow that you had described just a moment ago; is that correct?

MR. SCHLICHTMANN: Objection, your Honor. Leading.

MR. FACHER: Pardon me?

THE COURT: I didn't hear all of the question to start with.

Will you read the question back?

(Question read.)

THE COURT: I'll let it stand.

Q What did you mean by -- and would you please explain the concept of the reversal of gradient that you were referring to?

A Yes. What I was referring to then was that under pumping conditions of G and H, water that under non-pumping conditions used to go down the valley now flowed in a different direction. Gradients had changed.

Q And what is the comparison between the pre-pumping and post-pumping gradient?

A Okay. Pre-pumping flow direction, as I explained, had a gradient that went from the north to the south. After pumping had started, after the 30 days, the grade was changed so that groundwater flowed from a central location, away from the central location. A central location was approximately the Aberjona River. Groundwater flowed -- on the east side of the river groundwater flowed eastward, and on the west side of the river groundwater flowed westward.

Q Have you illustrated that, prepared a diagram, exhibit, showing that effect?

A Yes, I have.

Q Could you -- Let's bring this over.

All right, sir. What does the blue -- again, the blue portion refer to?

A Okay.

Q The light blue and dark blue?

A This blue area, again, is the river marsh system, and this is the area where we have the defined river channel and where we have marsh deposits that are saturated with river water that become a larger river channel during periods of high water, and just marsh, saturated marsh deposits during periods of lower water.

Q Now, explain to the jury the contour lines that you have drawn on that or that have been drawn on that map.

A Okay. Again, this map is a water table map and the black lines on the map are water table elevation contours, and these were constructed from water levels taken from the various monitoring wells which are shown by the dots on this map, and the contours are numbered according to their elevation which ranges from 42 down to 40 and a half feet and down to 40 feet on this side above sea level.

And again, the water table contours show the gradient in the vicinity.

Q Now, are those contours prepared -- that map prepared using the standard procedures and accepted procedures that a working field hydrologist with experience would use?

A Yes, they are -- it was.

Q Now, you have the arrows drawn on that map, which is Exhibit -- proposed Exhibit B-774. Would you explain those arrows, and with particular reference to your explanation about the reversal of gradients and the groundwater -- flow of groundwater?

A Yes. The arrows again are flow direction arrows, and they aid in describing the direction that groundwater would flow. They are drawn from the higher elevations down to the lower elevations following the shortest path, which is a path that would be perpendicular to these contours. That's how these arrows are drawn, and they are drawn to show that groundwater flows from the highest area, which happens to be underneath this red line, to the lower areas, which are in the direction that the arrows indicate.

On this side of the level, on the east side, the low areas or the Wells G and H, where the cone of depression had been created.

On the west side, the low area is toward the southwest. Groundwater flows away from this toward the southwest.

Q Now, you talked yesterday about a mound or a high point which had been created like a tent, I think you said, away from which the groundwater was flowing. Would you explain that to the jury with reference to the chalk that you are using?

A Yes, indicates a vision of a tank with a center line. The tarpaulin on top of the tank slopes away from the center part. If I was to put a model on the part, depending upon what part of the post I would put it on, it would flow either down one side or the other side.

In a similar way, the river creates this ridgepole effect, and it is the high point on the water table surface with the tarpaulin that slopes away on both sides. This is caused by the pumpage of G actually inducing water to leave the river. As the water goes out of the river channel, it forms a mound on the water table, and the mound is this ridge-shaped affair which then becomes a hill separating the cone of depression on one side of the river that is supported by G and H from groundwater on the other side. And the hill prevents anything on the east side of the river -- On the contrary, things on the west side are lower, water from the top of the hill flows down the river.

THE COURT: The 42-foot line is the ridgepole that you are speaking of?

THE WITNESS: The 44-foot contour goes around the ridgepole.

Q Is that the high point?

A The ridgepole is a high point, higher than 42. It shows the highest point along this---

THE COURT: Do you have a measurement along that? I don't see it.

THE WITNESS: From this cluster here at S-92 to S-77, which are all greater than 92. Ninety two, it is forty two and a half feet, and 77, S-77, it's almost forty two and a half feet.

Q Topographically there is no hill of earth, you are talking about a---

THE COURT: Water table.

THE WITNESS: The shape of the water table underneath the land.

THE COURT: What is the level of the bottom of the river, can you tell us that?

THE WITNESS: The bottom of the river, are you talking about the river channel itself?

THE COURT: The river channel itself.

THE WITNESS: I don't know that.

Q The measurements of 42, is that contour goes on both sides?

A Yes.

Q Just trace it so we can see it.

A The contour goes around to the south and up on the east side (indicating).

Q Some of those measurements you were actually taking yourself in the river?

A Yes.

THE COURT: Some of your contour lines are dotted. Now, we learned last go-around that we better find out what dotted lines mean.

Q All right.

THE WITNESS: Yes. If you notice this contour line over here is dotted in. That is because I really don't know the exact location of where this line should be put because I don't have any data points on this side to tell me where that 40 should be. However, I know that these, the elevation in these wells over here, S-84, S-90, and S-94, are lower than 40 feet. So I know the water table has to increase up here because topographically the ground increases in elevation in this direction. Therefore, the 40 is somewhere in here, but it is dotted because I don't know precisely where it is.

THE COURT: Would that be true with the rest of the dotted lines, that they are projections?

THE WITNESS: Well, again, I dotted lines where I don't have a data point on both sides of the line to show exactly where it should be. However, where I do have the data points, such as over here, the lines are not dashed in. Here we have data points that show exactly where the lines should be (indicating), and all these lines are drawn in with solid lines.

THE COURT: So the solid lines, you say, are established by the data and the dotted lines are estimates or projections by you?

THE WITNESS: Yes. These dotted lines occur in between these wells. Over here I talked to you about 88 and H.

THE COURT: But you don't know exactly?

THE WITNESS: I don't know exactly where they are occurring.

THE COURT: All right.

Q (By Mr. Facher) Now, this is the Riley solid land is the green?

A Yes, the green is the Riley solid land.

Q The Grace site is somewhere up here?

A Off the map in this corner up here (indicating).

Q All right.

Now, have you prepared a cross section which will illustrate the effect of the pumpage on the river?

A Yes, I have.

Q Now, can you explain to the jury what it is that they are looking at and from what vantage point they are looking at it?

A Yes. This is a cross section, a slice through the aquifer, basically from a west to east direction. It is a slice made using information collected from the monitoring wells that were drilled on the site. The location of the monitoring wells are shown here with their number. The monitoring wells used on this section are these 13, 14, 92, 93, G, and 94. Now, you see the cross section across the valley up to and past Well G. Here we have Cluster 13, 14, you have the marsh that separates 14 from 92, which is what we have over here., this blue area. We have Cluster 92, which is right in the river, we have the marsh on the other side, over here, you have Well G, and you have Cluster 94 (indicating).

What I've shown on this map is that instead of drawing all the wells at each cluster, because of space limitations, I have shown by these green lines where the various wells in the cluster are screened, that is, where their

intake is.
Q You are going to have to make it verbal, because the Reporter can't pick up---
A Cluster 13, we have three wells that we use; Custer 14, three wells; Cluster 92, we have three wells; 93, we have three wells in that cluster. Well G has one intake screen over here. Ninety four has three wells indicated, but we only use the data for two wells.
Q Where is the 42 contour that you previously referred to?
A Now, the 42 contour that is on this map is shown over here, going from the west side of Cluster 92, across the river to the east side.
Now, I would like to explain that. These intersections -- Let me back up a little bit and I will explain some other features on this map. This blue line on the top is the water table, and its height is the same as what is shown on this map. So what I've done is actually taken the intersection of these water table contours with the imaginary line of section and I've plotted those intersections on this map and connected the water table, which is the blue line, to each of those intersections at the correct elevation above satisfactory level which is shown on the scale on the side. So this water table that is shown here actually slopes according to the way it is indicated on

this area map. This is what we call an area map, and this longer map is what we call a cross section.

Q This is not the aerial, a-e-r-i-a-l, not the same as a photograph. Acra meaning a flat map. Cross section meaning a section through a certain area.

On both sides the water table is drawn to show you in a cross-section view what these water table contours really mean. So we can see there is a slope away from the river on both sides. The location of this slope is made by actually drawing these contour -- the intersection of these contrours at the water table at the correct elevation above sea level.

In addition, at each of the points where we have wells, we can construct another kind of water table map or map with lines on it showing equal elevation. But in this case, to show what the vertical gradient is because in addition to a gradient on the flat map area, there is also radial groundwater depth, because groundwater flows in three dimensions. So during the pumping tests we were able to take measurements in all of the wells in the cluster -- in most of the wells, and we had actual water elevation at each depth below land surface.

In a similar way to that map, indicating a water table map, we can connect lines to the elevations that are the same height above sea level, and we drew contours which are vertical contours through the ground to show how groundwater would flow through the ground in a vertical section; and, again, these contours range from higher levels, some are 42, down to lower levels, forty one and a half, 41.

On the east side of the river we start at 42, and we go down to much lower levels, 40 and down to something less than 24, because here is Well G and pumping and a bigger change in water table gradient occurs.

This really is the cone of depression of Well G.

Q What is? The record won't reflect that.

A What I'm indicating is that this line which indicates the top of the water table starting from the east side of the Aberjona River runs down to Well G and back up again on the other side to 94S, this big dimple in the water table which we call the cone of depression.

What this cross section shows is that this cone of depression extends after the river which is the high point on the water table in this area now and doesn't go any further. And that water from the river, which is shown by these orange arrows in this blue zone, actually leaks out through the river body because the height of the river now is much higher than the height of the -- than the water pressure in the ground. The gradient goes from the river into the ground. Water leaves the river, follows these arrows and eventually ends up in Well G, and in so doing this, this discharge from the river creates this barrier, barrier to any groundwater that is on the west side of the river from flowing to the east to Well G.

As a matter of fact, because this mound is created, what happens is that groundwater on the west side of the river now also flows away from this high point and flows to the west. So these arrows indicate that part of the river water flows to the west and that groundwater also flows to the west and it flows away from Well G.

Q On the flat map, flat surface, which is 774, you have a red line indicating, it says, "groundwater divide." Do you see that?

A Yes, sir.

Q What does that mean?

A The groundwater divide is a term given to an imaginary line that separates groundwater area that flows in two opposite directions. It divides the groundwater flow system. It's a convenient way of showing it on a map.

Q Is that a standard hydrological term?

A It's a standard term and a standard line that's drawn.

Q Is there a groundwater divide also before pumping? Does the same divide exist but in a different location?

A Well, the divide can exist before pumping. Depends on the circumstances of an area. But with this area the way it generally flows are north to south and doesn't cross the river.

Q Now, in view of what you just said, is there any cone of depression created by G and H pumping together which extends or can extend under the river to reach groundwater at the Riley site?

A Well, as these diagrams illustrate, the cone of depression from G and H, which is what we've depicted on this map, can only go up to the river. It does not cross the river. So the effect of G and H will not cross the river but will be contained and be stopped from leakage by the river itself.

Q Now, this is information prepared with G and H both pumping, is that right?

A Yes.

Q That is, the cross section Exhibit B-733. If G were pumping alone most of the time would there be any cone of depression which would extend under the river?

A Well, what we're seeing here --

Q First, will you answer --

A No.

Q Now would you explain?

A What we're seeing here is the effect of combined pumpage of two wells into a very heavy stress on the aquifer, and we see under this heavy stress the cone of depression stops at the river.

If we were only pumping one of these wells, the stress would be less, so the size of the cone of depression -- and it would be even smaller and it would be even less likely that any water would come in the other side of the river.

Q And if there were any contaminants in the groundwater on the Riley site, even assuming that, would they reach Wells G

and H in the groundwater?
A No, they wouldn't.
Q And why is that?
A Well, as this cross section shows, and as the area map here showing horizontal flow indicates, any water under the Riley site would flow away from G and H when G and H is turned on. Therefore, anything that was dissolved in the water would flow in the opposite direction and would never get to G and H.
Q What was the significance of the river discharge data from the loss of water from the river in your opinion?
A Well, the river was measured during the pumping test and it was measured to determine exactly how much water was in the channel. It was measured up here at Olympia Avenue where the river first got on the site, and it was measured down here on Salem Street after the river left the site, and what that information showed was before the pumping test started the river was a gaining stream.
What we mean by that term is that the amount of water in the river increased. It gained. And this is under normal conditions what you would expect. Groundwater flows down the valley, some flows into the river, and the river gleans water into the system. Therefore, as the river moves down it, its point of discharge, the stream flow increases and there's more water discharge.

However, at the end of the pumping test the measurements at Olympia Avenue and Salem Street showed that the river lost water. It's not even a factor that the river discharge didn't change, but it lost over 550 gallons a minute at that water level in the channel and entered the groundwater system.

Now, we see on this map that is exactly what happened because when the water level is at the channel it formed this mound on the water table. The mound is actually the river water that has moved into the ground and now has become groundwater, and it's flowing according to the low gradients in the river.

Q I'd like to read you a statement and ask you if you agree with it.

Dr. Pinder stated that what happened is that "Water which would normally go into the river is not going into the river any more. It doesn't mean it's leaving the river. It just means it's not going in."

Do you agree with that?

A I disagree with that.

Q Why is that, sir?

A Well, it's a simple process of arithmetic. If I'm told that a thousand gallons of water are in the river up here and there are only 500 gallons of water -- those aren't the actual numbers. -- if somebody told me there was a thousand gallons up here and 500 here, the 500 gallons had to go somewhere. So it couldn't be a factor of water not coming in. There's water actually leaving the river.

Q Would it take 10 to 20 years for any river water that was being discharged as a result of the pumping to reach Wells G and H?

A No, it would not.

THE COURT: Would surface evaporation be significant in the loss of water as it came through the valley?

THE WITNESS: Surface evaporation would not be significant especially during the time of the pumping test because it was during January and February when temperatures were very cold. In fact, it was freezing.

Q In your opinion is the peat that you examined any kind of a seal that would keep in the river water and prevent it from leaking or discharging under pumping conditions?

A There's no way that that could be considered a seal.

Q Would you resume your seat, please, Mr. Koch.

Did you, sir, examine Exhibit 558, which was a list of the data from wells which Dr. Pinder used in his triangulation calculations?

A Yes, I did.

Q And in his opinion.

And, sir, is it a good hydrological practice to use data from a shallow well at the beginning of a pump test and then use data from a deep well to compare at the end of the pump test?

A No, it isn't.

Q Would that be something that a working field hydrologist with experience would do?

A It would not do.

Q Why not, sir?

A Well, what we're trying to do here is compare a situation before an event to a situation after event, and we like to be able to compare apples to apples. So we want to use the same measuring points for the first event that we use for the second event and not change measuring points in between.

Q And did you, in reviewing the data from Dr. Pinder set out in Exhibit 558, ascertain whether he had used shallow wells at the beginning of the pump test compared to deep wells at the end of the pump test?

A Yes, I did.

Q And how many instances did that occur?

A Seven.

Q Now, is it good hydrological practice when you're trying to discover movement in soil, sand and gravel in the nature that we have here to use data from wells that are in bedrock?

A No, it isn't.

Q In reviewing Exhibit 558, were there data from wells in bedrock?

A Yes, there were.

Q In how many instances?

A Eleven.

Q And why is that not good practice?

A Well, the system -- when I mean system, the groundwater system we have here consists of two units. One unit is the sand and gravel that Wells G and H are screened in, that the river flows in, that Riley's wells are screened in, that most of the observation wells are screened in, and the sand and gravel is the unit that is seen at land surface which is the area that's been mapped by Drobinski, being the Riley property.

Underneath we have a bedrock unit which doesn't appear anywhere on the project site, but some places off to the sides if you look uphill we can see where the bedrock is exposed at land surface.

Groundwater flows differently in the bedrock than it does in the sand and gravel, and everything that we're discussing here is something that would have occurred in the sand and gravel. Therefore, if I wanted to determine how groundwater was flowing in the sand and gravel, I wouldn't use water levels from wells screened in the rock which may have nothing to do at all with what's happening with the sand and gravel.

Q Exhibit 558 at least indicates 11 wells that were in bedrock?
A Yes.
Q And that is this exhibit that had the elevations and the well numbers on it?
A Yes, it is.
MR. FACHER: I believe it's in evidence, your Honor.
Q I forgot to ask you: There's also a dotted line that shows the outline of the Riley property in addition to the green area. Do you see that? Is that on your map?
A Yes, the dotted line is on the map.
Q Now, you also, sir, in your experience have had experience in observation with respect to landfills and official -- and dumpsites?
A Yes, I have.
Q And was the Riley property, in your view, any kind of a dumpsite, in that context?
A No, it was not.
Q The step drawdown test, are you familiar with that?
A Yes, I am.
Q What information, if any, could be obtained or could any information about groundwater flow be obtained from a step drawdown test that was done in this situation?
A The step drawdown test really showed whether or not

Wells G and H were capable of being pumped at the rates that were projected for the 30 days test and it is very preliminary groundwater flow information that could be obtained from those tests.

Q And in your opinion, with both pumps on or with either pump on, would any groundwater flow from the Riley site to Wells G and H?

A No, it would not.

MR. FACHER: I have no further questions, your Honor.

Cross-Examination by Mr. Keating

Q You testified that you have been a hydrogeologist for 19 years, roughly?

A Yes.

Q And in that capacity you've had an opportunity to examine, I think you said this morning, 75 to a hundred sites?

A Yes, I did.

Q Have you ever had an occasion to examine a service station for groundwater contamination?

A Service station?

Q Yes, gas station.

A Yes.

Q And have you had an opportunity to determine what kind