

CONSOLIDATED HEARINGS BOARD

IN THE MATTER OF Sections 2 and 3 and 6 (3) of the Consolidated Hearings Act, 1981, S.O. 1981, c.20;

— and —

IN THE MATTER OF Section 12(2) of the Environmental Assessment Act, R.S.O. 1980, c.140;

— and —

IN THE MATTER OF Sections 30, 35 and 38 of the Environmental Protection Act, R.S.O. 1980, c.141, as amended;

— and —

IN THE MATTER OF Sections 24 and 61 (2) of the Ontario Water Resources Act, R.S.O. 1980, c.361, as amended;

— and —

IN THE MATTER OF Section 28 (3) of, and Regulation 164 under, the Conservation Authorities Act, R.S.O. 1980, c.85, as amended;

— and —

IN THE MATTER OF Section 40(12) of the Planning Act, S.O. 1983, c.1, as amended; in connection with site plan control of the sanitary landfill site;

— and —

IN THE MATTER OF Section 22(1) of the Planning Act, 1983 in connection with a referral to this Board by the Honourable Bernard Grandmaitre, Minister of Municipal Affairs, on a request by the Regional Municipality of Halton to amend the Official Plan for the Town of Milton to redesignate a parcel of land comprising Part Lots 3 and 4, Concession 2 H.S. in the Town of Milton from "Agriculture" and "Conservation and Hazard Lands" to permit the construction, operation and maintenance of a landfill site, Minister's File No. 24-OP-0208-AD1;

— and —

IN THE MATTER OF Section 34(11) of the Planning Act, 1983 in connection with an appeal to this Board by the Regional Municipality of Halton for an order directing an amendment to By-law 61-85 of the Town of Milton to rezone the lands situated at Lot 3 and part of Lot 4, Concession 2 H.S., in the Town of Milton from "Agriculture" to permit a regional sanitary landfill site and ancillary uses;

— and —

IN THE MATTER OF Section 15(1) of the Planning Act, R.S.O. 1980 ch.379 in connection with a referral by the Honourable Claude F. Bennett, Minister of Housing on a request by Tremaine Britannia Citizen's Group for consideration of part of the Official Plan for the Halton Planning Area with respect to Sections 1 to 5 inclusive, 7, 9 and 10 of Part III D3 Solid Waste Management, Minister's File No. OPC-0026;

— and —

IN THE MATTER OF Section 64 of the Ontario Municipal Board Act, R.S.O. 1980, c.347 as amended in connection with an application by the Regional Municipality of Halton for an order approving:

- a) the acquisition of land for the construction, operation and maintenance of a sanitary landfill site to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton and to do so by one of two alternative methods as follows:

- (i) landfilling at the site referred to in Halton's Environmental Assessment as Site F in the City of Burlington;
- (ii) landfilling at the site commonly referred to in Halton's Environmental Assessment as Site D in the Town of Milton

at an estimated cost of \$12,775,000.00, and the borrowing of money by way of temporary advances not exceeding in the aggregate such estimated cost pending the sale of debentures, and

- (b) the issuance of necessary debentures to a maximum of \$12,775,000.00 for a term not to exceed fifteen years;

— and —

IN THE MATTER OF Section 193(5) and Paragraph 84 of Section 210 of the Municipal Act, R.S.O. 1980, c.302, as amended;

— and —

IN THE MATTER OF Sections 6, 7 and 8 of the Expropriations Act, R.S.O. 1980, c.148;

— and —

IN THE MATTER OF an undertaking of the Regional Municipality of Halton to provide facilities for the purpose of receiving, dumping and disposing of waste as required by section 137 of the REGIONAL MUNICIPALITY OF HALTON ACT, R.S.O. 1980, c.436, as amended, by acquiring the land for, constructing, operating and maintaining a landfill to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton.

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BEFORE: H. H. Lancaster, Q.C. - Chairman

Dr. D.J. Kingham - Member



Nethercut & Co. Ltd.

Toronto, Ontario

Hearing conducted at The Oakville
Granary Commercial Centre, 105 Robinson
Street, Oakville, Ontario, on Monday,
April 18, 1988

VOLUME 125

APPEARANCES:

T.R. Lederer and
H.D. Hodgson

for the Regional
Municipality of Halton
(Proponent)

J.R. Tidball

for the Ministry of the
Environment

T. Vigod
J.F. Castrilli

for the West Burlington
Citizens Group

D. Estrin,
F.E. Leitch and
H. Dahme

for the Corporation of the
Town of Milton

S.R. Garrod and
A. Nurvo

for the Milton Area Citizens
Coalition and several
affected Milton area
landowners

R.B. Tuer, Q.C.
E.A. Cronk,
F. Perrier and
L. J. Griffiths

for National Sewer Pipe
Limited

L.F. Longo

for Azova Investments
Limited

M.J. McQuaid, Q.C.
and C.J. Tzekas

for the City of Burlington

C. Mansfield

for the Ministry of Natural
Resources

P. Renaud

for Cumis Limited



Nethercut & Co. Ltd.

Toronto, Ontario

APPEARANCES (Cont'd):

1	C. Stevenson	for Framgard Holdings,
2	P. Hancock	Fosseri Investments
3		Limited, Seriphos
4		Investments Limited and
5		Topic Investments
6		
7		
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185 Richmond St. W.
Toronto, Ontario
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Per: P. D. McQueen



Oakville, Ontario
April 18, 1988

1 ---Upon commencing at 9:30 a.m.

2 MR. LANCASTER: Please be seated.

3 Mr. Estrin, whenever you are ready.

4 ANTHONY J. CRUTCHER, (resumed)

5 JOHN M. PETRIE, (resumed)

6 MR. ESTRIN: Mr. Crutcher has indicated
7 he has prepared some kind of chart with regard to a
8 question by Dr. Kingham last week which he indicates he
9 will deal with.

10 MR. CRUTCHER: Last Thursday I presented
11 the various mounding scenarios with spacing and the
12 question was put to me to be answered, by Dr. Kingham:
13 what in fact would the spacing be having a 10^{-5}
14 consideration for the waste. I undertook to have those
15 calculations and I have presented this on a table. It
16 is dated April 14th. If I may just go through the
17 table.

18 We prepared four scenarios. Scenarios 1
19 and 2 deal with an infiltration rate of 150
20 millimetres. Scenarios 3 and 4 with an infiltration
21 rate of 300 millimetres per year. You will see at the
22 hydraulic conductivity we have a 10^{-5} for the waste
23 hydraulic conductivity in columns 1 or scenarios 1 and
24 3 and we also took a look into the scenario with a sand
25 blanket being placed on top of the base soils prior to



- and -

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placing waste and that is scenarios 2 and 4.

1 We labelled Site D "Trow Design" and we
2 should be careful in using the words "Trow design."
3 Mr. Hodgson indicated last time it is Site D using the
4 configuration that Trow has specified. The drain
5 spacing would obviously have to change. We specified
6 the mound height at 1.5 metres which is what is
7 designed presently. If the waste was at a permeability
8 of 10^{-5} using the design scenario of 300 millimetres
9 per year, we would have a drain spacing of
10 approximately ten metres, so you would be placing them
11 approximately every ten metres. Presently design is
12 every 30 metres. In fact if we used the sand blanket
13 in conjunction with the waste having 10^{-5} then the
14 drain spacing is approximately 18 metres. In the sand
15 blanket calculations, they are approximate on the basis
16 that you have to estimate the two different
17 permeabilities and the formula only works for one, so
18 there is an estimation procedure but they should be a
19 fair representation.

20 At Site F under the same scenario using
21 the design mound height of 1.2 metres with a slope of
22 3.3 per cent you would have under design scenario of
23 the 300 millimetres the spacing at 16 metres rather
24 than 50 metres. Likewise with the sand blanket, you
25



1 would have 32 metres.

2 I also undertook to have a look at what
3 the cost implications would be because I indicated that
4 would be costly. We did not cost the sand blanket item
5 because that is a little bit more involved but quickly
6 just taking a look at the cost of the increase in the
7 piping and assuming it is proportional, we are looking
8 at a cost increase under the design scenario which I
9 identify as scenario 3, of approximately \$1.8 million
10 for either site. That cost is over and above the
11 present cost, so there will be an incremental cost of
12 \$1.8 million. This information here is just a follow-
13 up on what I presented on Thursday and in response to
14 your question, Dr. Kingham, of the effect of 10^{-5} .

15 MR. LANCASTER: That relates to Exhibit
16 719 so we will mark this as B-719A.

17 --- EXHIBIT NO. B-719A: Table entitled "Comparison of
18 Drain Spacing for Equivalent
19 Leachate Mounds Using the
Moore Equation"

19 MR. HODGSON: Mr. Chairman, just before
20 Mr. Estrin begins, it came out during evidence on
21 Thursday afternoon that page 3 under Exhibit H-39A is
22 in fact a Theis recovery from the lower granular unit
23 for OW-1 and not PW-1. A question was put to the
24 witness as to the recovery data for PW-1. I just
25 indicate to my friends and for the Board that the fact



1 that the recovery data is already in evidence as
2 Exhibit H-727 is in fact the first page. You will
3 notice that it says on H-727 at page 1, the third line
4 from the top reads "Distance from pumped well 0"
5 indicating that is the data for a pumped well.

6 I also have obtained over the weekend a
7 much more legible copy of that page. I will photocopy
8 it and hand it around so that everyone can read the
9 numbers.

10 MR. LANCASTER: That would be helpful.

11 CROSS-EXAMINATION BY MR. ESTRIN, (continued):

12 Q. Now, Mr. Crutcher, while you are
13 still up there and with regard to Exhibit B-719A, the
14 sheets you have just given us, I will have questions
15 I'm sure when I've had an opportunity to carefully
16 consider this in association with Dr. Rowe when he
17 returns to Canada at the end of the week. Therefore I
18 probably won't have a chance to ask you any detailed
19 questions about this. Can you tell me, please, with
20 regard to Site F and looking at your scenario 3, you
21 say that to achieve the Trow design of a maximum mound
22 of 1.2 metres at Site F with a waste K of 10^{-5} you
23 would have to increase the numbers of pipes and reduce
24 the spacing to 16 metres? Did I understand that?

25 MR. CRUTCHER: A. That is correct.



1 Q. That is presently 50 metres?

2 A. What we did is specify the mound
3 height which is the 1.2 metres and then back-calculate
4 it using waste permeability of 10^{-5} .

5 Q. Was that going to -- that spacing
6 going to be for both leachate collection systems, that
7 is the upper and the lower?

8 A. The lower one, we have not done
9 any evaluations on the lower one. Essentially it is
10 not really a design collection system. My
11 understanding is it is to be placed in the valley as
12 part of filling and it does whatever it does. It
13 really didn't enter into the equation. It was the one
14 that was based strictly at the base of the landfill.

15 Q. And looking at the information
16 with regard to Site D, you are saying that Trow's
17 design head at Site D, as you interpret the documents
18 from their design, is 1.5 metres?

19 A. We actually verified that. We
20 did the calculations and came up with 1.5 and that in
21 fact was the number that was in the documents as well.

22 Q. If we look at scenario 3 with 300
23 millimetres infiltration, as I understand this document
24 you are saying if the waste had a K of 10^{-5} then we
25 would be looking at an average ten-metre mound for



1 leachate at Site D?

2 A. No. For a mound height of 1.5
3 metres and a 10^{-5} waste you need spacing of the drains
4 at ten metres which would give you the mound height of
5 1.5 under that design scenario.

6 Q. Let me try that again. Trow has
7 designed Site D for a 1.5-metre design height for the
8 average mounding of leachate; right?

9 A. The maximum height, yes, is 1.5.

10 Q. If the K of the waste was 10^{-5}
11 your calculations indicate that at the present design,
12 that is the 30-metres spacing, you would get how much
13 of a mound?

14 A. We didn't do that calculation.
15 Let me just see if I can find it here. If you refer to
16 Exhibit B-719, Table 2, Site D at 10^{-5} , leaving a
17 spacing of 30 metres you get 4.6. It is under scenario
18 8. So if a factor of the waste was used, a design
19 scenario of 10^{-5} and you wanted to place the mound
20 height at a maximum of 1.5 which is essential for the
21 hydraulic trap, therefore you would have to decrease
22 the spacing down to ten metres. As you are well aware
23 of I do not concur with the 10^{-5} design scenario. I
24 prepared these numbers at the request of Dr. Kingham.

25 Q. Now -- thank you. Mr. Petrie,



1 you will recall that on Thursday -- could you put up
2 your overhead of the upper granular unit? That was an
3 exhibit at this point.

4 MR. PETRIE: A. Yes, I recall, Exhibit
5 B-632.

6 Q. You recall we were discussing
7 pump tests in the upper granular unit and the
8 information about a response in MB-OW-4 recorded during
9 the time of that pump test of about 3.5 centimetres?

10 A. I recall that, yes.

11 Q. I suggested to you that that was
12 further evidence, if not proof of the pudding that the
13 upper granular unit extends between your two segregated
14 units. You said you wanted to have a chance to check
15 the barometric data.

16 A. That is correct.

17 Q. Did you do that?

18 A. Yes, I did. It does not appear
19 to be a result of barometric fluctuations.

20 Q. And therefore, I suggest to you
21 that what we have seen in the data provided in Exhibit
22 727, the further pump test results, is proof that there
23 is a response in the upper granular unit at MB-OW-4 to
24 the pump test which was carried out in the vicinity of
25 HC2?



1 A. The statement was made on the
2 basis of three water level readings taken from MB-OW-4,
3 piezometer 2 for which indeed there is indeed a 3.5
4 centimetre water level change in that interval. It is
5 a meagre record on which to define hydraulic
6 continuity. I have also noted on page 4, I believe it
7 is, of Exhibit H-727, page 4 relates to the lower
8 granular unit but I just want to point out some
9 information that is available for examination on this
10 record. Page 4 is listed at the top right-hand corner
11 "Site D Pump Test, December 11 and 12, 1985." In the
12 left-hand column we have one, two, three, four, five,
13 six, seven, eight well nests. Then we just have two
14 sets of water level readings being the initial reading
15 and the final reading which I understand to be initial
16 and final from pre-pump and following the pump. The
17 far right-hand column has delta WL in centimetres being
18 water level change. The thing to note on that table is
19 that a lot of the water levels have changed in these
20 nests varying from about half a centimetre to a maximum
21 of about eight centimetres. These numbers that appear
22 in brackets, for which I identify five, the water
23 levels have declined, whereas the other ones rose. The
24 point of bringing this information to you is showing
25 through what I understand to be approximately a 24-hour



1 period, water levels have changed; in some cases going
2 down, in some cases going up, probably none of which
3 may be related to pumping. Specifically at MB-OW-4,
4 piezometer No. 2 the water level rose three centimetres
5 during a pumping event. Now, that rise is only
6 described by two data points, being an initial data
7 point and a final data point. My point is to suggest
8 that three readings of which there were three-and-a-
9 half centimetre water level changes is in my mind not
10 necessarily indicative of a direct hydraulic connection
11 recognizing that that well was recorded as a three-
12 centimetre water level rise during another pumping
13 test.

14 So, very small fluctuations and very few
15 data in my mind cannot be interpreted comfortably to
16 show a hydraulic connection.

17 DR. KINGHAM: I wonder on that point --
18 excuse me just a moment because I've been wondering
19 about this over the weekend myself. You show that
20 upper granular unit is shown to be connected across
21 First Line Road and we are aware that there are a
22 number of wells across First Line Road. Does the
23 activity of the people who run those wells across First
24 Line Road affect our understanding of these results
25 shown in Exhibit 727?



1 MR. PETRIE: By "activity" do you mean
2 operation of their well?

3 DR. KINGHAM: Filling swimming pools,
4 watering lawns, trees, et cetera.

5 MR. PETRIE: It could, although I note
6 at the time of the year the swimming pools and the lawn
7 watering would not have occurred. A lot of domestic
8 wells operate on a pressure system so that when the
9 pressure at the tank drops the pump is activated. It
10 is my experience with some domestic wells that the
11 activation time is very short, five to ten minutes,
12 just to pump up the pressure in the system again. I
13 would expect that pumping at five or ten gallons per
14 minute -- I just say that number off the top of my head
15 -- is unlikely to interfere with water level readings.
16 If one is taking a water level reading at exactly that
17 time one might see that sort of change. In a nutshell
18 I do not see that operation of domestic wells would
19 cause widespread or significant water level changes in
20 that granular unit.

21 MR. ESTRIN: Q. Mr. Petrie, what was
22 the maximum variation you noticed in the pump test in
23 the lower granular unit?

24 MR. PETRIE: A. I'm sorry, could you be
25 a little more specific?



1 Q. You were reading from page 4 of
2 H-727?

3 A. Yes.

4 Q. What do you say is the maximum?
5 This is a pump test in the lower granular unit in
6 December?

7 A. That is correct.

8 Q. Nothing to do with the time
9 period we were discussing specifically?

10 A. Correct.

11 Q. Now, what do you say is the
12 maximum variation you note there?

13 A. I was just noting that water
14 level changes of up to eight centimetres have occurred
15 and I was just noting that from the right-hand column.
16 I wasn't referencing it to any level. I did specify
17 for MB-OW-4 that here was a three-centimetre change in
18 piezometer 2 and we discussed last week that that same
19 piezometer was completed in the upper granular unit. I
20 am just indicating to the Board that based on those two
21 numbers provided in this table that a three-centimetre
22 change occurred which in my mind, a three-centimetre
23 rise is unlikely to reflect a pumping event in the
24 lower granular unit. I'm just indicating that the size
25 of the ambient fluctuations of water levels in this



1 unit is similar to the three-and-a-half-centimetre
2 change noted on page 11 of Exhibit H-727. I concluded
3 that one can't conclude positively that the three or
4 three-and-a-half-centimetre change is necessarily
5 indicative of the pumping event.

6 Q. Mr. Petrie, what you are saying
7 is you simply want to discount any evidence, write it
8 off, where it tends to disagree with your theory?
9 Isn't that what you're saying?

10 A. No, I'm not.

11 Q. That was your first reaction on
12 Thursday?

13 A. That first reaction was I could
14 not read the table.

15 Q. You wanted to check the
16 barometric data, you checked the barometric data and
17 it didn't confirm your speculation, this barometric
18 data?

19 A. That is correct.

20 Q. Now you are looking at a pump
21 test at another point in time on another unit and you
22 are speculating again to negate this evidence; is that
23 what you're doing?

24 A. No, I'm merely noting that there
25 are changes in water levels within the system and I



1 referred to the magnitude of three centimetres already
2 identified at this well such that one cannot be too
3 positive from three water level readings recording a
4 three-and-a-half-centimetre change that that
5 necessarily described hydraulic connection. I note
6 that that well, MB-(IN)-OW-4 lies closer to the pumping
7 well than HC2-86. If one is just to draw straight
8 lines between PW-2 which I have indicated being
9 adjacent to HC2-85, a straight line to MB-(IN)-OW-4
10 relatively to a straight line from PW-2 to HC2-86 then
11 MB-(IN)-OW-4 would lie closer. One would expect more
12 pronounced fluctuation there relative to the
13 fluctuation recorded at HC2-86.

14 Q. Mr. Petrie, how much reliance do
15 you want to place on two data points to give you the
16 exact measure of drawdown comparison?

17 A. I don't. I'm just merely noting
18 that based on two there is a fluctuation of three
19 centimetres. You have provided me with three
20 measurements for a fluctuation of 3.5 centimetres. To
21 me they are in the same ballpark. One cannot
22 extrapolate that definitively to interpret hydraulic
23 connection.

24 Q. First of all you, I suggest, are
25 speculating that there is no connection. You wish to



1 negate the evidence. You are putting a very negative
2 hue on it, are you not?

3 A. I don't think so, I'm just
4 looking at the basis of other fluctuations I see and
5 note that you can't be positive.

6 Q. You can't be positive but you are
7 saying it can't even be reasonable, it can't even be
8 possible, it can't even be likely?

9 A. I am giving you my interpretation
10 of the data, that there is not a hydraulic connection
11 across there.

12 Q. So you're agreeing it is not
13 possible, it's not likely?

14 A. It is my interpretation there is
15 no hydraulic connection across there based on the data
16 we have available to us.

17 Q. Mr. Petrie, let us go at this
18 another way. Mr. Petrie, what you see on this sheet is
19 drawdown data for HC2-86 which is the observation point
20 for the upper granular unit where everyone agreed there
21 was a response. Fair enough?

22 A. Is that page 10 of Exhibit H-727?

23 Q. Yes, that is what it says.

24 A. Do you have a copy of the
25 original? Parts of this page I cannot read.



1 Q. I do not have copies of the
2 original.

3 MR. HODGSON: I have already made
4 undertakings, Mr. Chairman, to get the originals back
5 out here so that everybody can have access to them.

6 MR. PETRIE: I'm sorry, I beg your
7 pardon. You're bringing the whole of M-727 as the
8 original?

9 MR. HODGSON: I'm going to get the
10 originals, all the pumping data out here so that anyone
11 who wants can clarify. I apologize for the fact.

12 MR. ESTRIN: Q. My copy is clear.

13 MR. PETRIE: A. I would ask you to show
14 me a copy that is more legible. I cannot read that or
15 that. I have included that as a four.

16 Q. But the data is ...

17 A. It is just a notation at the top
18 of the page. I was not entirely sure what it was.

19 Q. Here is a copy where you can see.

20 A. It is slightly more legible but
21 we are talking about the same page.

22 Q. We are talking about what is
23 marked as page 10. What you can't read on your copy
24 reads on this copy report arrow HC2-86-2. What you
25 will see on the page I've handed out, Mr. Petrie, is



1 drawdown data for HC2-86 which spans a period for
2 which we have data from MB-OW-4. In other words, if we
3 look back on the page for MB-OW-4 we see that we have
4 drawdown data during certain times of the test which
5 you will see, 1722 to 1818 and 2825 minutes.

6 A. I'm sorry, you've lost me.

7 Q. If you look on page 11 of Exhibit
8 M-727 ...

9 A. Page 11?

10 Q. ... which is the drawdown data
11 for MB-OW-4 ...

12 A. It is.

13 Q. ... the time elapsed is noted in
14 the second column from the left and you start with 1722
15 minutes and then we go to 1818 and then if you're going
16 to calculate 9:15 a.m. on the next day it would be 2825
17 minutes.

18 A. Right.

19 Q. All right. So we know the time
20 period during which we have some drawdown data for
21 MB-OW-4. What we put on the sheet I have handed out
22 which is headed "Data from page 10, Exhibit M-727" is a
23 time period which includes that period?

24 A. Right. It is not the sum total
25 of the data from page 10.



1 Q. No, it is the data that would
2 include that range that we have data from for MB-OW-4?

3 A. Um-hum.

4 Q. On the lower part of the page
5 we've provided a simple arithmetic plot of the drawdown
6 against time. The straight line has then been
7 constructed through these points so we can estimate a
8 change in water level at HC2-85 over the time period
9 for which we have data for MB-OW-4 and the data for
10 MB-OW-4, Mr. Petrie, was already available -- I'm sorry
11 -- for 2-86, was available on the graph which you had
12 referred to in your evidence in chief and I think has
13 been marked as H-639?

14 A. The graphical data was available,
15 yes.

16 Q. There are points on the graph
17 from which to pull that data. So, from the graph I
18 suggest we can see that the drawdown for the time
19 period which is of relevance in looking at MB-OW-4, the
20 time period being 1818 minutes or looking at it in the
21 more vernacular, 16:28 hours. At 16:28 hours on April
22 the first to 2825 minutes or 9:15 a.m. on April the
23 2nd. We can see that the drawdown for that time period
24 was less than five centimetres. Do we agree?

25 A. Yes.



1 Q. Looking at the location of these
2 boreholes I am wondering, on the overhead up there we
3 can see that the distance from the pumping well for
4 MB-OW-4 and HC2-86 are of the same order of magnitude?

5 A. I'm sorry, I've lost you. Can
6 you say that again?

7 Q. The two boreholes are in the same
8 order of magnitude distance from the pumping well, that
9 is HC2-86 and MB-OW-4, although MB-OW-4 is a bit
10 closer.

11 A. It is definitely closer.

12 Q. We are talking the same order of
13 magnitude in terms of the pumping test and in terms of
14 looking at drawdown data. From the graph therefore we
15 can see that the drawdowns are also of the same order
16 of magnitude?

17 A. You are relating three-and-a-half
18 centimetres to less than five centimetres? Yes.

19 Q. And there was less than five
20 centimetres in HC2-86 and 3.5-centimetres drawdown in
21 MB-OW-4. Given that we don't have perfect data here I
22 put it to you, Mr. Petrie, that it would be reasonable
23 and prudent to assume that the drop in water level in
24 MB-OW-4 was a result of the pumping test and it would
25 also be reasonable and prudent to conclude that the



1 upper granular unit is continuous between the pumping
2 well and MB-OW-4?

3 A. I note there is a similarity in
4 those values. My interpretation is it is not
5 continuous. However, the data is somewhat meagre. One
6 could conclude perhaps there is a degree of continuity
7 between those points.

8 Q. Mr. Petrie, I suggest to you that
9 a prudent, reasonable hydrogeologist would be willing
10 to concede that this is evidence that the unit is
11 continuous, at least to MB-OW-4?

12 A. I would suggest it is a very
13 conservative interpretation and inconsistent with the
14 geology. It is not my interpretation.

15 Q. So you would not even say that
16 faced with these facts -- let me start again. You
17 haven't previously considered the analysis I have just
18 given you?

19 A. That is correct.

20 MR. ESTRIN: Mr. Chairman, could we have
21 this analysis marked, the time data from page 10,
22 Exhibit M-727?

23 MR. LANCASTER: M-728.

24 --- EXHIBIT NO. M-728: Time Data from page 10 of
Exhibit M-727

25 MR. ESTRIN: Q. So, Mr. Petrie, again



1 you hadn't done this particular analysis to confirm
2 what is exhibited on Exhibit M-728?

3 MR. PETRIE: A. Correct.

4 Q. Having considered it you stand by
5 your original opinion there is absolutely no connection
6 between those two units?

7 A. I said my interpretation is there
8 is not. However, based on this data it is not clear
9 that there is not an interpretation. Based on three
10 data points it's pretty hard to be definitive in any
11 way. As I've pointed out here we have ambient
12 fluctuations in the system of that magnitude.

13 Q. Mr. Petrie, we are now looking at
14 -- when you talked about fluctuations, you talked about
15 fluctuations in December, you talked about it in
16 connection with another pumping test?

17 A. That is correct.

18 Q. What I've given you in Exhibit
19 M-728 is the same pumping test and the actual
20 fluctuation in another monitoring well at the same
21 period of time. I suggest to you, sir, you are wanting
22 to ignore the most pertinent data if you won't agree
23 that there is reasonable likelihood that those two
24 units are connected.

25 A. There is a possibility I have



1 indicated. I have also indicated it is not my
2 interpretation. However, I realize there is more than
3 one way to interpret this set of data.

4 Q. I see. You are now acknowledging
5 there is a possibility but it is not your possibility,
6 it is not your opinion there is a possibility?

7 A. No, I said it is not my
8 interpretation. I am providing my interpretation of
9 what I think the hydrogeology of this unit is. You
10 have provided me with three additional data points
11 which lead to a suspicion that maybe there is a degree
12 of hydraulic connection.

13 Q. I want to get it clear. Are you
14 saying one can come to that conclusion but it is still
15 not your opinion?

16 A. Correct.

17 Q. Your opinion is there is no
18 possibility that they are connected?

19 A. My opinion is that they are not
20 hydraulically connected.

21 Q. When you say there is a
22 possibility that they could be, that possibility is not
23 one that is shared by you?

24 A. I do not believe it. However,
25 recognizing there is a degree of uncertainty with



1 respect to this unit I've indicated it would be prudent
2 to consider they are connected with respect to an
3 impact assessment.

4 Q. That was not my question.

5 A. I understand that was not your
6 question. I'm offering that information.

7 Q. So to get it clear there is no
8 possibility these two units are connected?

9 A. I've indicated based on these
10 three data points which show a fluctuation which is
11 similar to that recorded in a pumping well which is
12 also similar to that recorded in the same well at
13 another period of time, one could suspect that there is
14 a degree of hydraulic connection. I do not believe
15 there is a direct hydraulic connection across there.

16 Q. Mr. Petrie, in your master's
17 project paper at Waterloo you believed a three-
18 centimetre drawdown, when you talked about drawdowns in
19 the Maryhill Till as a result of your pumping test, you
20 had very large ones but you did remark and you did
21 observe in the narrative, if we can find Exhibit 707,
22 on page 26 right at the bottom of the page that last
23 paragraph is talking about predicting the response of
24 the Maryhill Till to pumping and using consolidation
25 tests you wouldn't have expected, you would have



1 expected low hydraulic conductivity values and then you
2 go on to say:

3 "The Maryhill Till as represented by CB
4 should remain in effect by pumping over
5 a six-day interval. However, observed
6 drawdowns after six days of pumping
7 ranged from as low as three centimetres
8 to as much as 2.2 metres indicating the
9 Maryhill Till is ..."

10 A. Three-point-seven-two metres.

11 Q. The point is that three
12 centimetres was significant enough for you in that
13 other situation, acknowledging it is another situation,
14 for you to take it into account as evidence that there
15 was fracturing or some other factor at work there; fair
16 enough?

17 A. We are dealing with vertical flow
18 in a tight unit. Here we are dealing with horizontal
19 flow in a less tight unit. I do not see the two
20 situations as similar at all.

21 Q. The point is you believed that
22 three-centimetre drawdown there?

23 A. I had measured that three-
24 centimetre drawdown with a large amount of data. I did
25 not have three data points over a two-day period which



1 is what I have indicated. The conclusion based on
2 three data points is somewhat weak.

3 Q. Mr. Petrie, I think we are in
4 agreement that there is a paucity of data for MB-OW-4
5 during the pumping test?

6 A. We are.

7 Q. In fact I would like to suggest
8 to you that the actual readings that were collected
9 from that hole were, at least in the first instance,
10 were collected by accident?

11 A. I could not speak to that.

12 Q. Let us do some detective work.
13 By someone mistaking MB-OW-4 for OW-4 which is what
14 they were calling HC2-86 for the purpose of the pump
15 test, were calling it HC2-86 for the purpose of the
16 pump test, calling it OW-4 ...

17 A. Can I just get that straight in
18 my head? OW-4 for the pumping test of the upper
19 granular unit was HC2-86, I believe that's what I've
20 just said.

21 Q. What I'm suggesting is someone
22 recorded some data at MB-OW-4, at least in the first
23 instance by accident, that is by mistaking it for OW-4.
24 The reason I suggest that to you is that if we look at
25 the data on page 11 of Exhibit M-727, we see that the



1 readings on the first day there, the Tuesday, were
2 taken by someone who crosses their sevens, whereas none
3 of the measurements at HC2-86 have their sevens
4 crossed.

5 A. There is one that says April the
6 7th down on the page but not through the pumping
7 interval.

8 Q. All I am suggesting, Mr. Petrie,
9 is that the reason that we likely have this paucity of
10 data with regard to MB-OW-4 is that it was mistaken
11 perhaps for the one they intended to do a full
12 monitoring scan on. All I'm suggesting, that in terms
13 of assessing the extent of the upper granular unit, Mr.
14 Petrie, it would have been prudent for Trow to have
15 included MB-OW-4 as a routine monitoring hole?

16 A. That I will agree with, yes.

17 Q. Nevertheless, with the limited
18 data available we should conclude that it is likely
19 that the unit extends across the site?

20 A. It is a possibility.

21 Q. Now, Mr. Petrie, I have another
22 question, line of questioning with regard to the upper
23 granular unit. Could you put up, please, the blowup of
24 C.2.4a from your report? I don't think it's been
25 marked.



1 Now, Mr. Petrie, this is a blowup from
2 Figure C.2.4a from your report, Exhibit B-618?

3 A. It definitely appears as that.

4 Q. Mr. Chairman, Mr. Petrie, you
5 should note it's not quite at the same scale as the
6 other blowup but it is a blowup.

7 A. Yes, it is not at the same scale
8 as the previous one being B-618-P85.

9 MR. ESTRIN: Mr. Chairman, I wonder if
10 we could mark this blowup of Figure C.2.4a of the CRA
11 report, Exhibit 618.

12 MR. LANCASTER: We will mark that the
13 same way as the other one.

14 MR. PETRIE: B-618. Does someone have a
15 page number for it?

16 --- EXHIBIT NO. B-618-P84: Blowup of Figure C.2.4a
of Exhibit No. B-618

17 MR. ESTRIN: Q. Mr. Petrie, can you put
18 back up your overhead of the upper granular unit? Now,
19 what we see on the blowup on the easel is cross-section
20 A-A?

21 MR. PETRIE: A. We do.

22 Q. Could you point that out on the
23 overhead, a hydrogeologic cross-section A-A'?

24 A. It is the one going top right,
25 bottom left.



1 Q. Mr. Petrie, what I am suggesting
2 is that the figure from your report, you see we have
3 highlighted in yellow what you have denoted as the
4 upper granular unit?

5 A. There is another piece over here
6 that is not so highlighted.

7 Q. We are looking at the major one.
8 I suggest to you that the figure from your report is
9 misleading with regard to the extent of the upper
10 granular unit as you show it, as you show it on the
11 figure on the easel not being continuous between CC-
12 OW-2 and HC2-86; correct?

13 A. Correct.

14 Q. Yet from your own plan it
15 obviously is continuous?

16 A. Yes.

17 Q. Mr. Petrie, would you take a
18 marker, please, and please correct that?

19 A. We note that we projected
20 boreholes onto the section, for example, HC5-84 is
21 offset 150 metres to the west. HC2-86 is offset 70
22 metres to the east.

23 Q. Right, exactly. Would it be
24 appropriate to draw the top and the bottom as you have
25 at the other locations and join them up with a line?



1 A. If that is what you're asking me
2 to do I can do it.

3 Q. Right, please. From HC2-86 to
4 CC-OW-2.

5 A. Thus?

6 Q. Yes, thank you. Now, can we look
7 at -- can you put that one down now for a moment and
8 put up the other enlargement, section B-B' which is
9 Exhibit B-618-P85? I am suggesting also that one is
10 fundamentally misleading with regard to the extent of
11 the upper granular unit if we accept your
12 interpretation. Again, go back and look at your
13 overhead on the wall and we are looking at section
14 B-B'. You will see that you have got it extending a
15 significant distance.

16 A. I'm sorry, could you repeat your
17 statement? B-B' extends across the site from the
18 bottom right to the top left.

19 Q. You have isolated these
20 particular chunks on B-618-P85 but on your plan view
21 you have denoted that it is continuous, at least
22 between about HC3 -- between about HC3-86?

23 A. One does not occur at HC3-86.

24 Q. I'm sorry, HC4-85.

25 A. We're projected CC-OW-2 onto the



1 cross-section, HC4-85 we've projected onto the cross-
2 section and HC5-84 we've projected onto the cross-
3 section.

4 Q. So CC-OW-2 begins at the left-
5 hand side of the figure?

6 A. CC-OW-2 is defined with the
7 materials we have interpreted as the upper granular
8 unit.

9 Q. I'm suggesting to be consistent,
10 Mr. Petrie, and not have that exhibit figure from your
11 text continue to be misleading you should join up the
12 yellow portions between CC-OW-2 and HC4-85.

13 A. It's not intended to be
14 misleading in any way, shape or form. The alignment of
15 the cross-section is provided. We note that wells are
16 extended into the line of the cross-section.

17 Q. I'm suggesting as you did with
18 the other one ...

19 A. You would like me to join those
20 up?

21 Q. Yes.

22 MR. HODGSON: Mr. Chairman, I have an
23 objection even if Mr. McQuaid doesn't. I want to know
24 if the witness' opinion is that the upper granular unit
25 extends through these boreholes for which he is being



1 asked by Mr. Estrin to draw lines. If it's his
2 opinion, fine. If it's not, it's just a yellow mark on
3 a piece of paper that some lawyer is going to confuse
4 with some meaningful evidence when we get to argument.
5 I don't know how it's going to help the Board. The
6 witness has projected wells into a cross-section. Is
7 he now giving evidence that those wells HC5-84 is the
8 one we're drawing through in both cross-sections? Has
9 HC5-84 got an upper granular unit or does it not? If
10 it does, by all means draw it in. If it does not, how
11 can it possibly help the Board to have a yellow line
12 drawn through a well where the upper granular unit
13 doesn't exist? It is just a meaningless exercise. You
14 may as well take a red pen and put a red cross on the
15 thing as well.

16 MR. ESTRIN: So my question is clear,
17 Mr. Chairman, what I'm asking the witness to do is make
18 the figure consistent with the extent of the upper
19 granular unit shown on the plan. I will ask the
20 witness to deal with what we see in the individual
21 boreholes in a minute but the plan view certainly shows
22 the UGU extending continuously in the vicinity between
23 the two boreholes, CC-OW-2 and HC -- whatever it is --
24 HC4-85. I am not suggesting that it is found in every
25 borehole that is projected onto it in between but that



1 his plan view would tell us that it is a continuous
2 unit but if one has regard for that figure, it would
3 appear not. His evidence is clearly that at least with
4 regard to the extension on the plan view it is
5 continuous. I am simply asking him to make the
6 isolated features consistent.

7 MR. HODGSON: Mr. Chairman, the witness
8 has chosen to put into evidence cross-sections with
9 boreholes projected in and a plan view. I don't know,
10 if one could do everything with one kind of thing why
11 would one do two kinds of things? He has got a plan
12 view that shows his interpretation of the upper
13 granular unit. He's got a cross-section that shows
14 something different. I don't see how it helps anybody
15 to now screw up the cross-sections by projecting all
16 the data from the plan view in a manner that simply
17 distorts the cross-section.

18 DR. KINGHAM: Yes, we do recognize the
19 difficulties. We do in fact recognize the difference
20 between a plan view and a cross-sectional view. We
21 would want to be careful that six months from now we
22 don't confuse one diagram with the other. We would
23 recognize that at HC5-84 the borehole information does
24 not show in the granular unit and thus the changes that
25 the witness is now making to the exhibits, we are going



1 to have to read in the context of the transcript that
2 says that these changes are intended to reflect a plan
3 view rather than intended to reflect what is found in
4 the borehole. I am not sure where this is leading us
5 because we do have the plans, Mr. Estrin. That is my
6 concern that when we come to review all of this
7 information we don't interpret from these latter two
8 cross-sections that this represents the findings of the
9 granular unit at a well in which it is not shown on the
10 geologic information. That is the problem.

11 MR. ESTRIN: Perhaps, Mr. Chairman, what
12 we should have done to Exhibits B-618-P85 and P84 is
13 put a note on them saying "See transcript of April
14 18th" in which it is observed that the plan view is the
15 one that gives us the better interpretation of the
16 extent of the upper granular unit.

17 MR. McQUAID: You can make that point in
18 argument.

19 MR. ESTRIN: Mr. Chairman, it is exactly
20 for the reason that we six months from now or hopefully
21 sooner, if we all forget, these things may be flashed
22 at us. That one may not be. It is for that particular
23 reason I think it is appropriate that some notation be
24 made by Mr. Petrie on these figures to indicate that
25 having regard to the plan view one would indeed show



1 the upper granular unit not being isolated features as
2 is indicated. That is really the point.

3 DR. KINGHAM: Make a note "See plan view
4 also".

5 MR. ESTRIN: Make a note "See plan and
6 transcript of April 18th" and I'll be happy.

7 DR. KINGHAM: Perhaps relate both of
8 these cross-sections to the plan view and the non-
9 existence of a found granular unit at that HC5-84 might
10 help us to remember the relationships when the time
11 comes. I think we will remember it now in any event.

12 MR. PETRIE: Could you suggest how I
13 might make that notation?

14 DR. KINGHAM: Perhaps you can go back
15 and perhaps just put an asterisk beside -- in red just
16 beside that point and put a footnote either on the
17 bottom or at the top.

18 MR. PETRIE: "Ignoring well record for
19 HC5-84."

20 DR. KINGHAM: Something like that.

21 MR. PETRIE: "See Exhibit B-632" and I
22 will put "(page 81 B-617)." Shall I indicate a date as
23 well, April the 18th?

24 MR. ESTRIN: Q. Yes. Could you do the
25 same thing with the other one, please, join it up in



1 yellow and put the same asterisk?

2 MR. PETRIE: A. On those Exhibits
3 B-618-P84 and B-618-P85 I have added additional yellow
4 colourings for the upper granular unit and noted with a
5 red asterisk "Ignoring well record for HC5-84. See
6 B-632 (page 81 B-617) April 18, 1988."

7 Q. Now, Mr. Petrie, let us put up,
8 if we could B-618-P84. Now, that is the A-A' cross-
9 section. You have projected between HC2-85 I believe
10 and HC3-85 ...

11 A. HC2-85 and HC3-85, yes.

12 Q. Along that line, Mr. Petrie, you
13 do have the upper granular unit; right?

14 A. Yes, that is correct.

15 Q. And the only reason that you
16 didn't join it, as I understand your original -- or
17 your evidence is that you have this borehole HC5-84
18 which is how far away from that line?

19 A. It is probably indicated on the
20 section, 150 metres.

21 Q. So really that is why I suggested
22 that section -- that figure was misleading. You
23 projected from 150 metres away not to join those,
24 whereas you show it plainly ...

25 A. I do. Had we projected HC6-84 on



1 this section we would similarly have had a break in the
2 system but that is correct. For the alignment I have
3 shown and for the boreholes I have shown, you are
4 correct.

5 Q. Mr. Petrie, I would like to talk
6 about HC5-84, this famous hole that is being used to
7 denigrate the continuance of the upper granular unit.
8 That is the one you are relying on in both cross-
9 sections?

10 A. It is a borehole at which we did
11 not encounter the upper granular unit.

12 Q. Mr. Petrie, and you are relying
13 on it to negate the continuance of the upper granular
14 unit on both of those figures?

15 A. That -- I beg your pardon -- on
16 those figures specifically.

17 Q. Let us talk about that. That
18 one, Mr. Petrie, was one of the 1984 series which was
19 not continuously sampled; right?

20 A. Correct.

21 Q. You will recall perhaps that
22 Dr. Charlesworth discussed that matter during his
23 evidence and was of the opinion that the UGU could
24 easily have been missed in that borehole such as you
25 and I, Mr. Petrie, discussed last Thursday how it could



1 have been missed in HC6-84?

2 A. I recall that discussion, yes.

3 Q. Now, looking at your section B-B'
4 on the overhead -- do you have the log out?

5 A. Yes, I do.

6 Q. Looking at your section B-B' on
7 the overhead we can see that we would expect to find
8 the top of the upper granular -- I'm sorry -- go back
9 to the blowup, please, on the B-B' cross-section.
10 Where is HC5-85? Can you point out HC5-84, I'm sorry?

11 A. It's in the middle of the figure,
12 being B-618-P85 there is a red asterisk.

13 Q. We would expect to find the top
14 of the upper granular unit if it is there at 172
15 metres?

16 A. That is correct.

17 Q. If you look at the borehole log -
18 -I see you have it out in front of you -- for HC5-84?

19 A. Yes, I have it.

20 Q. That log is in H-39A. We see at
21 the top of the page the depth of ten metres is at an
22 elevation of 174.8?

23 A. Correct.

24 Q. Thus an elevation of 172 metres
25 would be at 2.8 metres below that, i.e., at about 13.2



1 metres, 13.2 metres depth?

2 A. Is an elevation of -- what did
3 you say?

4 Q. We see at the top of the page a
5 depth of ten metres is at an elevation of 174.8?

6 A. Correct.

7 Q. Thus an elevation of 172 metres
8 which we are looking for would be at a point 2.8 metres
9 below that?

10 A. Correct.

11 Q. i.e., 13.2 metres on this log?

12 A. No, I believe it would be 12.8 on
13 this log.

14 Q. I'm sorry, 12.8 on this log. If
15 we look to the right of the page on this log, the
16 split-spoon samples we see what, that there is no
17 sample at that depth?

18 A. Correct.

19 Q. Indeed the sampling throughout
20 this zone is rather poor?

21 A. At the elevations you have in
22 mind I believe it is not continuous, correct.

23 Q. More than that, from the bottom
24 of the first split-spoon sample on the page at a depth
25 of 11 metres to the top of the third split-spoon sample



1 at an approximate depth of 13.7 metres is 2.7 metres.

2 In other words, there is a distance of 2.7?

3 A. Correct.

4 Q. In that depth we only have split-
5 spoon sample SS-8; correct?

6 A. Correct.

7 Q. Which is less than 20 centimetres
8 deep?

9 A. Correct.

10 Q. So we have 20 centimetres sampled
11 out of 270 centimetres, i.e., about 7.4 per cent in
12 round figures?

13 A. Over the vertical interval you
14 have described, assuming your mathematics, yes.

15 Q. If we look at the description for
16 this whole portion of the borehole, Mr. Petrie, which
17 is at the top of the page, we see these old words "May
18 be reworked lacustrine material" the very same words
19 that appeared in HC2-86 at that elevation?

20 A. Can I just refer back to HC2-86?
21 Could you direct me to where it is on HC2-86?

22 Q. You will find it on ...

23 A. HC6-84.

24 Q. At that depth we were interested
25 in it says it "May be reworked lacustrine material." I



1 have my finger on it.

2 A. It does indeed say that, yes.

3 Q. I'm sorry, the same description
4 which was in 6-84?

5 A. That is what I believe you're
6 saying, yes.

7 Q. That is what I meant to say. So,
8 I am suggesting, Mr. Petrie, that what we may be seeing
9 here is that a mythical, I'm sure it did exist or she
10 did exist at one time, that hypothetical field
11 personnel's interpretation of what was in fact the
12 upper granular unit. In other words, in 1984 they
13 didn't have any cause to think there was this famous
14 upper granular unit on which we are spending so much
15 time and effort. They had inadequate samples to
16 reasonably identify the fact. To be frank, they simply
17 weren't expecting to find it because it had not been
18 identified in any of their preceding holes but here we
19 have the same descriptions, "May be reworked lacustrine
20 material" at the same depth in both holes. I am
21 suggesting to you that there is some cogent evidence
22 here to understand why there is no particular
23 description of upper granular unit at either of these
24 locations but we still have the same notations.

25 A. I cannot speak to the mythical,



1 as you use it, field person. Lacustrine materials are
2 typically clays or silts, fine-grained material
3 deposited in standing water. Reworked lacustrine
4 materials typically means that the bedding or the
5 standing water structured within them have been
6 modified in some fashion due to the action of moving
7 water. Typically they are fine-grained materials. I
8 do note the words are there and one could consider they
9 may be at the elevations you describe. I also note
10 that they are encountered at the other borehole, being
11 HC6-84 to which you made reference. Reworked
12 lacustrine material to me is not sand and gravel. As I
13 indicated the other day when we were discussing this I
14 find it difficult to believe that someone would drill
15 through a metre of sand and gravel interbedded within a
16 till unit and not note it in some fashion. The upper
17 granular unit is described as sand and gravel and the
18 calculated hydraulic properties for that unit are
19 consistent for sand and gravel. Reworked lacustrine
20 till is likely to have permeabilities of 10^{-5} or less,
21 low permeabilities, and not to be hydrogeologically
22 significant.

23 Q. Mr. Petrie, you have to speculate
24 when you say what he was describing.

25 A. You are also speculating, yes.



1 Q. Mr. Petrie, and secondly, what
2 the driller has told us at both locations at the same
3 elevation is that there is something different in the
4 till there?

5 A. Excuse me, it's not the driller
6 that tells us that, it is the field person and it is
7 not specific to those elevations. He is describing a
8 silty sand till as greyish, wet, brown, hard silty
9 laminations and it may be reworked lacustrine material.
10 That relates to the whole vertical interval there.

11 Q. Mr. Petrie, there is something
12 similar and something different in both locations.

13 A. Then I misunderstood you. I
14 thought you were indicating that the reworked
15 lacustrine material was specific to an elevation. I am
16 noting he is describing it over approximately five
17 vertical metres, the same description. I suspect again
18 that had he encountered sand and gravel somewhere he
19 would have felt there were some differences within the
20 system and maybe more specific or focused with respect
21 to elevation addressing those differences. He has used
22 the same set of words for a five-metre interval.

23 Q. Mr. Petrie, with a 7.4-metre
24 sample recovery you are really on a very poor base to
25 deny what could well be there.



1 A. We are talking reworked
2 lacustrine material, is that consistent with sand and
3 gravel for the upper granular unit and I am saying, no,
4 it is not.

5 Q. I understand you're saying it is
6 not but you're also negating a whole theory.

7 A. I'm sorry, what theory am I
8 negating?

9 Q. That an adequate sampling program
10 it might have ...

11 A. A continuous sampling program
12 would give you a better definition of that I would
13 agree.

14 Q. I want to continue with HC5-84,
15 Mr. Petrie. Your position is there is no geological
16 evidence at HC5-84?

17 A. That is correct.

18 Q. Your position is there is no
19 geological evidence and there is no hydrogeological
20 evidence to indicate it is the upper granular unit?

21 A. Correct.

22 Q. You may recall that Trow felt a
23 bit ambivalent about that. They showed it as being
24 present on one of their cross-sections but absent on
25 another one?



1 A. I believe Mr. Sobanski did not
2 indicate that was ambivalence on his part but he felt
3 that there were some inconsistencies in the
4 presentation of the data. I believe that he felt that
5 his line that he indicated on his Drawing 18 was what
6 he considered as the hydrogeologically significant
7 portions of the upper granular unit.

8 Q. Mr. Petrie, on Trow's drawing of
9 the upper granular unit they show it to be present.
10 Let us look at your own overhead.

11 A. They do, that is their
12 interpretation regarding the hydrogeologically
13 significant portion. I believe Mr. Sobanski wasn't
14 firm when it was pointed out to him that at HC5 it was
15 not encountered and his line interpreted it to be more
16 extensive.

17 Q. To summarize, Trow has it on one
18 cross-section and not another but they have it in their
19 interpretation of the upper granular unit, that's what
20 they have?

21 A. I recall something to that
22 effect.

23 Q. Now, given Trow's own
24 interpretation of the extent of the unit over in that
25 area don't you consider it would be prudent to monitor



1 the deep piezometer in HC5-84 during a pump test of the
2 upper granular unit in light of your -- turn around, if
3 you would, and I'll show you what I'm talking about.
4 Can you point out HC5-84?

5 A. It is the one that has the
6 asterisk on it, B-618-P85.

7 Q. Your cross-section shows that
8 piezometer in HC5-84 to be sitting at the elevation at
9 which one would expect to find the UGU if it was there;
10 correct?

11 A. Correct.

12 Q. Mr. Petrie, wouldn't it be useful
13 based on your own master's project paper and other
14 statements you made about the reliability of pump tests
15 to look and see what response, if any, was had in that
16 piezometer during the pump test?

17 A. Most definitely.

18 Q. Have you done that?

19 A. I've gone through the data
20 available to me. I do not recall reading for that
21 piezometer.

22 Q. Did you have trouble reading the
23 data?

24 A. Yes, I did.

25 Q. Did you ask Mr. Sobanski about



1 it?

2 A. I received this data just last
3 week. One question I addressed to him he could not
4 answer and he referred it back to his office. I have
5 not had an opportunity to ask him additional questions.
6 I understand that Mr. Hodgson has said he will
7 undertake to provide the original data for those
8 sections which are difficult to read. We will then be
9 in a position to be able to read it.

10 Q. Mr. Petrie, do you know if Trow
11 monitored HC5-84?

12 A. By their admission I do not. I
13 believe the question was put to them and they were
14 vague to that fact.

15 Q. Can you turn to page 12 of
16 Exhibit 727? That is the new pump test data and if
17 your copy is like ours the borehole number is not
18 really all that legible.

19 A. In my copy it's not legible at
20 all.

21 Q. But we can tell something about
22 the borehole. First of all I will give you the copy
23 that was provided to us from Trow and from which all
24 the others were made. There is something at the top of
25 the page that would seem to indicate that it is HC



1 series and a 4, just a notation "HC", it has been cut
2 off.

3 A. It looks like HC and the last
4 number there looks like a four.

5 Q. You can't tell any more at this
6 point until we get the original?

7 A. That is correct.

8 Q. Now, I think we can go on. That
9 sheet, page 12 indicates there are two piezometers,
10 shallow and deep?

11 A. It does.

12 Q. Suggesting it is one of the 1984
13 series?

14 A. Yes, it does suggest that.

15 Q. It is only the 1984 series that
16 had two piezometers, is that our logic?

17 A. Only the 1984 series had two
18 piezometers. The 1984 ones were called shallow and
19 deep initially and then got called 1 and 2 or something
20 like that.

21 Q. Let us look at the water level in
22 the deep piezometer as shown on page 12. It is close to
23 three metres. We are looking at the first line.

24 A. It says "Measured from gnd" which
25 I understand to be ground and I see an elapsed time of



1 zero, yes, 2.94 for the deep piezometer.

2 Q. The water level in the shallow is
3 almost what, three metres below ground level?

4 A. That is correct.

5 Q. Let us look at the stick-up of
6 the pipe. What is a stick-up zone?

7 A. I'm sorry, where am I looking at?
8 The stick-up ...

9 Q. Just define the term.

10 A. Stick-up is a pipe, not that the
11 piezometer protrudes from the ground, above ground
12 level.

13 Q. Mr. Petrie, if you look at the
14 difference between the data in the first two lines, the
15 third and fourth lines, I am suggesting that we can
16 determine that the stick-up is probably about 1.5
17 metres or less.

18 A. You are subtracting the third
19 line where it says 1230 and then D4.38 from the first
20 line of 2.94. It sounds like 1.42.

21 Q. Right, and the stick-up for the
22 shallow is a little less, about 0.7 metres?

23 A. Zero point six-seven, yes.

24 Q. If we can look at the first page
25 of Appendix 5 of Exhibit H-39A ...



1 A. Appendix 5?

2 Q. Yes, it is the first page of that
3 appendix, the groundwater elevation data for April 15,
4 1986. I am suggesting that HC5-84 is the only hole
5 which appears to fit this description. The stick-up is
6 the top elevation minus the ground elevation. I am
7 looking at HC5-84 and the top elevation and ground
8 elevation and the difference between those two is 1.4
9 metres?

10 A. That is correct.

11 Q. And the difference between the
12 shallow, between 185.45 and 184.8 is 0.65 metres?

13 A. Yes, it is.

14 Q. We can also check the static
15 water level?

16 A. We can.

17 Q. We see that the static water
18 level in the deep piezometer was 3.2 metres?

19 A. As it is recorded here, yes.

20 Q. And the shallow was 0.34?

21 A. Correct.

22 Q. Which are close to the estimates
23 which we read from looking at page 12 of the pump test
24 data?

25 A. That is correct.



1 Q. So, Mr. Petrie, I suggest that
2 without even having a witness here from Trow it seems
3 reasonable to assume that the data on page 12 of
4 Exhibit M-727 is for HC5-84?

5 A. It would definitely be worthwhile
6 having a clarification to that effect.

7 Q. I think you would agree it seems
8 reasonable to work with this data in the absence of
9 something to the contrary. We had three pieces of some
10 numbers that would confirm this?

11 A. Yes, it could be reasonable.

12 Q. Let us look at the data in the
13 deep piezometer and on page 12 of Exhibit M-727.

14 A. I have it.

15 Q. With the stick-up, the deep
16 piezometer has that stick-up of 1.4 metres. The depth
17 of the water from the measuring point at time zero is
18 2.94 plus 1.4 or 4.34 metres?

19 A. Sorry, could you say that again?
20 I'm not sure what you meant.

21 Q. If you look at the first line on
22 this page 12 ...

23 A. Where it says 12.94?

24 Q. Two point nine-four.

25 A. I beg your pardon, 2.94.



1 Q. And you add the stick-up of 1.4
2 metres which we just calculated ...

3 A. Right.

4 Q. ... you get the static water
5 level of 4.34 metres?

6 A. Yes.

7 Q. If we go down the page to the
8 time 2810, before the test ended, the depth to water
9 was 4.575?

10 A. That appears to be the case.

11 Q. That is a drawdown of 23
12 centimetres?

13 A. Relying on your mathematics, yes.

14 Q. In fact it seems to continue to
15 fall to a depth of 4.62 at time 3060 or a drawdown of
16 28 centimetres?

17 A. Correct.

18 Q. Mr. Petrie, what I am suggesting
19 to you is that this indicates the existence of the
20 upper granular unit at HC5-84.

21 A. I am looking at this for the
22 first time and we still have to confirm from Trow if we
23 can that this is indeed HC5-84. I note that HC5-84 is
24 about 250 metres from PW-2. I think it would be a
25 worthwhile exercise to use the hydraulic parameters



1 developed for PW-2 and calculate what the drawdown
2 should have been at this well. I do note it appears to
3 have continued to draw down after pumping stopped.

4 Q. That is like 2-86?

5 A. HC2-86 or the HC5-84 is
6 significantly closer.

7 Q. But HC2-86 continued to do the
8 same thing and everyone agrees that HC2-86 is part of
9 the upper granular unit as determined by the pumping
10 test?

11 A. Correct.

12 Q. So do you want to think about
13 this?

14 A. Well, I need one to confirm with
15 Trow.

16 Q. Assuming that that in fact is the
17 data for HC5-84, I am suggesting to you that the data
18 we have just discussed does prove the existence of the
19 upper granular at HC5-84.

20 A. I suggest it would be prudent to
21 evaluate this data, assuming it is HC5-84, with respect
22 to the hydraulic parameters developed for the upper
23 granular unit and compare the calculated drawdown with
24 the measured drawdowns. There are measured drawdowns
25 at this installation, that is correct.



1 The point perhaps that is also of
2 pertinence is that if we have fine-grain material
3 through there that is laterally continuous with the
4 upper fine grain -- I beg your pardon -- the upper
5 granular unit, some measure of drawdown in fine-grain
6 material does not demonstrate continuity of the upper
7 granular unit. It demonstrates hydraulic response as
8 it also moves through the fine-grain material
9 presumably laterally in the context we are talking.

10 Q. Mr. Petrie, does it matter?

11 A. Most definitely. If we are
12 dealing with much more fine-grain material, the amount
13 of water or the rate at which the water would move
14 would be, perhaps orders of magnitude lower than the
15 sand and gravel deposits.

16 Q. Mr. Petrie, you concluded as a
17 result of your pumping test data at Waterloo that
18 something that was part of the aquitard should really
19 be considered as part of the aquifer. I am really
20 suggesting to you that even if you don't want to
21 speculate that it's not part of the upper granular unit
22 at HC5-84, there was definitely the response and based
23 on your own work it should be considered part of the
24 aquifer?

25 A. With respect, your reference to



1 my project, the drawdowns we had in mind were 10 metres
2 at two installations and five at another.

3 Q. That is because the aquifer drew
4 down significantly?

5 A. I considered that stony till was
6 behaving like an aquifer. Now, five and ten metres of
7 drawdown relative to 11 metres of drawdown in the
8 underlying aquifer, there is a significant drawdown.

9 Q. Mr. Petrie, you can't compare ten
10 metres of drawdown at Site D to Waterloo because your
11 aquifer is only one metre thick.

12 A. You drew the reference,
13 Mr. Estrin. Would you please repeat your question?

14 Q. First of all, let's get it
15 straight; you can't compare a five or ten-metre
16 drawdown at Waterloo to here because the aquifer at
17 Waterloo was ten metres and here the maximum you show
18 is to be about one metre?

19 A. The amount of drawdown was
20 independent of the aquifer thickness provided you
21 maintain saturated conditions.

22 Q. The fact that one of the
23 essential elements of your thesis project was to
24 demonstrate that what was formerly considered part of
25 the aquitard was part of the aquifer, it was done



1 through pumping test response similar to this?

2 A. We were dealing with quite a
3 different flow field. We were looking at vertical flow
4 that replenished an aquifer. We knew the aquifer
5 behaved as a leaky aquitard because the type of curves
6 from the aquifer indicated that. We're looking at a
7 flow field where we knew there was a degree of vertical
8 leakage. That was part of the program for my
9 university project. With respect to the data here it
10 does not relate to the Waterloo case in any way, shape
11 or form. Perhaps if you could rephrase your question,
12 I misunderstood you.

13 Q. Mr. Petrie, we discussed drawdown
14 data for another hole this morning and you -- it was
15 3.5 centimetres. Your first tendency was to dismiss it
16 as being something other than drawdown.

17 A. I beg your pardon. We also noted
18 there were only three data points.

19 Q. That was your first tendency and
20 it remains your position that it is something other
21 than drawdown in that other hole we were discussing
22 this morning?

23 A. Based on three data points it
24 cannot ...

25 Q. Now I'm giving you how much



1 drawdown, we're talking about 23 centimetres.

2 A. Yes, that is definitely more
3 positive than three centimetres and I note there are
4 more than three water level readings there.

5 Q. And you still wish to take the
6 position that that can't be the upper granular unit, it
7 is not affected by the pumping tests?

8 A. That's not my position at all.
9 You did not hear me. I indicated that I would like to
10 do some calculations and see if this drawdown, being
11 0.235 of a metre, is consistent with the hydraulic
12 parameters calculated for the upper granular unit at
13 the pumping wells or those wells that responded more
14 significantly. If it is not I would still suggest it
15 reflects a response to pumping but we are looking at
16 very fine-grain materials for which I believe they are
17 not hydrogeologically significant, vis-a-vis the upper
18 granular unit.

19 Q. Mr. Petrie, what if you had a
20 piezometer at that depth, 172 metres, at HC5 -- HC6-84?
21 We might have had the same response?

22 A. If the piezometer was monitored
23 we might have and we might not have.

24 Q. But where we do have this and I
25 guess, Mr. Petrie, if I now dug up some new data for



1 HC6-84 with a piezometer at the right depth I guess
2 your first reaction would be "Oh, no, that can't be the
3 upper granular unit there"?

4 A. Excuse me, Mr. Estrin, if you
5 have the data I would like to see it and secondly I am
6 noting that here we have ten data points for which
7 there is a more uniform pattern. These are the three
8 data points with only a three-centimetre change. I
9 also pointed out to you that in a non-pumping event or
10 a pumping event in another aquifer they also had a
11 three-centimetre change. One has to separate response
12 to pumping from background fluctuations. Three data
13 points does not give me any comfort to that effect.
14 The data you provided me on H-727, page 12 definitely
15 looks like a response to pumping in some fashion. I
16 indicated that. I would like to check it against the
17 hydraulic parameters developed for the pumping test.
18 Were we to get the same permeabilities, the
19 permeabilities as I recall from the pumping test were
20 in the order of 10^{-2} . Were we to get the same
21 hydraulic conductivities from this data, yes, it would
22 be very fair to conclude the upper granular unit was
23 continuous to this point. If we were to get calculated
24 hydraulic conductivities significantly lower then the
25 question is, is it reasonable to conclude that



1 permeable sands and gravels extend to this point, this
2 point being HC5-84. That is another question.

3 Q. Mr. Petrie, I guess you will be
4 able to check that over night?

5 A. Yes, I will.

6 MR. ESTRIN: Mr. Chairman, would this be
7 an appropriate point?

8 MR. LANCASTER: Thank you.

9 --- Recess

10 MR. LANCASTER: Please be seated.

11 MR. ESTRIN: Q. Mr. Petrie, I wonder if
12 we could go back to the cross-section I had you draw or
13 the schematic of the Waterloo site that you were
14 investigating. It is probably behind M-696, I am not
15 sure.

16 Now, just to refresh our recollection,
17 in the Waterloo investigation that you did, you had the
18 aquifer at depth and you were -- your pump test gave
19 you results with regard to two tills, the Maryhill Till
20 and the Catfish Creek Till, the Catfish Creek Till
21 being the lower till and closest to the actual aquifer?

22 MR. PETRIE: A. Correct.

23 Q. Just looking at page 26 of your
24 thesis project again, Exhibit M-707, there is just one
25 line I am going to read out.



1 A. I'm sorry, the page number?

2 Q. Page 26.

3 A. Yes, I have it.

4 Q. As a result of doing the pump
5 test essentially you concluded at page 26 and in other
6 places -- I am looking in the middle of the page:

7 "The Catfish Creek Till acts more like
8 an aquifer than an aquitard. It should
9 be considered as part of the aquifer."

10 A. Correct.

11 Q. That was as a result of the
12 responses of piezometers in the Catfish Creek Till to
13 the pumping test in the aquifer below?

14 A. Correct. For purposes of
15 analysis that was necessary because the method of
16 analysis I was using could only examine an
17 aquifer/aquitard system. So if I was looking at the
18 Maryhill Till I would have no means of doing the
19 analysis using the methods I had at my disposal. I had
20 to consider the lower aquitard as an aquifer and I
21 noted there were some significant responses within that
22 system.

23 Q. Now, let us look at, if we could,
24 Exhibit H-174, the earlier raw pump test data at page
25 13 of that. I now want to discuss the lower till,



1 Mr. Chairman. I am now turning my attention to the
2 lower till at Site D for a moment.

3 A. Which page of data?

4 Q. Page 13. Mr. Crutcher, maybe you
5 could put it back up, the blowup of section A-A'. Now,
6 if you look at page 13 of Exhibit 174 that gives water
7 level data for OW-1 or HC2-85 during the pumping test?

8 A. OW-1 and, yes, I checked that with
9 Mr. Sobanski, he is of the opinion that is HC2-85. We
10 can also glean that from the drawdown data in the
11 appendices.

12 Q. Could you -- do you want to check
13 something?

14 A. I get a little confused with this
15 data sometimes.

16 Q. I am sure you are not the only
17 one.

18 A. The lower granular unit -- I
19 think we should be at -- I'm confused again. I'm not
20 sure whether it is HC4-85 or HC2-85.

21 Q. I am directing my attention to
22 the water level data for HC2-85 during the pumping
23 test.

24 A. You referred me to page 13 which
25 is called OW-1 and you understand that to be HC2-85?



1 Q. Yes.

2 A. I would like to be sure before we
3 start.

4 Q. Mr. Petrie, if you look on that
5 graph, the Theis graph, you will see in Exhibit H-39,
6 you will see OW-1 noted as HC2-85.

7 A. Excuse me, I thought you were
8 talking about the lower granular unit.

9 Q. I didn't say that. I'm talking
10 about the lower till.

11 A. That's what you said. Now I am
12 with you. So we're still talking the upper granular
13 unit pumping test?

14 Q. Right. So could you point out on
15 the exhibit behind you, Exhibit B-618, the blowup of
16 A-A', point out the location of HC2-85?

17 A. HC2-85 is located approximately
18 in the centre of the cross-section. It has three
19 piezometer installations, No. 1 being at the bedrock
20 contact essentially in some materials being described
21 as the gravelly till and 2 being in the upper granular
22 unit or part of the upper granular and the third a
23 standpipe in the upper till.

24 Q. What I would like you to do is
25 look at page 13 of Exhibit H-174 and I guess you will



1 also have to look at pages 12 and 13. We see the
2 drawdown data for piezometer No. 1?

3 A. I see an entry for No. 1, yes.

4 Q. And we see the data at the bottom
5 of the page, 1.92?

6 A. One point nine-two, 1.93.

7 Q. And it continues and the last
8 reading is 2.335?

9 A. Correct.

10 Q. The difference or the drawdown in
11 that piezometer was 0.415 metres. Could you just check
12 that for me?

13 A. I think you were taking the
14 reading after 300 minutes as the static.

15 Q. It was at least that much?

16 A. Correct. I can check it as you
17 requested. Zero point four-one-five, as you say, at
18 least.

19 Q. I wonder if you would colour in
20 the first piezometer on that blowup, Exhibit B-618-P84
21 in blue.

22 A. The bottom piezometer for HC2-85
23 I have coloured in in blue.

24 Q. Could you mark in beside that in
25 a -- as long as it isn't red -- the drawdown?



1 A. Zero point four-one-five.

2 Q. You better put metres.

3 A. Metres.

4 Q. Thank you. Now, can we look at
5 Exhibit H-84, the Weir and Foulds interrogatory and
6 then Addendum B?

7 A. Yes, I have it.

8 Q. I think we can see that the
9 drawdown in OW-3, which was Comcor-2, CC-OW-2, we can
10 see the drawdown there reported was 1.76 metres?

11 A. Correct, we can.

12 Q. Could you colour in that
13 piezometer and write in 1.76 metres? Can you confirm
14 for me that that piezometer No. 2 is located within the
15 lower till extending up into the upper till?

16 A. I can take the information as
17 provided in the Comcor documents.

18 Q. Why don't you look at your own
19 drawing?

20 A. That's where I took it from. I
21 thought you asked me to confirm it.

22 Q. I thought you would take your own
23 drawing as accurate but, fine.

24 A. I am assuming it is but when you
25 said "confirm" I was going back to the original data.



1 From the cross-section B-618-P84, yes, that screen is
2 within the upper portions of the lower till and into
3 the upper till. That stratigraphic delineation is
4 provided from Comcor's CC-2.

5 Q. I wonder if you would write at
6 the bottom of that exhibit what those numbers are
7 indicating just so we have a legend in other words.
8 Something to indicate those numbers in piezometers 1
9 and 2 are drawdown occurring during pumping test of the
10 upper granular unit.

11 A. Drawdown during UGU pumping.

12 Q. Yes. Mr. Petrie, what I am
13 suggesting to you when we look at that data is we see
14 drawdowns occurring, first of all, in a gravelly unit
15 below the lower till and also at the top of the lower
16 till as a result of the pumping test?

17 A. With respect to your first
18 comment, gravelly till below the lower till, we were
19 calling it within the lower till but it is at the basal
20 portions. That is what those numbers say. With
21 respect to your second statement at CC-OW-2 given the
22 well-screen elevations as provided, I agree, yes, that
23 is what those numbers say.

24 Q. Therefore, Mr. Petrie, what I
25 suggest we have at Site D is a situation similar to



1 that which you found for the Catfish Creek Till and
2 that is that as a result of a pumping test drawdowns
3 were occurring in a unit which would be expected to be
4 our protective layer and in light of this information a
5 conservative hydrogeologist would be led to the
6 conclusion that the lower till should be considered as
7 part of the aquifer unit?

8 A. No, I disagree.

9 Q. Well, Mr. Petrie, we do have
10 significant drawdowns occurring both in the top of the
11 lower unit and in the bottom of the unit even though
12 the pump test is in this supposed lens?

13 A. The first portion of your
14 statement referenced the work at Waterloo. What we had
15 there at the Waterloo site was that when we pumped the
16 aquifer we saw the effects of vertical leakage in the
17 response of the aquifer. In other words, because
18 additional water is being input into the system, to put
19 it in simple terms, the type or the drawdown, the
20 pattern of drawdown in the aquifer deviated from the
21 standard curve. It deviated in fact in a manner that
22 showed there was additional water put into the system.
23 To put it simply, that additional water was from
24 vertical leakage from the materials or the till units
25 that bound the aquifer, bound the top and/or bottom.



1 What we have for the upper granular unit pumping test
2 is a drawdown curve which deviates in the opposite
3 manner, i.e., that there is not continuity within the
4 system. We get more drawdown than we would expect.
5 That statement was made with reference to the pattern
6 of drawdown one can see in the appendix to the Site D
7 report. Just taking the -- I haven't numbered my
8 pages, about the fourth page in. I shall do that now.
9 Numbering in Appendix 10 -- have we numbered Appendix
10 10 before? Taking the title page to Appendix 10 as
11 page 1 and the first graph in Appendix 10 is then page
12 2, 3, 4. The fifth page is then entitled "Pumping Test
13 No. 2 Upper Granular Unit PW-2." What I notice on
14 those graphs with reference to OW-1 and OW-2 being the
15 far left ...

16 Q. Can we make sure we're talking
17 about the same thing? What page number are you using?

18 A. I have called it No. 5.

19 DR. KINGHAM: That is the colourful
20 page.

21 MR. PETRIE: I coloured an overhead, not
22 my page. With reference to the colourful page, looking
23 at the drawdown curve, we see as evidenced by the
24 for the left two series of installations being OW-1 and
25 OW-2, we note that the two curves converge. If one was



1 to extrapolate in a straight line approximately from
2 where those two curves converge and just move further
3 to the right you will note that the data points lie
4 above that line. Above that line indicates that there
5 is more drawdown in the aquifer than one would have
6 expected by extrapolating that curve. More drawdown in
7 the aquifer implies that there is not a pronounced
8 vertical leakage. To the contrary, there is not
9 continuity in the system in some fashion. Were we to
10 have vertical leakage as evidenced by the water levels
11 recorded from HC2-85, piezometer No. 1 and CC-OW-2,
12 whichever piezometer that is, if that was to indicate
13 significant vertical leakage then it is my opinion that
14 the water levels in the aquifer would not have drawn
15 down so far and this data, this set of data would
16 probably plot on or -- I beg your pardon -- plot below
17 the extrapolated line I just asked you to identify.
18 Then comes the difficulty, what do those data points
19 mean at HC2-85 and CC-OW-2? With respect to the first
20 one, HC2-85, I note it is below the upper -- I beg your
21 pardon -- it is below the lower granular unit. It is
22 also my understanding that piezometer 1 and piezometer
23 2 in that borehole are located within the same
24 borehole, i.e., the borehole is drilled to depth, in
25 this case to the top of rock. One piezometer pipe is



1 installed, some materials to backfill the hole to an
2 elevation, within that annulus a second pipe is
3 installed. It is possible there is a measure of
4 vertical leakage within the borehole. This is
5 speculation on my part but I do note that a number of
6 hydrogeologists do not recommend that two pipes be
7 installed in one borehole because there is always a
8 degree of speculation regarding vertical connection
9 within a borehole. So it is my opinion that the record
10 at HC2-85, piezometer No. 1, may be erroneous. It is,
11 however, obvious that the data provided shows there is
12 definitely a water level change at that point. I
13 believe it reflects vertical connection within the
14 borehole.

15 At CC-OW-2 the picture is less clear.
16 Stratigraphic data is provided for this borehole, being
17 CC-2. A well screen at depth is provided. I note that
18 that depth is consistent with the depth as measured by
19 Trow in the field. It is probable that this
20 installation lies very close to the upper granular unit
21 or it is indeed very close to the first installation of
22 CC-OW-2 and perhaps there is some vertical continuity
23 in the system. However, the well does appear to
24 respond more like an aquifer well rather than an
25 aquitard well. I make that statement with reference to



1 the pattern of drawdown and, I believe, the recovery at
2 that well.

3 Can I make an additional statement?
4 HC2-85, No. 1 is below the lower granular unit. I
5 suspect we should have seen more pronounced responses
6 in the lower granular unit were the response at HC2-85,
7 piezometer No. 1 to reflect real responses within the
8 system. I am not sure we have the data to be able to
9 work that through.

10 MR. ESTRIN: Q. All right, but,
11 Mr. Petrie, you will agree that the most important
12 issue that we have recognized here is that significant
13 drawdown in the piezometer between the upper and lower
14 till?

15 MR. PETRIE: A. At CC-OW-2, yes.

16 Q. I think I heard you say that
17 looking at the data that indicates it should be
18 regarded as more like the aquifer than the aquitard?

19 A. Correct, I believe it reflects
20 some sort of continuity with the aquifer materials.

21 Q. And the fact when you referred to
22 page 5 of the Theis curve a few minutes ago, the
23 conditions that you were noting at that time, more
24 drawdown, et cetera, that is equally consistent with
25 the theory that you have put forward before about a



1 boundary to the east?

2 A. Yes.

3 Q. That boundary to the east can
4 have a masking effect on what is really going on?

5 A. Perhaps it could. I could also
6 note that the data provided in Exhibit H-727, on page 4
7 of that exhibit, the data set I am discussing is for
8 the lower granular unit. There is an entry there for
9 piezometer HC2-85 during the pumping of the lower
10 granular unit. We see a one-centimetre water level
11 rise at HC2-85 during the pumping of the lower granular
12 unit.

13 Q. Which piezometer?

14 A. HC2-85.

15 Q. Which piezometer?

16 A. No. 1, piezometer No. 1. It's
17 just a way of noting that when the lower granular unit
18 was pumped we did not appear to see much of a response
19 at HC2-85. However, they are at some distance away.

20 Q. Right. Well, Mr. Petrie, your
21 whole thesis was, as I understand it, is that Site D,
22 the critical layer at Site D is the unweathered upper
23 till?

24 A. Correct.

25 Q. And the response that we have



1 just looked at in this borehole, HC2-85, the Comcor
2 piezometer ...

3 A. I'm sorry, HC2-85 was a Trow
4 piezometer.

5 Q. The Comcor piezometer.

6 A. Yes.

7 Q. The response that we see in the
8 Comcor piezometer marked as 1.76 metres drawdown on
9 Exhibit B-618-P84, I suggest has to be taken very
10 seriously into consideration as to how much of a
11 protective layer we can take from just looking at the
12 depth of that material?

13 A. Are you referring to the upper
14 till?

15 Q. Yes, the upper unweathered till.

16 A. That piezometer CC-OW-2
17 straddles two geologic layers, one being the upper till
18 and one being the lower till. In my mind there is no
19 question that the lower till is the more permeable of
20 the two such that any response to pumping recorded at
21 that installation would reflect in my mind the response
22 of the most permeable layer. I cannot take that
23 drawdown to be indicative of the least permeable of
24 that pair of layers. Secondly, I would note that the
25 elevation at which the granular strata identified at



1 HC2-85 being approximately -- the approximate elevation
2 of the base of the screen at CC-OW-2. That is where
3 there was a degree of lateral continuity at that
4 elevation. The response of CC-OW-2 would not be
5 unexpected. However, at CC-OW-2 the granular strata
6 are encountered at a greater depth.

7 Q. Which indicates, Mr. Petrie, that
8 as soon as you get into the bottom of your unweathered
9 upper till you are really looking at a unit that has
10 significantly greater permeability, at least at that
11 location?

12 A. You are referencing the upper
13 till to the lower till?

14 Q. Yes.

15 A. Visually, as I read the borehole
16 logs and the data provided by Trow I recognize there is
17 a difference in the hydraulic conductivities of those
18 two layers. I do not see it specifically from here.
19 Perhaps I misunderstood your question. Could you
20 repeat it, please?

21 Q. What we see is -- the response in
22 that piezometer is certainly indicating that the upper
23 part of the lower till ...

24 A. Yes, I have your ...

25 Q. ... is, as you say, should be



1 regarded at least at that location as part of the
2 aquifer?

3 A. It responds more like an aquifer
4 well than an aquitard, yes.

5 Q. Do we have similar information at
6 any other locations which would allow us to test the
7 rest of it?

8 A. I'm sorry, I don't know what you
9 mean by the rest of it.

10 Q. You haven't pointed to me another
11 hole or another piezometer which would directly
12 contradict that interpretation or is there one?

13 A. I'm sorry, I am not with you.
14 You are asking me to address those two piezometers. I
15 am addressing those two piezometers.

16 Q. I just thought you might want to
17 respond as to whether or not there was another one that
18 would contradict the response that we see in the upper
19 piezometer. Should we believe it?

20 A. Should we believe what?

21 Q. That the response is real.

22 A. At CC-OW-2 there are measured
23 water levels there. I believe the data are real.

24 Q. Mr. Petrie, I would like to turn
25 to another topic and that is the gradients at Site D.



1 Can I ask you to look, first of all, at your report
2 which is Exhibit B-618 and at the bottom of that page I
3 wonder if you could just read the first ...

4 A. I'm sorry, which page?

5 Q. Page 47, at the bottom of the
6 page.

7 A. I have it.

8 Q. Read that.

9 A. "CRA is in general agreement with
10 Trow that groundwater flow at this site
11 is predominantly directed downwards with
12 the bedrock being the receptor of the
13 bulk of the infiltration at the site."

14 Q. Is that still your opinion?

15 A. In a general sense, yes.

16 Q. Can we have a look at Exhibit B-
17 207 for a moment?

18 A. What exhibit is that?

19 Q. That is a stratigraphic schematic
20 that you prepared or CRA prepared.

21 A. Yes, I recognize it.

22 Q. This, I take it, was prepared or
23 rather the arrows on B-207 -- rather the discharge as a
24 percentage of infiltration, let me put it that way --
25 was that data prepared by your firm?



1 A. Yes, it was.

2 Q. Was that prepared by you?

3 A. Specifically, I don't recall.

4 Q. You or Mr. Crutcher?

5 A. I suspect it was one of our
6 colleagues. Those are calculations taken straight from
7 the data in the tight portion of that figure.

8 DR. KINGHAM: Can I be clear on this
9 exhibit? We have a B-207A and a B-207B and the B-207B
10 has arrows on it and handwritten numbers. When you are
11 talking about typed portions, are we talking about the
12 same ...

13 MR. PETRIE: I am turning the page and
14 note we have a B-207B.

15 MR. ESTRIN: Q. Let us talk about
16 B-207B. Who put the arrows on B-207B?

17 MR. PETRIE: A. Let us back up. There
18 are essentially three columns of data on 207B. The far
19 left-hand one is a sort of stratigraphic column with
20 some values for hydraulic conductivities on it and that
21 is taken essentially straight from Trow. There is a
22 little column headed "Q = KIA" and those numbers are
23 taken directly from Trow. There are some alterations
24 on that column and I believe they were provided by Trow
25 in chief and those alterations have been carried



1 through to this figure. The right-hand column which is
2 headed "Discharge as Per Cent Infiltration" was
3 provided by CRA using the numbers in the middle column
4 as provided by Trow.

5 Q. And the same percentages
6 essentially are shown on 207B as on 207A?

7 A. I don't have an A on mine but for
8 the two pages I have, these numbers are essentially the
9 same, yes.

10 Q. So you are showing -- CRA is
11 showing approximately 70 per cent or more of the flow
12 to the shale?

13 A. As taken directly from Trow's
14 numbers.

15 Q. This is a document that you may
16 recall Mr. McQuaid put to Dr. Charlesworth and Dr. Rowe
17 with the suggestion that the flow was at least 70 per
18 cent to the bedrock.

19 A. My recollection of that was
20 vague. It was initially presented to Mr. Sobanski.

21 Q. And it was also put, I believe,
22 to Dr. Charlesworth?

23 A. I believe that to be the case,
24 yes.

25 Q. In any event what you show on



1 207, these numbers, at least in terms of percentages,
2 what you say in your report, B-618 at page 47 is
3 consistent, is it not, with what you say on page 47:

4 "Groundwater flow at the site is
5 predominantly directed downwards with
6 the bedrock being the receptor of the
7 bulk of the infiltration."

8 A. Yes.

9 Q. Looking up on that page 47 under
10 item No. 1 it says:

11 "Strong downward gradients ranging from
12 ..."

13 Such and such to whatever. No. 2 it says downward
14 gradients and upward gradients locally within the lower
15 till at HC4-85, you say something about transient
16 upward gradients occur at several other locations
17 reflecting seasonal variations and then you say:

18 "The mean gradient at these locations is
19 directed downwards."

20 A. That is what it says, yes. I
21 believe we had some discussion with Mr. Tidball on that
22 trying to recall that.

23 Q. Right. What I want to discuss
24 with you, Mr. Petrie, is the gradient data and I want
25 to discuss and suggest to you the following. First of



1 all, that there are upward gradients at many locations
2 where we have adequate data. That is the first thing I
3 wanted to go over the data with you about.

4 Secondly, that this site is much more
5 complex than you choose to consider it and, thirdly,
6 that your interpretation of the data with regard to
7 gradients as reflected on page 47 and as reflected in
8 the percentage of flow to the bedrock in B-207 that
9 your interpretation conflicts with the data and really
10 indicates you don't understand this site. We can go
11 through each one of those.

12 Now, with regard to the matter generally
13 you were quite correct, of course, you discussed this
14 matter with Mr. Tidball and he raised with you and
15 discussed with you Exhibit 460A. This was an exhibit,
16 you recall, prepared by Dr. Charlesworth?

17 A. That was my recollection, yes.

18 Q. He was showing on this figure the
19 location of holes where you could say that upward
20 gradients exist and also locations where we could say
21 with some degree of certainty that there were downward
22 gradients into the bedrock. That is what his
23 interpretation was?

24 A. Yes, I believe that to be the
25 case.



1 Q. If my recollection is correct,
2 after some discussion with Mr. Tidball, you agreed with
3 most of those upward gradients as plotted by
4 Dr. Charlesworth?

5 A. I didn't hear the question.

6 Q. You agreed with most of the
7 upward gradients as plotted on Exhibit 460A?

8 A. I do not recall the extent of the
9 discussion.

10 Q. Was your evidence essentially
11 that, still to the effect that the patterns are really
12 transient or seasonal and you couldn't agree that
13 upward arrows should be indicated at all those
14 locations?

15 A. I believe we discussed two
16 installations and I've made a note here but I don't
17 know if it was from Mr. Tidball. We talked about 1-85
18 and 2-86. I believe it was one of them. I agreed with
19 him that the initial downward one, the downward
20 gradient had been upward for some time. I think on the
21 second one we indicated there were some reversals in
22 the gradient.

23 Q. I guess I want to discuss these
24 with you and you really have left the impression,
25 Mr. Petrie, particularly on page 47 and particularly in



1 your evidence here that to the extent that there are
2 upward gradients these are really transitional
3 conditions or transient conditions. These are
4 ephemeral and they could change and will change and
5 that as you say in your report the mean gradient is
6 reflected downwards?

7 A. That is what I said, yes.

8 Q. Let us, if we could, look at the
9 water data for HCl-85 in your Appendix I to B-618.
10 Mr. Chairman, it may be helpful to look at this
11 appendix. It has a lot of numbers but I think if we
12 take a highlighter and highlight the particular line it
13 will become clear. This is Appendix I, B-618 on page
14 5, data sheet 4, HCl-85. I wonder, if we were to
15 highlight the first six data entries beside the words
16 "vertical gradient (1-2)" that is September 24th, 25th,
17 26th, 27th, October 7th and October the 18th, if we
18 were just to highlight those for a moment so we know
19 what we are looking at, I am looking at HCl-85. I am
20 looking at the second column from the left. First of
21 all, the words "vertical gradient (1-2)" and then there
22 are some dates and I am asking you, the first number
23 under September 24th, I'm asking you to highlight
24 - 0.08, reading to the right; - 0.07, - 0.06, - 0.05,
25 - 0.03 and - 0.0. Do you see those? What we see here



1 -- this gradient by the way, Mr. Petrie, I wonder if
2 you can show us where it is taken from. It is taken
3 from -- it is the gradients to the lower piezometer
4 which is at the bedrock contact -- I'm sorry -- between
5 the lower, the lowest and the second one from the
6 bedrock?

7 A. One and 2, 1 I believe is near
8 the bedrock contact. I have put Exhibit B-618-P85
9 again which shows HC1-85. One is at the bedrock
10 contact and piezometer No. 2 is at the top of the lower
11 granular unit.

12 Q. So what we're looking at now is
13 data which would help to tell us about the gradient
14 between those two points?

15 A. That is correct.

16 Q. Now, when you look at those data
17 I have just asked you to highlight that is, first of
18 all, between September 24th and September 27th. The
19 first four were on successive days, 24th, 25th, 26th
20 and 27th of September?

21 A. That is correct.

22 Q. That is essentially, I suggest,
23 one point in time relative to the two years covered in
24 your table?

25 A. That is fair.



1 Q. Then, if we were to check Exhibit
2 39, the Trow report on page 11 ...

3 A. I'm sorry, page 11 of the Trow
4 report?

5 Q. Yes, Exhibit 39. Do you see that
6 this borehole could only have been drilled in September
7 of '85?

8 A. Correct.

9 Q. What I suggest to you is we
10 cannot assume that the water levels that you have
11 reported to us in those first four data entries, that
12 the water level had reached equilibrium?

13 A. That is reasonable. I am
14 reporting the data here as it was provided by Trow.

15 Q. I understand but you would agree
16 it would indicate that given that the well had only
17 been drilled at that point the water levels wouldn't
18 have reached equilibrium, not likely?

19 A. Correct.

20 Q. If we look at the actual values
21 for the gradients, include those first four and indeed
22 the first six, that is taking us to October the 7th and
23 October the 18th. What we see, I suggest, is that the
24 downward gradient was consistently declining until on
25 October 18 it was essentially zero. Do you see 0.00?



1 A. I do.

2 Q. And we see, by October 31st, we
3 see an upward gradient described by Dr. Charlesworth?

4 A. October the 31st there is an
5 upward gradient, correct.

6 Q. Because we no longer have a
7 negative sign?

8 A. That is correct.

9 Q. If we keep reading to the right
10 into November, December we see that that continues?

11 A. We see it in part of December,
12 yes.

13 Q. I want to come back to the last
14 two entries. Just stopping with -- would you at that
15 point -- it would appear that after equilibrium of that
16 well had been reached we see an upward gradient at
17 least from the middle of December?

18 A. Correct.

19 Q. Let us look at the last two data
20 entries of that line, December 22nd and January 3rd.
21 Mr. Petrie, let us look up to the actual water levels
22 on that page, please. Mr. Chairman, I am moving my pen
23 up three lines and I'm asking Mr. Petrie to highlight
24 the numbers 183.68 and 183.38 perhaps in a different
25 colour.



1 A. I have circled those in my
2 document.

3 Q. What we see, I suggest, is
4 something most peculiar, I suggest. The water level
5 has apparently risen by more than two metres between
6 December 4th and December 22nd?

7 A. With reference to those numbers
8 that appears to be the case, yes.

9 Q. If we go over to the next page,
10 that is page I-5 of your exhibit we see that by the
11 time it was measured again on January 18th -- I am
12 looking at the number 181.55 and then it dropped back
13 by a similar amount and was standing at 181.55 which is
14 very similar to the December 4th value of 181.56, the
15 December 4th value, that is?

16 A. Yes.

17 Q. Now, Mr. Petrie, I put it to you
18 that an experienced hydrogeologist would conclude that
19 the two high readings in piezometer No. 2 which led to
20 a temporary reversal of the upward gradient are, to use
21 your terminology, incredible and not representative of
22 natural conditions?

23 A. I'm sorry, I don't recall
24 describing these as incredible.

25 Q. No, but I'm using your language



1 from other events. I am saying to you that it is not
2 credible to believe that those are real numbers that
3 you would get a more than two-metre jump in the water
4 level in that piezometer over two or three weeks and
5 then it would fall back down again immediately.

6 A. It does seem somewhat
7 inconsistent, yes.

8 Q. Either that or we've got a very
9 active system?

10 A. Yes.

11 Q. Yes. Now, let us look at the
12 remainder of the data for HCl-85, that which we, in
13 that piezometer which we haven't highlighted. I am
14 looking under the column, go back to the column
15 "vertical gradient (1-2)" and we go to October 31st, we
16 see an upward gradient of 0.03.

17 A. What year are you referring to?

18 Q. The same line we were at before,
19 back on page I-4.

20 A. I have an October 31st, yes.

21 Q. There was an upward gradient of
22 0.03 and the next one, November 20th, 0.03 upward again
23 and December the 4th, 0.01 and let's ignore the next
24 two that you've agreed are not consistent with what one
25 would expect at that site. Turn the page and let us



1 keep going, the same entry "vertical gradient (1-2)"
2 January 18th and let us read right through for that
3 piezometer, right through January, '86 right to August,
4 '87 and I suggest, Mr. Petrie, there are no downward
5 gradients, they are all up?

6 A. That is correct.

7 Q. There is therefore no evidence,
8 Mr. Petrie, to suggest to an experienced hydrogeologist
9 that under natural conditions at this location the
10 gradient between the bedrock and the LGU varies
11 seasonally?

12 A. At that location. I believe we
13 had some discussion with Mr. Tidball on that. I do not
14 recall it.

15 Q. You would agree with me there is
16 no evidence to suggest that the gradient between the
17 bedrock and the LGU at HCl-85 varies seasonally?

18 A. On the basis of the data we have,
19 correct, and recognizing the two numbers provided by
20 Trow which I checked on Exhibit B-618 with that
21 provided in Exhibit H-84, the numbers appear identical,
22 yes.

23 Q. Now, Mr. Petrie, as we cast our
24 eyes over the vertical gradient data that you have
25 presented in these tabulated forms on page I-4, let us



1 say HCl-85, whether we take the first page or the
2 second page we see an awful lot of negative numbers.
3 Virtually all the numbers you have there seem to be,
4 almost all of them, apparently just on a first-glance
5 basis seem to be negatives?

6 A. There are a lot of negative
7 numbers, yes.

8 Q. But, Mr. Petrie, what I want to
9 suggest to you is that by presenting the data in this
10 way you have presented it in a way that would mislead
11 one into the impression that you have conveyed in your
12 report that there are predominant downward gradients
13 and I want to discuss with you the fact that you have
14 presented it in this way is not helpful and indeed may
15 be misleading. I don't know if there is a title on it.

16 A. It reads "Hypothetical
17 Groundwater Installations." I note that they are all
18 in separate boreholes which may not be consistent with
19 the Trow installations.

20 Q. Mr. Petrie, this would not be
21 relevant to the principle we are just about to discuss,
22 I take it?

23 A. I do not know what you are about
24 to discuss.

25 Q. The principle is how you present



1 gradient data.

2 A. That I understand.

3 Q. Mr. Petrie, help me with this
4 because I have difficulty understanding. If we were to
5 look at and try and determine the gradient between
6 piezometer 1 -- first of all, can we assume that these
7 are all in one location?

8 A. One well nest.

9 Q. One well nest so it is clear we
10 are not talking about three separate locations?

11 A. You are saying side-by-side
12 location?

13 Q. Yes.

14 A. Yes, I understand that.

15 Q. It represents one geographic
16 point essentially. Let us try and determine what the
17 gradient is between piezometer 1 and piezometer 2. It
18 would I take it be up?

19 A. The pressure head in piezometer 2
20 as evidenced by the blue arrow line, that is lower than
21 in piezometer 1. The gradient in those two
22 installations is directed upward.

23 Q. Mr. Petrie, I had some difficulty
24 understanding this. It was suggested to me for my
25 simplistic mind that it might be helpful to imagine



1 that there was a tube going from No. 1 to No. 2. If
2 you were to just sketch a tube of water, if you like,
3 running from No. 1 up to No. 2, could you do that on
4 the overhead, just in a different colour, a dashed
5 line?

6 A. Just draw a sort of dashed line
7 like this (indicating)?

8 Q. Certainly.

9 A. Certainly.

10 Q. We can imagine that the water
11 pressure, if you like, if I understand this correctly,
12 in piezometer 1 -- I think you'll have to bring it down
13 a bit so we can see the name of the piezometer --
14 piezometer 1 is higher than No. 2 and therefore the
15 flow would be from the higher to the lower?

16 A. Correct.

17 Q. So the water in an imaginative
18 form would be flowing down No. 1 and up to No. 2?

19 A. Flowing from No. 1 to...

20 Q. To No. 2, not up from but to it.
21 The natural direction would be between the two heads?

22 A. Between the two blue arrows is
23 the direction of flow. I beg your pardon, the
24 direction of gradient.

25 Q. Now, let us try the same thing



1 between No. 1 and No. 3. Just draw an arrow, if you
2 would, as to what is the direction of the gradient
3 between No. 1 and No. 3.

4 A. In the vertical plane it is
5 downwards from No. 3 to No. 1. How should I do it on
6 here?

7 Q. Whatever way you think might be
8 of help. Perhaps an arrow straight down like that
9 (indicating).

10 A. I see what you have, yes. I have
11 drawn a vertical red arrow from the water level at
12 piezometer 3. Ideally it should be from the well
13 screen at piezometer 3. I've indicated from the well
14 screen at piezometer 3 down to -- I'll extend that a
15 little further, to the elevation of the piezometer at
16 piezometer No. 1. That is just based on the relative
17 elevation of the blue markings.

18 Q. Could you put a similar arrow
19 beside No. 1 going up from the bedrock?

20 A. To where?

21 Q. To piezometer 2. Sorry, the
22 wrong piezometer.

23 A. I should have stopped that at the
24 piezometer.

25 Q. Now, let us look at -- you have



1 done -- you have taken those kinds of gradients in your
2 data sheet?

3 A. Yes, that is correct.

4 Q. I also understand that the data
5 you reported would report a gradient that would be
6 illustrated on this overhead between piezometer 2 and
7 piezometer 3?

8 A. Yes, we have that gradient
9 option.

10 Q. Where would that one be? How
11 would you draw that one?

12 A. That is a downward gradient from
13 piezometer 3 to piezometer 2.

14 Q. Could you show what that one
15 would be like?

16 A. I have shown a downwards directed
17 red arrow from the elevation of piezometer 3 to the
18 elevation of piezometer 2.

19 Q. Right. Now, what I am
20 suggesting, Mr. Petrie, is that that kind of gradient,
21 that downward gradient from piezometer 3 to piezometer
22 1 is irrelevant and misleading information, that if
23 there is downward flow from piezometer 3 it will go to
24 the granular unit and then laterally?

25 A. If the granular unit can contain



1 that flow. I disagree it is irrelevant and misleading.

2 Q. I suggest to you, Mr. Petrie,
3 that water is going to, if it is a downward gradient,
4 it's going to go where it finds it easiest?

5 A. That is correct, I will agree
6 with that.

7 Q. That means, Mr. Petrie, it is
8 going to go in one of those granular units?

9 A. For the system you have drawn
10 here one would expect it to move laterally in the
11 granular unit, yes.

12 Q. And it can't get from the
13 granular units down to the bedrock given that drain
14 that we have...?

15 A. For the water levels you have
16 shown, that is correct.

17 Q. And also, that is also so, is it
18 not, because you have an upward gradient from the
19 bedrock to the granular unit?

20 A. That is correct. That is what
21 you've shown on this exhibit.

22 Q. So that to the extent you have an
23 upward gradient from the bedrock to the granular unit
24 and you have a granular unit at all, my suggestion is
25 it is misleading and not helpful to start presenting a



1 lot of data which talks about a downward gradient from
2 the upper till right to the bedrock when it can't
3 happen?

4 A. It was not the intention to be
5 misleading in any way, shape or form. This is just a
6 total matrix of the data available.

7 Q. But, Mr. Petrie, we want to
8 present the data which is meaningful. We want to
9 interpret the data which is meaningful. You would
10 agree with that?

11 A. I believe when we went through
12 this in chief I indicated that the lines in this data
13 set were meaningful.

14 Q. Let us go and look at some of the
15 particular data we have for some of these holes, having
16 this overhead in mind.

17 A. I'm sorry, which one; the one we
18 have before us?

19 MR. ESTRIN: Could I have this marked?

20 MR. LANCASTER: Yes, this will be M-729.

21 --- EXHIBIT NO. M-729: Document entitled
22 "Hypothetical Groundwater
Installations"

23 MR. ESTRIN: Q. If you could put up
24 M-460A again and we've just discussed HCl-85 and found
25 that all the relevant data shows an upward gradient



1 from the bedrock.

2 MR. PETRIE: A. Yes.

3 Q. The next piezometer I believe
4 which you discussed with Mr. Tidball was HC2-85 and
5 which Dr. Charlesworth did not include on Exhibit 460A.

6 A. Mr. Crutcher is indicating he
7 thinks it was HC2-86 we discussed with Mr. Tidball. My
8 note I had written down was 2-86, although I didn't
9 indicate with whom I had discussed it.

10 Q. Let us look at your figure which
11 is behind you, the blowup of C.2.4B. Is that page 84?
12 The other one.

13 A. Which installation are you
14 referring to?

15 Q. If you look at HC2-85 ...

16 A. Yes, I have it.

17 Q. ... near the middle of the
18 section we see that there is indeed a downward gradient
19 between the bottom piezometer No. 1 and the next up
20 from the bottom, No. 2.

21 A. An 11-centimetre head difference,
22 yes.

23 Q. However, we note that the second
24 piezometer is in the upper granular unit?

25 A. Correct.



1 Q. And we don't have any data for
2 the lower granular unit?

3 A. Correct.

4 Q. We will come back to that.

5 Mr. Petrie, just to make sure we're on
6 the same wavelength and I'm looking at the transcript,
7 page 26810 and Mr. Tidball's cross-examination simply
8 says:

9 "If we could turn to the next one, the
10 next hydrograph I get is HC2-85 ..."

11 A. I'm sorry, could you give me the
12 page number again?

13 Q. Page 26810.

14 A. And then it just says "Turn to
15 the next one."

16 Q. And you proceed to discuss it?

17 A. Two-85, I understand.

18 Q. Yes. Now, do we see on the left-
19 hand side of that blowup HC1-85?

20 A. I'm sorry?

21 Q. Is it in the middle?

22 A. No, it's not on this.

23 Q. I'm sorry, it's the other one.

24 A. It's on Exhibit B-618-P85.

25 Q. You see the locations of the



1 piezometers and the water levels beside them?

2 A. We do.

3 Q. Let us imagine if we did not have
4 -- can you point out this hole for us?

5 A. HC1-85 is at the far left of
6 Exhibit B-618-P85.

7 Q. Let us imagine we did not have
8 piezometer No. 2 in that hole, can you point out
9 piezometer No. 2?

10 A. Piezometer No. 2 has a water
11 level of 181.18.

12 Q. If you did not have the
13 piezometer would you suggest or conclude there is a
14 downward gradient from the bottom of the upper till to
15 the bedrock?

16 A. Correct, I would.

17 Q. Let us look at HC4-85. We see a
18 similar situation where we know from the data you
19 present there is an upper ...

20 A. I'm sorry?

21 Q. HC4-85, is it on there?

22 A. Yes, it is.

23 Q. Look at your -- your water levels
24 are on there?

25 A. Yes, they are.



1 Q. I suggest a similar situation
2 where we know from the data presented there is an
3 upward gradient from the rock to the LGU but if we
4 didn't have piezometer No. 2, can you point it out?

5 A. Piezometer No. 2 in the lower
6 granular unit.

7 Q. Then you would conclude there was
8 a downward gradient from the overburden to the rock?

9 A. Correct, I would.

10 Q. In fact if we turned to your
11 table in Appendix I of Exhibit B-618, pages I-4 and I-
12 5, Appendix I to your report, B-618, we can see that
13 you show a series of downward gradients along the
14 middle line for piezometers 1 to 3?

15 A. We are looking at HC -- which one
16 are we looking at?

17 Q. I'm asking you to turn back to
18 your report, B-618.

19 A. I have the page. I've just lost
20 the well.

21 Q. It is HC4-85 and I am looking at
22 the second line, the second line from the bottom under
23 the heading "vertical gradient", the one that is headed
24 1-3.

25 A. I have it, yes.



1 Q. We can see, Mr. Chairman, if you
2 were to highlight the second line from the bottom for
3 HC4-85-3 under the heading "vertical gradient (1-3)" so
4 it is the second-last line of data, the last seven
5 entries on the right-hand side of the page, it would
6 indicate - 0.11, - 0.11, - 0.10, - 0.12, et cetera. it
7 seems obvious that we get a bunch of negative numbers,
8 Mr. Petrie.

9 A. That is correct.

10 Q. If we look back at your overhead
11 there, the blowup ...

12 A. Yes.

13 Q. ... I suggest to you it becomes
14 obvious that this is a meaningless number because at
15 this location we know that water is not going to flow
16 from the vicinity of piezometer 3. Can you point it
17 out?

18 A. Piezometer 3 being the uppermost
19 one at HC4-85.

20 Q. To piezometer 1.

21 A. Being the lowermost one in that
22 well nest.

23 Q. Rather it can't get past the
24 lower granular unit?

25 A. Correct, for the water levels on



1 this one figure, yes.

2 Q. Now, let us look -- there are
3 also upward gradients shown consistently from the
4 bedrock?

5 A. Correct.

6 Q. For piezometer 1?

7 A. That is correct.

8 Q. Now, let us go back to the
9 blowup, Exhibit B-618, page 85. Do we see on that one
10 borehole, HC3-86?

11 A. Yes, we do.

12 Q. There is no piezometer in the
13 LGU?

14 A. That is correct.

15 Q. I suggest to you, Mr. Petrie, you
16 can't draw any conclusion about the gradient between
17 the two lower piezometers. Can you point them out to
18 us?

19 A. The two lower piezometers, one at
20 the bedrock contact and one higher up in the lower
21 till.

22 Q. Because we don't have a
23 piezometer in the LGU unlike the other two boreholes
24 we've just discussed?

25 A. You can make a conclusion but as



1 you say we don't have data at the elevation which may
2 be relevant.

3 Q. In fact we note that there is an
4 upward gradient from piezometer 2 in the lower till to
5 piezometer 3 in the upper till and Dr. Charlesworth
6 included this as a small arrow on, Exhibit 460A, if you
7 go back to the overhead on the wall?

8 A. Yes, I see it. I was just
9 reading the legend.

10 Q. Meaning somewhere in the vertical
11 profile there were upward gradients meaning water could
12 not get down from the surface to the bedrock?

13 A. As I read that figure the water
14 level of 180.74 I think would be the lowest water level
15 on site. I have indicated earlier that I do not
16 believe that a real water level. That is partly why I
17 presented the data in this fashion being the sum total
18 of a combination of gradients such that if one wished
19 to ignore a certain piezometer because one had concerns
20 with the water levels, in this case HC3-86, ignoring
21 piezometer 3, being a value of 180.74 and I wish to
22 have combinations of gradient which included ones on
23 either side of it such that I could reference the data
24 available.

25 Q. Mr. Petrie, look while we are on



1 that figure at HC2-85 -- I'm sorry, we'll have to go
2 back to the other blowup. At HC2-85 ...

3 A. Yes, I see it.

4 Q. ... I believe in cross-
5 examination by Mr. Tidball you postulated a downward
6 gradient to the rock?

7 A. For the data available at HC2-85
8 it is my recollection today.

9 Q. I am suggesting to you we can't
10 say that because there is not -- what I'm saying is we
11 can't say that there is not an upward gradient from the
12 bedrock to the LGU.

13 A. I'm sorry, slowly. From the
14 bedrock to the LGU at HC2-85 we do not have that data
15 at that installation; that is correct.

16 Q. Hence you understand
17 Dr. Charlesworth would not include HC2-85 on Exhibit
18 460A where he was showing data about which he could be
19 reasonably certain. He didn't show it because the data
20 doesn't exist to tell us what the real situation is
21 between the bedrock and the lower granular unit?

22 A. I don't recall his reasoning but
23 I do note it is not on Exhibit M-460A.

24 Q. Mr. Petrie, what I am suggesting
25 to you is a close examination of the gradient data



1 shows it is much more complex than one would conclude
2 from reading your words on page 47, which say that:

3 "At this site groundwater flow is
4 predominantly directed downwards with
5 the bedrock being the receptor of the
6 bulk of the infiltration."

7 A. That's what I said, yes.

8 Q. I am suggesting to you the
9 situation is much more complex than that. Where we
10 have the data we see that that doesn't necessarily
11 follow at all. We have upward gradients from the
12 bedrock?

13 A. In places we do have upward
14 gradients from the bedrock.

15 Q. Mr. Petrie, looking at that
16 Exhibit M-460A I would suggest to you there is a
17 significant part of Site D where we have upward
18 gradients from the bedrock to the lower granular unit.
19 If you were to contour that overhead, for example, by
20 excluding the red situations which are downward, if you
21 were to draw a line as might be appropriate to try and
22 contour it we see a significant portion of that site
23 actually indicating upward gradient from the bedrock to
24 the LGU. Do you understand what I mean by contour?

25 A. I know what you mean by contour,



1 yes. Do you wish me to contour it; is that what you're
2 saying?

3 Q. Just put a dashed line to exclude
4 those areas.

5 A. If we are looking from the
6 bedrock to the overburden, the installations that are
7 identified are HC1-85, HC2-86 and HC4-85. I have just
8 put a line there, although we have included one I feel
9 is erroneous and we haven't addressed -- one I feel
10 erroneous and I feel HC3-86 with the very low
11 piezometric elevation in the upper till and we have
12 another one within that envelope of MB-OW-4 which we
13 haven't addressed this morning.

14 Q. Mr. Petrie, thank you for doing
15 that. You have put some green dashed lines on the
16 Exhibit 460A which indicates approximately the area
17 where the data put on that would indicate upward
18 gradients from the bedrock ...

19 A. ... to the overburden,
20 recognizing there are some other arrows in there that
21 are not bedrock to overburden.

22 Q. I suggest to you that that would
23 indicate a significant portion of Site D has those
24 upward gradients?

25 A. From the bedrock ...



1 Q. ... to the lower granular unit?

2 A. Correct.

3 Q. I am suggesting to you therefore
4 that this site has complexities and perhaps it is as
5 complex as you have always suggested Site F is?

6 A. No, I would not agree with that.

7 Q. All right, Mr. Petrie, over lunch
8 I'm wondering if you could assist us and I will tell
9 you what I mean but with your permission, Mr. Chairman,
10 if you could mark the two blowups, B-618-P85 and P-84.
11 Colour-code them with gradients in a manner that I am
12 going to suggest to you over lunch similar to the
13 colour-coding for upward and downward gradients we have
14 seen done for Site F in the same borehole.

15 A. Yes, I can do that if you could
16 indicate ...

17 MR. ESTRIN: Yes, I will.

18 MR. LANCASTER: A quarter to 2:00.

19 --- Luncheon recess at 12:33 p.m.
20
21
22
23
24
25



1 --- Upon resuming at 1:47 p.m.

2 MR. LANCASTER: Please be seated.

3 MR. ESTRIN: Q. Mr. Petrie, over the
4 lunch hour you were kind enough to do some colouring on
5 Exhibits B-618-P85 and B-618-P84. Let us start with
6 the one from page -- the one with HC2-85.

7 MR. PETRIE: A. HC2-85 is on B-618-P84
8 and on both those exhibits, being P-85 as well, I have
9 indicated in pink as shown by Dr. Charlesworth's
10 discussions with me at the lunch break the pink
11 indicates the downward vertical gradient, yellow
12 indicates no vertical gradient and green is an upward
13 vertical gradient.

14 Q. You have done this colour coding
15 at our request only on those installations where there
16 are more than two piezometers?

17 A. Correct, as indicated to me by
18 Dr. Charlesworth during the lunch hour, yes.

19 Q. Well, all I'm asking you ...

20 A. Yes, I believe that to be the
21 case.

22 Q. The colour-coding does correspond
23 to the available data?

24 A. As provided on these exhibits and
25 that data is the water level data for April, 1986 with



1 one correction that was pointed out to me by
2 Dr. Charlesworth. The water level at HC5-85 which is
3 on Exhibit B-618-P85 should indeed have read 181.47 for
4 the lowermost piezometer. I had previously indicated
5 181.81 for the lowermost piezometer on HC5-85. It
6 should have read 181.47.

7 Q. Now, Mr. Petrie, where there was
8 no piezometer in the lower granular unit we have only
9 taken the gradient data down to the lower granular unit
10 on the colouring you have done?

11 A. Correct. Starting at the top and
12 working downwards, we have stopped at the lower
13 granular unit if there is no screen in the lower
14 granular unit.

15 Q. So for example on HC3-86 really
16 we should put a question mark between the bedrock and
17 the lower granular unit?

18 A. Correct, would you like me to put
19 a question mark?

20 Q. Yes, please.

21 A. What colour would you like it to
22 be?

23 Q. Green.

24 A. Green indicates upward on the
25 legend so you are putting a green question mark -- I



1 beg your pardon, I am putting it at your request for
2 HC3-86?

3 Q. Yes. What about 5-85?

4 A. Using the same colour again?

5 Q. Yes, and 2-85?

6 A. Two-85 is on Exhibit B-618-P84.

7 Q. So that what we see when we code
8 the installations where we have more than two
9 piezometers in colour in accordance with the gradient
10 data we do know, it would appear that we do not have
11 anything like uniformity of downward gradients to
12 bedrock across the site. If we did we would see pink
13 lines or red lines going to the bedrock on all these
14 holes?

15 A. That is correct.

16 Q. In fact we don't see that. The
17 only place in fact we actually see one going to the
18 bedrock, the only place I see one there is in HC3-85
19 and there is no lower granular unit intervening?

20 A. Correct, there is no lower
21 granular unit intervening at that borehole.

22 Q. So that again this helps us see
23 that there are upward gradients, the green ones over a
24 large percentage of the site where we have adequate
25 data in order to determine that?



1 Q. Yes, I believe we are talking
2 chlorides here. Actually it is not so obvious. I
3 don't see the word "chlorides." I see the same number
4 and I suspect it is for chlorides.

5 Q. I wonder if you could take a
6 clean piece of paper on the flip chart and write down
7 that number that both Trow and Dr. Rowe used.

8 A. Shall I write down "chloride
9 diffusion coefficient"?

10 Q. Yes.

11 A. Six x 10⁻⁶ cm²/sec. I will put
12 "(Trow and Dr. Rowe)."

13 Q. Now, do you also agree that this
14 is a reasonable value?

15 A. There is some confusion regarding
16 the diffusion coefficients whether they incorporate a
17 porosity term in their formulation. It is a value that
18 has been quoted in the literature and it is one that
19 comes to mind quite quickly when I think of chlorides.
20 Also I am not certain if that reference has a porosity
21 term within it or not.

22 Q. I believe if you check what I
23 believe is your Exhibit B-642 you will see ...

24 A. I'm sorry, B-642?

25 Q. It is your calculations, I



1 believe, diffusion profiles at Site D.

2 A. Yes, we have not located it as
3 yet.

4 Q. I will show you my copy.

5 A. Yes, I see it.

6 Q. Do you agree that in 642, 643 and
7 644 which were produced by you, that is a value that
8 you used?

9 A. Six x 10⁻⁶ cm²/sec is the value
10 we have reported here.

11 Q. The value you used?

12 A. Yes, correct.

13 Q. Now then I guess you can put down
14 CRA.

15 Now, in your report on Site D at page 93
16 the groundwater velocity which you used in that
17 analysis on page 93 of Exhibit B-618, contaminant
18 transport through the upper till would be significantly
19 affected by diffusion.

20 A. I'm sorry, could you say that
21 statement again?

22 Q. For the groundwater velocity you
23 were using when you produced that breakthrough curve,
24 page 93 ...

25 A. Yes.



1 Q. ... I am suggesting that
2 contaminant transport through that upper till would be
3 significantly affected by diffusion.

4 A. I'm sorry, I don't quite
5 understand the question. You are saying the velocity
6 would be affected by diffusion?

7 Q. Well, the fact that -- yes, not
8 the groundwater velocity would be affected by diffusion
9 but for the groundwater velocity which was inherent in
10 the calculation on page 93 which was in the order of
11 10^{-8} , somewhere around that?

12 A. That was a permeability, that
13 number you just referenced.

14 Q. What velocity did you use?

15 A. It is in there, water velocity is
16 0.476×10^{-7} .

17 Q. The groundwater velocity which
18 was used for contaminant transport through the till
19 will be significantly affected by diffusion or do you
20 know?

21 A. I'm sorry, I still don't get the
22 drift of your question. The two are related.

23 Q. The slower it goes the more
24 diffusion one might expect?

25 A. The magnitude of the diffusion,



1 yes.

2 Q. I am asking you simply can you
3 agree with me that for the groundwater velocity used
4 here contaminant transport would be significantly
5 affected by diffusion. If you can't agree I guess I
6 need to know did you perform studies to examine this?

7 A. Could I rephrase your question?
8 For the groundwater velocity here which is the lower
9 value used by Trow the extent of the diffusion profile
10 is greater. I am having trouble understanding your
11 question.

12 Q. I am sorry. Did you perform
13 studies to examine the extent to which contaminant
14 transport through the upper -- unweathered upper till
15 would be affected by diffusion at that velocity?

16 A. We do not perform studies, no.

17 Q. Do you have any experience in
18 modelling this yourself, modelling diffusion?

19 A. I have modelled diffusion.

20 Q. But you didn't do any particular
21 work here on this -- in connection with this
22 particular...

23 A. You mean did we use different
24 diffusion coefficients?

25 Q. Yes.



1 and ask you to please put 6×10^{-6} over 1.5×10^{-6} ?

2 DR. KINGHAM: I wonder before you go too
3 much further in this, my recollection of the original
4 evidence was that the 1.5×10^{-6} included a porosity
5 value which when multiplied times 6×10^{-6} gave the
6 1.5×10^{-6} used in Exhibit B-642 which is not obvious
7 to me whether the porosity value has been included or
8 not. I am aware that this was done in co-operation
9 with Mr. Feenstra. I am wondering how valuable it is
10 until we find out what has happened in terms of the
11 numbers. Maybe we can find a way of doing that.

12 MR. HODGSON: I don't know whether this
13 will clarify or confuse things but the original Trow
14 report had one value, that value was corrected. The
15 work that was done was done by Mr. Feenstra.
16 Mr. Feenstra corrected that value in his witness
17 statement, Exhibit H-86A and did another diffusion
18 calculation based upon the corrected value. The
19 original value is obviously still sitting in the
20 original report but it is not the basis of the Region's
21 evidence. Whether or not this witness was likely to
22 use it because it was in the original report I don't
23 know.

24 MR. ESTRIN: Q. That is an interesting
25 question and one of the ones that I am exploring. What



1 beg your pardon, I am putting it at your request for
2 HC3-86?

3 Q. Yes. What about 5-85?

4 A. Using the same colour again?

5 Q. Yes, and 2-85?

6 A. Two-85 is on Exhibit B-618-P84.

7 Q. So that what we see when we code
8 the installations where we have more than two
9 piezometers in colour in accordance with the gradient
10 data we do know, it would appear that we do not have
11 anything like uniformity of downward gradients to
12 bedrock across the site. If we did we would see pink
13 lines or red lines going to the bedrock on all these
14 holes?

15 A. That is correct.

16 Q. In fact we don't see that. The
17 only place in fact we actually see one going to the
18 bedrock, the only place I see one there is in HC3-85
19 and there is no lower granular unit intervening?

20 A. Correct, there is no lower
21 granular unit intervening at that borehole.

22 Q. So that again this helps us see
23 that there are upward gradients, the green ones over a
24 large percentage of the site where we have adequate
25 data in order to determine that?



1 A. We have upward gradients at some
2 of the boreholes, yes, where we have gradient data.

3 Q. Contrary to the statements on
4 page 47 of Exhibit B-618 you say the mean gradient at
5 these locations is directed downwards, the site
6 exhibits upward gradients and indeed lateral gradients.

7 A. We have only referenced vertical
8 gradients except for I believe there was one at HC1-86
9 where there was no head change between the lower
10 gradient and the bedrock. One can infer that is a
11 lateral gradient.

12 Q. What I am suggesting, Mr.
13 Petrie, is that when the data is looked at carefully
14 and analyzed in a fulsome way we can see that the site
15 is behaving contrary to your belief as stated in your
16 report and contrary to your description in the report
17 where you say in another statement "downward gradients
18 predominate."

19 A. Yes, downward gradients do not
20 predominate right through the section.

21 Q. Mr. Petrie, I suggest that your
22 position as taken in your report and your evidence when
23 viewed against this evidence, this data, indicates that
24 at the time you wrote the report, the report at least,
25 you did not understand Site D in the terms that we



1 need to understand it in order to make predictions
2 about it?

3 A. No, I do not agree with that.

4 Q. I would like to turn to another
5 topic, Mr. Petrie. Now, this has to do with
6 contaminant modelling, your contaminant modelling for a
7 complete failure at Site D assuming the hydraulic trap
8 doesn't work. It also involves the topic of diffusion.

9 Now, I take it you are aware or will
10 recall that Trow and Dr. Rowe considered it was a
11 reasonable value for a diffusion coefficient of
12 chloride through the upper till?

13 A. I have that recollection, yes.

14 Q. I want to check the number Trow
15 used, it was 6×10^{-6} cm²/sec. I believe that's at
16 page 189.

17 A. Yes, I see an effective diffusion
18 coefficient for chloride.

19 Q. Dr. Rowe used that number in his
20 witness statement, Exhibit M-442 at page 28, M-442. I
21 just want you to check. Not his witness statement, 442
22 is, I believe, his report.

23 A. I believe it is. I can locate
24 that in a second. Sorry, which page?

25 Q. Page 28, just below formula 8.



1 Q. Yes, I believe we are talking
2 chlorides here. Actually it is not so obvious. I
3 don't see the word "chlorides." I see the same number
4 and I suspect it is for chlorides.

5 Q. I wonder if you could take a
6 clean piece of paper on the flip chart and write down
7 that number that both Trow and Dr. Rowe used.

8 A. Shall I write down "chloride
9 diffusion coefficient"?

10 Q. Yes.

11 A. Six x 10⁻⁶ cm²/sec. I will put
12 "(Trow and Dr. Rowe)."

13 Q. Now, do you also agree that this
14 is a reasonable value?

15 A. There is some confusion regarding
16 the diffusion coefficients whether they incorporate a
17 porosity term in their formulation. It is a value that
18 has been quoted in the literature and it is one that
19 comes to mind quite quickly when I think of chlorides.
20 Also I am not certain if that reference has a porosity
21 term within it or not.

22 Q. I believe if you check what I
23 believe is your Exhibit B-642 you will see ...

24 A. I'm sorry, B-642?

25 Q. It is your calculations, I



1 believe, diffusion profiles at Site D.

2 A. Yes, we have not located it as
3 yet.

4 Q. I will show you my copy.

5 A. Yes, I see it.

6 Q. Do you agree that in 642, 643 and
7 644 which were produced by you, that is a value that
8 you used?

9 A. Six x 10⁻⁶ cm²/sec is the value
10 we have reported here.

11 Q. The value you used?

12 A. Yes, correct.

13 Q. Now then I guess you can put down
14 CRA.

15 Now, in your report on Site D at page 93
16 the groundwater velocity which you used in that
17 analysis on page 93 of Exhibit B-618, contaminant
18 transport through the upper till would be significantly
19 affected by diffusion.

20 A. I'm sorry, could you say that
21 statement again?

22 Q. For the groundwater velocity you
23 were using when you produced that breakthrough curve,
24 page 93 ...

25 A. Yes.



1 Q. ... I am suggesting that
2 contaminant transport through that upper till would be
3 significantly affected by diffusion.

4 A. I'm sorry, I don't quite
5 understand the question. You are saying the velocity
6 would be affected by diffusion?

7 Q. Well, the fact that -- yes, not
8 the groundwater velocity would be affected by diffusion
9 but for the groundwater velocity which was inherent in
10 the calculation on page 93 which was in the order of
11 10^{-8} , somewhere around that?

12 A. That was a permeability, that
13 number you just referenced.

14 Q. What velocity did you use?

15 A. It is in there, water velocity is
16 0.476×10^{-7} .

17 Q. The groundwater velocity which
18 was used for contaminant transport through the till
19 will be significantly affected by diffusion or do you
20 know?

21 A. I'm sorry, I still don't get the
22 drift of your question. The two are related.

23 Q. The slower it goes the more
24 diffusion one might expect?

25 A. The magnitude of the diffusion,



1 yes.

2 Q. I am asking you simply can you
3 agree with me that for the groundwater velocity used
4 here contaminant transport would be significantly
5 affected by diffusion. If you can't agree I guess I
6 need to know did you perform studies to examine this?

7 A. Could I rephrase your question?
8 For the groundwater velocity here which is the lower
9 value used by Trow the extent of the diffusion profile
10 is greater. I am having trouble understanding your
11 question.

12 Q. I am sorry. Did you perform
13 studies to examine the extent to which contaminant
14 transport through the upper -- unweathered upper till
15 would be affected by diffusion at that velocity?

16 A. We do not perform studies, no.

17 Q. Do you have any experience in
18 modelling this yourself, modelling diffusion?

19 A. I have modelled diffusion.

20 Q. But you didn't do any particular
21 work here on this -- in connection with this
22 particular...

23 A. You mean did we use different
24 diffusion coefficients?

25 Q. Yes.



1 A. No, we did not.

2 Q. Mr. Petrie, I would like you to
3 confirm for me that the diffusion coefficient you used
4 to obtain the impact calculations -- this is an impact
5 calculation on page 93?

6 A. You could describe it as that,
7 yes.

8 Q. Would you agree with me that the
9 diffusion coefficient used in that calculation was
10 $1.5 \times 10^{-6} \text{ cm}^2/\text{sec}$?

11 A. Yes, that's what it says or 0.15
12 $\times 10^{-5} \text{ cm}^2/\text{sec}$.

13 Q. You could convert it to
14 1.5×10^{-6} ?

15 A. That's just what I did, yes.

16 Q. Could you put that down on the
17 flip chart, please?

18 A. I'm confused why we have the two
19 different ones. I don't have an explanation right now.

20 Q. Maybe you could use a different
21 one. Could you put down Exhibit B-618, page 93,
22 diffusion coefficient used, could you put it down as
23 $1.5 \times 10^{-6} \text{ cm}^2/\text{sec}$? Mr. Petrie, isn't it true that the
24 diffusion coefficient you have used on this page of
25 your report would underestimate the mass of flux



1 passing through the upper till by about 400 per cent,
2 looking at the proportionality of the two ratios?

3 A. The lower the diffusion
4 coefficient the lower the diffusive flux. That value
5 is about four times lower than the one provided on the
6 chart behind us. Mr. Crutcher is just indicating to me
7 on page 92 that we make the statement that the input
8 parameters for this model are the same as used by Trow.
9 We reference page 98 of Trow but I believe we just
10 looked at Trow a minute ago and had a different number.

11 Q. Yes.

12 A. Can I just locate the relevant
13 document, please? I notice on page 98 of Trow which is
14 their Figure 9, migration downward through unweathered
15 upper till, we have a value for the diffusion
16 coefficient of 1.5×10^{-6} . So it appears that Trow
17 have used -- quoted two different numbers.

18 Q. Well, Mr. Petrie, you have told
19 us that on page -- you yourself used 6×10^{-6} in the
20 calculations you have presented to the Board as a
21 result of questions by Dr. Kingham; do you recall that?

22 A. That is correct.

23 Q. I'm asking you simply to compare
24 the number you used in those exhibits to the one you
25 used on page 93. Can I ask you to go to the flip chart



1 and ask you to please put 6×10^{-6} over 1.5×10^{-6} ?

2 DR. KINGHAM: I wonder before you go too
3 much further in this, my recollection of the original
4 evidence was that the 1.5×10^{-6} included a porosity
5 value which when multiplied times 6×10^{-6} gave the
6 1.5×10^{-6} used in Exhibit B-642 which is not obvious
7 to me whether the porosity value has been included or
8 not. I am aware that this was done in co-operation
9 with Mr. Feenstra. I am wondering how valuable it is
10 until we find out what has happened in terms of the
11 numbers. Maybe we can find a way of doing that.

12 MR. HODGSON: I don't know whether this
13 will clarify or confuse things but the original Trow
14 report had one value, that value was corrected. The
15 work that was done was done by Mr. Feenstra.
16 Mr. Feenstra corrected that value in his witness
17 statement, Exhibit H-86A and did another diffusion
18 calculation based upon the corrected value. The
19 original value is obviously still sitting in the
20 original report but it is not the basis of the Region's
21 evidence. Whether or not this witness was likely to
22 use it because it was in the original report I don't
23 know.

24 MR. ESTRIN: Q. That is an interesting
25 question and one of the ones that I am exploring. What



1 basis did this witness in the exhibit that he produced
2 for the Board, those three calculations he used,
3 6×10^{-6}

4 MR. PETRIE: A. That is correct in
5 those three calculations, Exhibits B-642, 643 and 644.

6 Q. In your report in Exhibit 618,
7 page 93 you used 1.5?

8 A. I note on page 92 that the input
9 parameters for this model being the model referenced on
10 page 93 are the same as those used by Trow and I
11 referenced Figure 8 of Exhibit H-39, except I changed
12 the velocity to incorporate a different value for the
13 hydraulic conductivity. So, I carried Trow's work
14 through with the exception of one value.

15 Q. Can we just make this point quite
16 simple, Mr. Petrie, the difference between those two
17 figures, the diffusion coefficient is a factor of four?

18 A. Correct.

19 Q. If in fact you have used one
20 number in one place and one number in another place,
21 that means that if in fact the diffusion coefficient
22 that you used on page 93 is in error by a factor of
23 four, the time for contaminant arrival will be
24 substantially faster than you've indicated on page 93?

25 A. I do not know that it is



1 substantially faster.

2 Q. I suggest that we are talking in
3 the vicinity of almost four times as fast?

4 A. I'm not sure if you can relate
5 the profile directly to the coefficient of molecular
6 diffusion. The velocity term is dominant in this
7 calculation.

8 Q. Yes. My suggestion, Mr. Petrie,
9 is that it is almost four times as fast as you have
10 indicated on page 93.

11 A. I cannot agree with that until I
12 have gone through and done the mathematics myself.

13 Q. Mr. Petrie, if in fact you had
14 used on page 93 the value that you have used in your
15 subsequent exhibits, the result would be increases in
16 chloride concentrations calculated in the lower till or
17 in the aquifer. I am suggesting that you could cause
18 unacceptable impact within as little as just over 40
19 years.

20 A. I cannot agree. In the absence
21 of doing the calculations it is my opinion it is
22 unlikely that by changing the molecular diffusion
23 coefficient by a value of four would lead to four
24 times.

25 Q. Almost?



1 A. Almost four times the rate of
2 travel through that till.

3 Q. Perhaps if you wish you could
4 take the time, I will leave it to you, to re-do that
5 calculation, using the diffusion coefficient you
6 produced in other exhibits.

7 A. I can and will do so, yes.

8 Q. Now, on page 93 you performed
9 this analysis assuming a hypothetical four-metre-thick
10 unfractured unit of till?

11 A. Again as indicated on page 92 I
12 took the input data directly from Trow.

13 Q. Having a hydraulic conductivity
14 of 1.4×10^{-8} ?

15 A. That is the change I made.

16 Q. Do I understand correctly you are
17 telling the Board this is a conservative calculation?

18 A. I believe it is a reasonable
19 calculation.

20 Q. Now, would you agree that if one
21 wanted to be reasonable you would also perform the
22 assessment using a minimum thickness of the natural
23 barrier which in this case, I'm talking about the
24 material which you say has this K of 1.4×10^{-8} ?

25 A. What do you have in mind for the



1 minimum thickness?

2 Q. I'm asking you, just if you can
3 deal with my question as a generality then we will go
4 to discuss the actual data.

5 A. We do that later on for a
6 thickness of 3.2 which for the design that CRA is
7 suggesting is the minimum thickness for the upper
8 unweathered till and that is provided on page 98, at
9 least the profile is.

10 Q. Can you agree with me, Mr.
11 Petrie, that it would be conservative or reasonable to
12 perform these calculations using a minimum thickness
13 that exists?

14 A. Trow did not provide a minimum
15 thickness. We have interpreted one -- I beg your
16 pardon -- we have reviewed the Trow landfill design as
17 we understood it. With respect to the thickness of the
18 till that information is provided in our report
19 generally in Section 5 being page 58 onwards. I recall
20 that we had some concern respecting the thickness of
21 the till, had some concern respecting the hydraulic
22 trap criteria that Trow had developed and we felt for a
23 proportion of the site they did not meet the criteria
24 they developed. Also going through this exercise and
25 in discussions with Mr. Crutcher there were some



1 concerns respecting the design proposed by Trow. To
2 that end CRA undertook to provide a new design.

3 Q. Yes, I understand that.

4 A. We took the lowest thickness or
5 the thinnest portion of the till being 3.2 metres as I
6 recall it in one cell, I forget which one. I used that
7 value of 3.2 metres on page 98 of Exhibit B-618. So
8 where I have good control on the till I used the CRA
9 minimum thickness number I believe.

10 Q. All right, Mr. Petrie, but you
11 took -- you were looking at your cross-sections?

12 A. I was looking at my cross-
13 sections, the data I had interpreted, yes.

14 Q. Your cross-sections do not
15 necessarily represent the whole of the site by any
16 means?

17 A. No, they do not.

18 Q. Can we go back to my question?
19 Do you not consider it appropriate when performing an
20 impact assessment to use the minimum thickness for the
21 natural barrier which you say is the most critical one
22 at this site?

23 A. I do consider it appropriate.

24 Q. I don't have the coloured
25 sections here for the Geocon report. I apologize, we



1 are going to get them from upstairs but can you pull
2 out, Mr. Petrie, the plan view from the Geocon report?
3 A. Is this the one you are referring
4 to?
5 Q. Yes.
6 A. M-438-D1.
7 Q. Can you confirm for me that
8 Section RH-RH runs approximately from west to east
9 through the landfill?
10 A. Section RH-RH runs approximately
11 midway through the landfill, east-west.
12 Q. You have not shown a section like
13 that in your report?
14 A. That is correct.
15 Q. Perhaps while we are waiting for
16 the coloured version we can each pull out our own copy
17 of the Geocon report and look at Figure 5 which is RH-
18 RH.
19 A. Figure 5?
20 Q. I believe it is Figure 5. Yes.
21 Can you -- what I want you to do, Mr. Petrie, you could
22 -- we'll find it easier when we get the mounted one
23 here but in the meantime I would ask you to look at the
24 west portion of the site around MB-OW-4.
25 A. I have it.



1 Q. The thickness, I'm suggesting and
2 would like you to confirm that the thickness of the
3 upper till beneath the base of the proposed landfill is
4 less than three metres, approximately 2.8?

5 A. I have a little trouble
6 confirming it on this scale. It appears to be
7 interpreted thus. I believe we had quite different
8 thicknesses for the upper till there. We had
9 undertaken a similar exercise in Section B.5 in our
10 report in Exhibit B-618. The figure addressing that
11 exercise is the figure on page 60 for which we report
12 base elevation of upper till at each piezometer and I
13 note for MB-1 and OW-4 we have interpreted the base of
14 the upper till as 173.9 metres in elevation. Looking
15 at this figure here you appear to have a base elevation
16 in excess of 175. I am just eyeballing the figure. We
17 appear to have a different base elevation.

18 MS CRONK: Mr. Chairman, can I ask for
19 clarification of that number again, Mr. Petrie?

20 MR. PETRIE: Yes, I can.

21 MS CRONK: Thank you.

22 MR. PETRIE: I referred to page 60 of
23 Exhibit B-618 where we have provided base elevations of
24 the upper till. The indication for that is in the
25 bottom left-hand corner of the legend where we have a



1 Q. I am suggesting that below that
2 line we are into a sandy silt. The log indicates clay,
3 numerous sand seams and that demarcates the upper and
4 lower till.

5 A. We have reviewed the same data
6 and interpreted at, I believe, a depth of 7.92 metres
7 which is consistent with the elevation of 173.9 that we
8 have provided on Figure 60.

9 Q. Mr. Petrie, let us understand
10 which interpretation are you talking about when it's
11 179.2 metres ...

12 A. CRA's interpretation.

13 Q. ... is that your interpretation?

14 A. Yes, I am.

15 Q. Whose interpretation is that?

16 A. CRA's.

17 Q. CRA doesn't speak except by
18 individuals.

19 A. I have reviewed the data and I
20 agree with that interpretation.

21 Q. Whose interpretation originally
22 was it?

23 A. I cannot speak to that. I cannot
24 say specifically. It would be one of my colleagues who
25 worked through more data than I and we went through



1 each of the data sets again.

2 Q. Tell me about the qualifications
3 of the one of your colleagues, the one who came up with
4 the original interpretation.

5 A. The one who did it is a geologist
6 with about five years' experience.

7 Q. Mr. Petrie, which way do you want
8 to have it? We have now taken the upper till to
9 include, by looking at the borehole log, between five
10 and 7.32 metres. I am looking at a supposedly -- this
11 is a critical layer now, Mr. Petrie, this is a critical
12 layer to protect the residents around Site D. Numerous
13 sand seams, sandy silt and then below 7.32 again clayey
14 silt with sand seams, grey-brown, fine sand, many
15 pebbles. Do you want that to be interpreted as the
16 critical layer of Site D, Mr. Petrie?

17 A. It is definitely more sandy by
18 its description than some of that which appears above
19 although we have sand partings described in general
20 terms above that elevation. We have the words "sand
21 pockets." We have clay, silt material described
22 elsewhere.

23 Q. Sorry. So, what is your
24 interpretation? Do you want to have the upper
25 unweathered till to go down to include those features?



1 Mr. Petrie. How thick is the upper till beneath the
2 base of the proposed landfill there, your
3 interpretation? I am suggesting that it is also less
4 than three metres there, at least according to the
5 Geocon cross-section.

6 A. Excuse me, your referenced
7 HC5-84, I have a reference on page 60 of our document
8 being 175.2. Reading the cross-section Figure 5 of
9 Trow I believe I get 175.4 which is just within the
10 thickness of a line that we're dealing with at the same
11 elevations. With reference to the proposed base
12 elevation of the landfill I believe Trow's landfill
13 does not extend that far but I see a base elevation
14 there of 178. Looking at Trow's original drawings as we
15 understand it, yes, at that corner there is a base
16 elevation of approximately 178 so that gives us a
17 thickness there of 2.6 metres from Trow's base
18 elevation to the interpreted position of the base of
19 the upper till.

20 Q. And that is less than what you
21 had said was the minimum for your purposes?

22 A. The minimum for our purposes was
23 based on our design.

24 Q. In any event you had, you told me
25 you had used a number of calculations and had assumed



1 that the base, the difference between the base, the
2 thickness of this upper till was something over three
3 metres?

4 A. Yes, 3.2 but that was based on a
5 different design, Mr. Estrin.

6 Q. Mr. Petrie, what was the
7 calculation on page 93 based on?

8 A. It was based solely on Trow's
9 data as was taken from, as indicated on the previous
10 page, being 92.

11 Q. Based on a thickness of four
12 metres?

13 A. Correct. All those variables in
14 that calculation are taken from Trow with the exception
15 of the groundwater velocity term. Recognizing that in
16 Part B of the report we had evaluated the landfill
17 design and identified some points for where the till
18 was definitely going to be thinner than that suggested
19 by Trow. We undertook that new design and came out
20 with a different value. Can I point out one other
21 thing? On page 61 of Exhibit B-618 we note in the
22 second complete paragraph, two-thirds of the way
23 down...

24 Q. What page are you on?

25 A. Sixty-one in the paragraph that



1 is two-thirds of the way down the page. The paragraph
2 reads:

3 "Also the minimum thickness of
4 unweathered upper till underlying each
5 cell as interpreted by CRA varies from
6 2.6 to 3.6 metres. This contrasts with
7 the four metres used by Trow for the
8 impact assessment."

9 So we've identified there we are not in agreement with
10 the thicknesses used by Trow.

11 Q. Thank you. So that in effect I
12 suggest it is inappropriate to produce an impact
13 calculation, as you have done on page 93, which assumes
14 a thickness of four metres, when elsewhere in your
15 report you in fact say your interpretation has that
16 unweathered upper till varying from 2.6 to 3.6 metres?

17 A. I just indicated that we simply
18 took the Trow numbers and varied them by one parameter
19 in order that we would be able to draw some comparisons
20 with the numbers previously before the Board.

21 Q. Mr. Petrie, if you wanted to
22 present a fair impact calculation you would have taken
23 what you yourselves have determined to be the minimum
24 thickness of the unweathered upper till of 2.6 to 3.6
25 metres?



1 A. No, I cannot agree to that
2 completely. We had evaluated the landfill and found
3 that the thickness of the till was such that other
4 conditions for a hydraulic trap could not be met. I
5 therefore do not feel it appropriate to evaluate a
6 landfill design that we could not support. That in
7 essence is, I believe, your question.

8 Q. My question to you, Mr. Petrie, I
9 put it to you that you have not done a fair impact
10 calculation on page 93, that to the extent that that is
11 meant to tell this Board that there is not going to be
12 any problem at Site D based on what you say the
13 hydraulic conductivity is, you ought to not only have
14 changed the values that you thought were appropriate to
15 change but changed the other ones as well?

16 A. I disagree. We were not
17 supporting the Trow landfill design. The thickness of
18 the till is a function of the Trow landfill design. So
19 we undertook a re-evaluation of that design and for
20 that re-evaluation we have noted on page 96, the very
21 last paragraph:

22 "This alternative design incorporates a
23 minimum unweathered upper till thickness
24 of 3.2 metres."

25 We then used a minimum thickness in the following



1 discussions.

2 Q. Mr. Petrie, come on, let us look
3 at what it says on pages 92 and 93. The graph I took
4 you to was on page 93. Do you see that? Let us look
5 at 92. You weren't talking in this discussion about
6 the redesigned site; you were talking about the Trow
7 site?

8 A. Correct.

9 Q. Yes, and the figures you have
10 produced on page 93 should have taken into account what
11 you have already just pointed out to me that the
12 thickness of that unweathered till is substantially
13 less than Trow said it was. You knew that, you
14 reported it. It's only when you get to the next chart
15 further over on page 98 that we get to a modelling
16 based on your redesign, I suggest?

17 A. That is correct.

18 Q. So it's not appropriate and it's
19 completely misleading for you to take the subsequent
20 pages. I'm asking you if you would just address
21 yourself to the impact calculation reproduced on page
22 93 and I'm saying that you misled us and misled this
23 Board by not taking into account the minimum thickness
24 which is substantially less than you used in this
25 calculation. That's all I'm asking.



1 Q. The thickness, I'm suggesting and
2 would like you to confirm that the thickness of the
3 upper till beneath the base of the proposed landfill is
4 less than three metres, approximately 2.8?

5 A. I have a little trouble
6 confirming it on this scale. It appears to be
7 interpreted thus. I believe we had quite different
8 thicknesses for the upper till there. We had
9 undertaken a similar exercise in Section B.5 in our
10 report in Exhibit B-618. The figure addressing that
11 exercise is the figure on page 60 for which we report
12 base elevation of upper till at each piezometer and I
13 note for MB-1 and OW-4 we have interpreted the base of
14 the upper till as 173.9 metres in elevation. Looking
15 at this figure here you appear to have a base elevation
16 in excess of 175. I am just eyeballing the figure. We
17 appear to have a different base elevation.

18 MS CRONK: Mr. Chairman, can I ask for
19 clarification of that number again, Mr. Petrie?

20 MR. PETRIE: Yes, I can.

21 MS CRONK: Thank you.

22 MR. PETRIE: I referred to page 60 of
23 Exhibit B-618 where we have provided base elevations of
24 the upper till. The indication for that is in the
25 bottom left-hand corner of the legend where we have a



1 bracketed elevation and the elevations are written in
2 in italics. Looking for the installation
3 MB-(1N)-OW-4 up in the map above we have a base
4 elevation of 173.9 metres. I am referring back to
5 Geocon's Figure 5, it appears that their base elevation
6 is in excess of 175 metres in elevation being the base
7 elevation of the upper till as I see it interpreted by
8 Geocon.

9 DR. KINGHAM: Can you give us a little
10 bit more precision on that number by scaling it off the
11 cross-section?

12 MR. PETRIE: Yes, I can. I think it
13 looks like 177 metres in elevation for MB-OW-4 as I
14 read Geocon's Figure 5.

15 MR. ESTRIN: Q. What was the number you
16 were reading again?

17 MR. PETRIE: A. I was using a scale at
18 installation MB-OW-4 from Figure 5, I read that as an
19 elevation of 177 for the base elevation of what is
20 described as clayey silt till which I believe to be the
21 upper till.

22 Q. One seventy-seven?

23 A. That is as I am reading Geocon's
24 Figure 5.

25 Q. I suggest it is really, to be



1 more accurate, if you can try and help us to be more
2 accurate, it is 176.7 or 0.8?

3 A. I know it's not perfectly on a
4 line on my scale. You are suggesting it should be
5 176.8?

6 Q. Yes.

7 A. I can agree with that. While
8 reading a pencil line that is about 0.2 of a metre
9 thick, yes.

10 Q. I can appreciate that. If you
11 were to then give us the thickness at that point of the
12 upper till beneath the base?

13 A. I'm not sure from Figure 5 what
14 is the interpreted upper till. It would appear to be
15 from ground level to that elevation and if ground level
16 is 181.8 then we are looking at about five metres.

17 Q. You are trying to get some
18 assistance from the borehole log?

19 A. No, I'm waiting for you.

20 Q. Sorry. Perhaps to assist you if
21 you look at the borehole log for that hole in the
22 Geocon report, M-438, I am directing your attention to
23 the depth of 5.05 metres.

24 A. Five point zero five metres, I
25 have it.



1 Q. I am suggesting that below that
2 line we are into a sandy silt. The log indicates clay,
3 numerous sand seams and that demarcates the upper and
4 lower till.

5 A. We have reviewed the same data
6 and interpreted at, I believe, a depth of 7.92 metres
7 which is consistent with the elevation of 173.9 that we
8 have provided on Figure 60.

9 Q. Mr. Petrie, let us understand
10 which interpretation are you talking about when it's
11 179.2 metres ...

12 A. CRA's interpretation.

13 Q. ... is that your interpretation?

14 A. Yes, I am.

15 Q. Whose interpretation is that?

16 A. CRA's.

17 Q. CRA doesn't speak except by
18 individuals.

19 A. I have reviewed the data and I
20 agree with that interpretation.

21 Q. Whose interpretation originally
22 was it?

23 A. I cannot speak to that. I cannot
24 say specifically. It would be one of my colleagues who
25 worked through more data than I and we went through



1 each of the data sets again.

2 Q. Tell me about the qualifications
3 of the one of your colleagues, the one who came up with
4 the original interpretation.

5 A. The one who did it is a geologist
6 with about five years' experience.

7 Q. Mr. Petrie, which way do you want
8 to have it? We have now taken the upper till to
9 include, by looking at the borehole log, between five
10 and 7.32 metres. I am looking at a supposedly -- this
11 is a critical layer now, Mr. Petrie, this is a critical
12 layer to protect the residents around Site D. Numerous
13 sand seams, sandy silt and then below 7.32 again clayey
14 silt with sand seams, grey-brown, fine sand, many
15 pebbles. Do you want that to be interpreted as the
16 critical layer of Site D, Mr. Petrie?

17 A. It is definitely more sandy by
18 its description than some of that which appears above
19 although we have sand partings described in general
20 terms above that elevation. We have the words "sand
21 pockets." We have clay, silt material described
22 elsewhere.

23 Q. Sorry. So, what is your
24 interpretation? Do you want to have the upper
25 unweathered till to go down to include those features?



1 A. I have interpreted it as the
2 upper till. I recognize that some of the descriptions
3 there are different from the descriptions above
4 although the words "sand partings" and the like appears
5 elsewhere in the till above that point. I note that it
6 is described as clay silt as it is down between 7.3 to
7 7.92 metres. The colouring grey-green is something
8 that is described elsewhere as I recall for the upper
9 till. I suspect the delineation between upper till and
10 lower till at that point is open to some debate.

11 Q. Mr. Petrie, how deep -- what is
12 the bottom elevation of the lower -- I'm sorry -- of
13 the upper unweathered till in MB-OW-4?

14 A. I believe it to be 7.92 metres in
15 depth.

16 Q. Now, so at that location we have,
17 what shall we call it, a sandier phase of your
18 unweathered till?

19 A. To use the words I used before,
20 that would be consistent, yes.

21 Q. Mr. Petrie, you recall from my
22 discussion with you of borehole 1-85 ...

23 A. I believe that was the other one
24 in which we identified sandy phases.

25 Q. I thought that was the only one.



1 A. That is correct.

2 Q. Now we have two with the sandier
3 phase?

4 A. We do.

5 Q. Perhaps you would like to put
6 1-85 back into the calculation of the geometric mean
7 and bring it back to 10^{-7} in that case, as Dr.
8 Charlesworth did.

9 A. Permeability ...

10 Q. Yes, it is no longer a singular,
11 isolated event according to your geological
12 interpretation?

13 A. You pointed out to me a second
14 portion of this upper till which is not as uniform as
15 elsewhere on the site. I believe it would be very
16 conservative to be incorporating a value from HC1-85.
17 I believe that value is in the order of 10^{-6} for the
18 permeability.

19 Q. What I am suggesting, Mr. Petrie,
20 is that careful analysis of the data for the critical
21 layer, the more carefully we look, the more we are
22 going to find these variations?

23 A. We have reviewed the data and we
24 have come to some conclusions.

25 Q. Yes. Let us look at HC5-84,



1 Mr. Petrie. How thick is the upper till beneath the
2 base of the proposed landfill there, your
3 interpretation? I am suggesting that it is also less
4 than three metres there, at least according to the
5 Geocon cross-section.

6 A. Excuse me, your referenced
7 HC5-84, I have a reference on page 60 of our document
8 being 175.2. Reading the cross-section Figure 5 of
9 Trow I believe I get 175.4 which is just within the
10 thickness of a line that we're dealing with at the same
11 elevations. With reference to the proposed base
12 elevation of the landfill I believe Trow's landfill
13 does not extend that far but I see a base elevation
14 there of 178. Looking at Trow's original drawings as we
15 understand it, yes, at that corner there is a base
16 elevation of approximately 178 so that gives us a
17 thickness there of 2.6 metres from Trow's base
18 elevation to the interpreted position of the base of
19 the upper till.

20 Q. And that is less than what you
21 had said was the minimum for your purposes?

22 A. The minimum for our purposes was
23 based on our design.

24 Q. In any event you had, you told me
25 you had used a number of calculations and had assumed



1 that the base, the difference between the base, the
2 thickness of this upper till was something over three
3 metres?

4 A. Yes, 3.2 but that was based on a
5 different design, Mr. Estrin.

6 Q. Mr. Petrie, what was the
7 calculation on page 93 based on?

8 A. It was based solely on Trow's
9 data as was taken from, as indicated on the previous
10 page, being 92.

11 Q. Based on a thickness of four
12 metres?

13 A. Correct. All those variables in
14 that calculation are taken from Trow with the exception
15 of the groundwater velocity term. Recognizing that in
16 Part B of the report we had evaluated the landfill
17 design and identified some points for where the till
18 was definitely going to be thinner than that suggested
19 by Trow. We undertook that new design and came out
20 with a different value. Can I point out one other
21 thing? On page 61 of Exhibit B-618 we note in the
22 second complete paragraph, two-thirds of the way
23 down...

24 Q. What page are you on?

25 A. Sixty-one in the paragraph that



1 is two-thirds of the way down the page. The paragraph
2 reads:

3 "Also the minimum thickness of
4 unweathered upper till underlying each
5 cell as interpreted by CRA varies from
6 2.6 to 3.6 metres. This contrasts with
7 the four metres used by Trow for the
8 impact assessment."

9 So we've identified there we are not in agreement with
10 the thicknesses used by Trow.

11 Q. Thank you. So that in effect I
12 suggest it is inappropriate to produce an impact
13 calculation, as you have done on page 93, which assumes
14 a thickness of four metres, when elsewhere in your
15 report you in fact say your interpretation has that
16 unweathered upper till varying from 2.6 to 3.6 metres?

17 A. I just indicated that we simply
18 took the Trow numbers and varied them by one parameter
19 in order that we would be able to draw some comparisons
20 with the numbers previously before the Board.

21 Q. Mr. Petrie, if you wanted to
22 present a fair impact calculation you would have taken
23 what you yourselves have determined to be the minimum
24 thickness of the unweathered upper till of 2.6 to 3.6
25 metres?



1 A. No, I cannot agree to that
2 completely. We had evaluated the landfill and found
3 that the thickness of the till was such that other
4 conditions for a hydraulic trap could not be met. I
5 therefore do not feel it appropriate to evaluate a
6 landfill design that we could not support. That in
7 essence is, I believe, your question.

8 Q. My question to you, Mr. Petrie, I
9 put it to you that you have not done a fair impact
10 calculation on page 93, that to the extent that that is
11 meant to tell this Board that there is not going to be
12 any problem at Site D based on what you say the
13 hydraulic conductivity is, you ought to not only have
14 changed the values that you thought were appropriate to
15 change but changed the other ones as well?

16 A. I disagree. We were not
17 supporting the Trow landfill design. The thickness of
18 the till is a function of the Trow landfill design. So
19 we undertook a re-evaluation of that design and for
20 that re-evaluation we have noted on page 96, the very
21 last paragraph:

22 "This alternative design incorporates a
23 minimum unweathered upper till thickness
24 of 3.2 metres."

25 We then used a minimum thickness in the following



1 discussions.

2 Q. Mr. Petrie, come on, let us look
3 at what it says on pages 92 and 93. The graph I took
4 you to was on page 93. Do you see that? Let us look
5 at 92. You weren't talking in this discussion about
6 the redesigned site; you were talking about the Trow
7 site?

8 A. Correct.

9 Q. Yes, and the figures you have
10 produced on page 93 should have taken into account what
11 you have already just pointed out to me that the
12 thickness of that unweathered till is substantially
13 less than Trow said it was. You knew that, you
14 reported it. It's only when you get to the next chart
15 further over on page 98 that we get to a modelling
16 based on your redesign, I suggest?

17 A. That is correct.

18 Q. So it's not appropriate and it's
19 completely misleading for you to take the subsequent
20 pages. I'm asking you if you would just address
21 yourself to the impact calculation reproduced on page
22 93 and I'm saying that you misled us and misled this
23 Board by not taking into account the minimum thickness
24 which is substantially less than you used in this
25 calculation. That's all I'm asking.



1 A. I disagree entirely. I have
2 noted on page 63 that CRA is in general agreement that
3 a hydraulic trap landfill design can be implemented,
4 however, a modified design will have to be considered
5 in order to achieve the hydraulic trap design in a
6 portion of the site. I have no intention of misleading
7 anyone with respect to the impact assessment work
8 provided.

9 Q. Then why did you not, Mr. Petrie,
10 in the calculation you produced on page 93 take into
11 account what it says back on page 62, 61, whatever,
12 where you say in the second full paragraph:

13 "The minimum thickness is 2.6 to 3.6
14 metres."

15 That would have been fair?

16 A. I could have done that.

17 Q. That would have been accurate,
18 wouldn't it?

19 A. Mr. Estrin, I have indicated
20 already that we have not agreed with Trow's landfill
21 design. I have also suggested that the reason we
22 undertook this work was to provide some measure of
23 comparison between that developed by Trow and that
24 developed by ourselves. Having done that we then
25 incorporated an assessment of a thing called conceptual



1 landfill design.

2 Q. Mr. Petrie, you will have a lot
3 of opportunity to talk about your new design. I am
4 talking about the impact assessment you presented to
5 this Board. Your intention may have not been to
6 mislead. I hear what you're saying. I suggest to you
7 the effect is to mislead.

8 A. I categorically disagree with
9 that, Mr. Estrin.

10 Q. Unless one goes back and looks at
11 the data you yourself produced and compare it, unless
12 you do that you wouldn't know that the graph on page 93
13 is completely inaccurate and without meaning?

14 A. I don't agree with that at all.
15 I pointed out to you, the thicknesses. I believe you
16 were not aware of them until I did it. We went through
17 this in chief, I pointed out we could not agree with
18 the landfill design. It was proposed and I have a
19 notation in my text here that I read that paragraph. I
20 believe I read that paragraph pointing out that the
21 minimum thickness of the unweathered till as we
22 interpret Trow's design was the 2.6 to 3.6 metres. I
23 cannot interpret that to be misleading in any way,
24 shape or form.

25 Q. You did not take it into account



1 in this calculation on page 93?

2 A. We did not believe that the Trow
3 landfill design met their landfill criteria and we did
4 not support their design.

5 Q. Mr. Petrie, let us look at the
6 report on page 78. Let us look at the thickness of the
7 unweathered upper till at HC2-85. Maybe you can put up
8 the blowup of this cross-section.

9 A. Which one is that?

10 Q. It is A-A' I believe. I'm sorry,
11 there may not be a blowup of this.

12 A. I have HC2-85 on B-618.

13 Q. That may do it. What I'm asking
14 you specifically is look in the vicinity of HC2-85 and
15 I am suggesting to you that the thickness of the
16 unweathered upper till as shown on this diagram which
17 your firm prepared is about 2.3 metres?

18 A. You are referencing that to the
19 thickness of the upper unweathered till?

20 Q. Yes.

21 A. Yes, it would appear that the
22 base of weathering, the separation between the base of
23 weathering and the top of the till is that 2.3 metres.

24 Q. Mr. Petrie, that is even a lesser
25 thickness than you describe on page 61. The minimum



1 thickness you gave is 2.6 metres on page 61 and now you
2 are telling me it is only 2.3, at least at that
3 location?

4 A. It is all relevant to the
5 excavation depths. The base of excavation is what is
6 provided in Trow's document across the site. We took
7 the base of excavation to the base of the upper till to
8 provide the numbers shown on page 61.

9 Q. Mr. Petrie, I don't care where
10 Trow is going to excavate.

11 A. That was the document I was
12 reviewing.

13 Q. I'm asking, Mr. Petrie, based on
14 your own report how thick is the unweathered upper till
15 at HC2-85 and you're telling me you do agree it is 2.3
16 metres?

17 A. As we have shown it there, yes.

18 Q. By excavating you are not going
19 to make it thicker?

20 A. I think we can agree on that.

21 Q. And, Mr. Petrie, it was that
22 piezometer screen in the unweathered upper till, in the
23 lower till at CC-OW-4 that responded to the pump test
24 indicating hydraulic conductivity between the lower
25 till and the UGU?



1 A. I'm sorry, can you say that
2 again?

3 Q. It was the piezometer in that
4 borehole?

5 A. HC2-84 is in the granular...

6 Q. CC-OW-2 immediately nearby.

7 A. CC-OW-2 is nearby.

8 Q. Yes, and it was the piezometer
9 screen in very close proximity, according to this, at
10 least the way you have drawn it here and it was that
11 one that responded to the pump test in the UGU?

12 A. CC-OW-2 responded to the pump
13 test in the UGU as I recall, yes.

14 Q. Mr. Petrie, do you think we could
15 get even less of a till at a -- a critical layer at
16 Site D than 2.3? Shall we keep looking or shall we go
17 on to something else? Don't you think it was your job,
18 sir, when coming here to make a prediction and
19 calculation about the impact of a landfill site at Site
20 D to thoroughly look at the data and tell us what the
21 minimum numbers were and plug those into your
22 calculations?

23 A. We have provided the minimum
24 thickness as we have interpreted. You are pointing out
25 to me that at one hole, being HC2-85, the depth of



1 weathering as I have interpreted it extends a little
2 deeper than elsewhere on the site. I have not
3 considered that in addressing the relative elevations
4 between the base of the proposed landfill and the base
5 of the upper unweathered till.

6 Q. So what is the answer to my
7 question? Do you not think it appropriate as a
8 hydrogeologist asking this Board to approve a major new
9 landfill site to come and make impact predictions based
10 on the actual data rather than on data that fits your
11 theory?

12 A. I consider that an inappropriate
13 question, Mr. Estrin.

14 Q. I consider what you've done
15 inappropriate and I'm asking you to tell me whether you
16 agree.

17 A. The base of weathering at one
18 borehole you have just indicated to me is lower than we
19 have indicated elsewhere on the site. For the
20 condition with the hydraulic trap in operation,
21 essentially that portion of the upper weathered till
22 will not impact the calculations.

23 Q. Mr. Petrie, you were calculating
24 what the impact would be if the trap didn't work?

25 A. That is correct, I was.



1 Q. All right, let us move along.
2 Mr. Petrie, let us suppose that the lower till directly
3 beneath the upper till is part of the aquifer as we
4 have already discussed it could be this morning based
5 on some of the pump test responses.

6 A. I don't recall that the till was
7 part of the aquifer.

8 Q. Do you remember you told me the
9 pump test was part of the -- it's right behind you.
10 Look at B-618-P84, the blue mark in the upper part of
11 the till and you told me that should be considered part
12 of the upper aquifer?

13 A. I said it responded like an
14 aquifer piezometer. I didn't say the whole of the
15 upper till responded like an aquifer.

16 Q. We don't have other
17 instrumentation at an equivalent place or at least if
18 we did it wasn't monitored according to the funny pump
19 test monitoring that went on here. I am suggesting to
20 you that I would like you to tell me what you consider
21 to be a reasonable value for the head in the lower till
22 near HC2-85.

23 A. A reasonable value for the head
24 in the lower till near HC2-85, it would lie somewhere
25 between the head in the upper till and the head in the



1 upper granular unit.

2 Q. What would that be?

3 A. Well, we have a range of 182.61
4 metres in elevation to 181.65. Somewhere between those
5 elevations one could expect head in the lower till at
6 that point.

7 Q. Let us look at page 92 of your
8 report. The failure case you considered in this
9 section used the Trow gradient of 0.85; is that
10 correct?

11 A. If that was Trow's input data I
12 believe that was correct. There is some uncertainty in
13 my mind as to which value Trow used. In one portion of
14 the report they use a value of 0.85 and in another
15 portion of the report they use a value of 0.5. I
16 believe that is indicated on the previous page of the
17 Trow report, the previous page we looked at earlier,
18 page 88 of Exhibit H-39. It is a value of 0.85 for the
19 vertical gradient with the system failed.

20 Q. So that is the value you used in
21 the calculation?

22 A. That is correct.

23 Q. For the gradient?

24 A. Yes.

25 Q. Would you agree that a gradient



1 of 0.85 corresponds to a head drop of 3.4 metres across
2 the four metres of upper till?

3 A. Could you repeat those numbers?

4 Q. That a gradient of 0.85
5 corresponds to a head drop of 3.4 metres cross four
6 metres of upper till?

7 A. I recall that to be the case,
8 yes. Yes, I just checked the calculation, I agree.

9 Q. If the head in the aquifer is
10 181.8, for example look at page 84 of CC-OW-2?

11 A. One eighty one point eight.

12 Q. Then this corresponds to a head
13 in the waste of 181.8 plus 3.4 metres?

14 A. That is correct.

15 Q. Or 185.2 metres?

16 A. Correct.

17 Q. If the base of the landfill is at
18 an elevation of 179 metres as proposed by Trow the
19 height of mounding is that figure 185.2 minus 179 or
20 6.2 metres?

21 A. Correct.

22 Q. Now, if the upper till is only
23 2.3 metres thick, for example as we've just looked at
24 HC2-85 instead of four metres thick, then assuming the
25 same base elevation for the landfill of 179 the



1 gradient would be equal to the head drop across the
2 upper till of 3.4 metres divided by the thickness of
3 the upper till which is 2.3 metres, giving a gradient
4 of 3.4 divided by 2.3 or about 1.5, 1.478?

5 A. That calculation is correct,
6 yes.

7 Q. Would you agree that that
8 gradient is about 75 per cent greater than the value of
9 0.85 that you used?

10 A. That appears to be the case. Can
11 I just go back to the value of 2.3? Am I correct that
12 you are applying that as the thickness of the upper
13 till being the thickness beneath the base of weathering
14 at HC2-85?

15 Q. That is the hole we last
16 discussed, yes.

17 A. I am just referring to the
18 borehole log for HC2-85 and I'm not entirely sure how
19 we generated that line for the base of weathering. I
20 would like to check that and come back to that.

21 Q. If you wish to re-interpret your
22 cross-sections.

23 A. I wish to check the borehole log
24 and be comfortable with the number.

25 Q. It's your number, Mr. Petrie.



1 A. That is the number. It's the
2 number I've shown on the cross-section. I'm indicating
3 to you I want to check the number.

4 Q. Mr. Petrie, what downward
5 gradient velocity would this gradient give? You could
6 calculate that I guess by assuming your conductivity of
7 1.4×10^{-8} ?

8 A. And using a gradient of, say,
9 1.5.

10 Q. Yes?

11 A. Or 1.48 rounded out to two
12 decimal places.

13 Q. If you like.

14 A. For a K of 1.4×10^{-8} centimetres
15 per second, I guess you ought to have a porosity term
16 in there if you want to have a velocity.

17 Q. Zero point two five.

18 A. That is the value that has been
19 used by Trow. I have 8.29×10^{-10} metres per second.
20 Which units would you prefer it in?

21 Q. Can you give me metres per annum
22 or millimetres per annum?

23 A. We have 26.14 millimetres per
24 annum.

25 Q. Thank you. If the base of the



1 landfill, Mr. Petrie, were raised and, Mr. Crutcher,
2 you may want to confirm this, as I understand it your
3 redesign would raise the base to 179.6 metres on
4 average, that is based on Plan 2 in your design report?
5 I am looking around manhole 26.

6 MR. CRUTCHER: A. I would have to check
7 that.

8 Q. Would you do that for me? Let's
9 assume that. If the base of the landfill was raised as
10 CRA is proposing to 179.6, say, on the east side or
11 around manhole 26?

12 MR. PETRIE: A. One seventy-nine point
13 six.

14 Q. Then for the same six-metre mound
15 the head drop would be increased from 3.4 metres to
16 four metres, increased, the head drop?

17 A. The head drop over what?

18 Q. If we raised the base ...

19 A. To 179.6?

20 Q. ... had the same mounding under
21 failure conditions.

22 A. That was the 6.2 metres.

23 Q. Six metres. The head drop that
24 we had previously calculated of 3.4 metres under
25 natural...



1 A. Okay, yes.

2 Q. ... would be increased by 0.6
3 metres raising the base of the landfill 0.6 metres to
4 four metres, giving a gradient of 4/2.3 or 1.74?

5 A. I understand that 4/ 2.3 is 1.74
6 but I haven't managed to follow the gist of your
7 argument.

8 Q. You don't recall where the 2.3
9 was coming from?

10 A. I've got to take each step at a
11 time.

12 Q. I understand, it's not easy.

13 A. Shall we start again? We are
14 taking the base of the landfilling at 179.6?

15 Q. We could round it off to 179.

16 A. You are saying keep the same
17 mound as the situation described earlier and that mound
18 was a 6.2-metre mound?

19 Q. We can round it off to six
20 metres.

21 A. A six-metre mound.

22 Q. I'm saying the head drop would be
23 -- we had previously calculated across the upper till.

24 A. That was using the water levels
25 at CC-OW-2.



1 Q. Which was 3.4 metres?

2 A. That is 3. -- that 3.4 came from
3 185.2 - 181.8 = 3.4.

4 Q. I am asking you to -- the head
5 drop would decrease from that 3.4 by the 0.6 metres you
6 are raising the base?

7 A. Correct.

8 Q. To four metres?

9 A. Correct.

10 Q. Which gives us a gradient under
11 the situation of the redesign landfill base of -- the
12 way I get that is the four metres ...

13 A. Yes, I'm with you to the four
14 metres.

15 Q. ... divided by the 2.3, the
16 thickness of the upper till.

17 A. So you are -- your thickness of
18 the upper till being 2.3 metres there suggests that the
19 base of the upper till is about 175, 177, is that what
20 you are telling me?

21 Q. I don't know. You can't get more
22 of an upper till if it's only 2.3 metres thick.

23 A. You are taking the 2.3 metres
24 from HC2-85; correct?

25 Q. Yes.



1 A. I indicate to you I wish to
2 reflect upon that over the break but taking that as a
3 given you changed ...

4 Q. That will give us a gradient of
5 $4 / 2.3$ which is 1.74?

6 A. Correct.

7 Q. Which is twice the gradient which
8 I think you used in this calculation?

9 A. That is correct but what you are
10 suggesting then is that one could excavate to 179.6 and
11 were one to note fracturing in that horizon not do
12 anything about it; is that what you're saying? You are
13 ignoring the thickness of till between an elevation
14 approximately 176 -- I beg your pardon -- elevation 178
15 and the base of landfilling.

16 Q. I don't think so, Mr. Petrie.
17 The thickness of the till, the critical till remains
18 the same as I understand it.

19 A. But you are ignoring the vertical
20 thickness between 179.6 and ...

21 Q. I thought the weathered till was
22 not something you chose to rely on.

23 A. No, I would not. I am just
24 indicating to you that if one were to excavate and
25 encounter weathered till in the floor I would suggest



1 some engineering considerations would have to be taken
2 at that time. It would not be the advice of a
3 hydrogeologist if I may speculate on what another
4 hydrogeologist would or would not do. It would not be
5 my advice were fracturing and weathering encountered on
6 the floor to be left there.

7 Q. If it is removed?

8 A. One would remould it and replace
9 it to -- the elevations would be more critical.

10 Q. You really would have to be very,
11 very careful?

12 A. As I indicated to you from
13 borehole 2-85 I am puzzled as to how the line of
14 weathering was drawn on that section. I would refer to
15 that again. If no weathering is encountered of any
16 sort in the borehole floor then we would have the full
17 thickness of till at that point which we haven't
18 discussed.

19 Q. If the gradient is doubled then
20 the downward flow and the groundwater velocity will be
21 doubled?

22 A. That is correct, yes.

23 Q. The downward Darcy velocity we
24 could calculate?

25 A. We could. Can I just reflect on



1 another point? For the CRA design there are different
2 drain spacings and a sand blanket. For the same
3 failure scenario we may have a different head, probably
4 lower but if it was not six it would probably be lower.

5 Q. I'm sure we will hear more about
6 that in due course but we can calculate the downward
7 Darcy velocity by taking your conductivity and the
8 gradient that I have asked you to assume there, 1.74?

9 A. Correct.

10 Q. I get that to be about 0.007
11 metres per annum.

12 A. I don't get the same number.

13 Q. Point four x 10^{-8} ?

14 A. Point four or 1.4?

15 Q. One point four.

16 A. I will do the number again. Yes,
17 multiplying by a gradient of 1.74 and dividing by a
18 porosity of 0.25 I get a value there in metres per
19 second or millimetres per annum, I get 30.73
20 millimetres per annum.

21 Q. I'm sorry, what was that?

22 A. Three zero point seven three
23 millimetres per annum. I got that twice. So your
24 number was ...

25 Q. ... 0.007 metres.



1 A. I have a three and you have a
2 seven. We had different numbers there.

3 Q. Maybe we can check that at the
4 break.

5 A. Yes.

6 Q. Using this method we can
7 calculate the groundwater velocity?

8 A. It was a method of calculating
9 groundwater velocity, yes.

10 Q. Mr. Petrie, what I guess I am
11 asking you is if your -- there are methods of doing
12 this and if you were to repeat your contaminant
13 transport analysis like you did on page 93 and used a
14 minimum base for the landfill, used the base of the
15 landfill as proposed by CRA and a 2.3-metre-thick
16 unweathered upper till, I am suggesting, Mr. Petrie,
17 you would get increases in chloride concentrations in
18 the aquifer of 30 milligrams per litre in about 15
19 years?

20 A. I don't know where you get the 30
21 milligrams per year or for the 15 years.

22 Q. Just let me finish, and increases
23 in excess of 100 milligrams per litre in a little more
24 than 20 years even assuming your K value of 1.4×10^{-8}
25 for the unweathered upper till?



1 A. I cannot speak to those numbers.

2 Q. Did you do any such calculation?

3 A. No, I did not. The calculations
4 we did were based on a minimum thickness of CRA's
5 design and that is reported on page 98.

6 Q. Mr. Petrie, I put it to you as I
7 have before that the calculation on page 93 doesn't
8 really assist this Board because it is not based on
9 real data, is not based on the correct diffusion
10 coefficient, it is not based on real values for minimum
11 thicknesses of the upper till. It gives us values
12 essentially which are implausibly low and it doesn't
13 really assist the board; would you agree?

14 A. I believe I indicated to you that
15 these numbers were taken straight from Trow and I was
16 comparing Trow's results to ours recognizing we were
17 using a different value for hydraulic conductivity. I
18 can only change one variable at a time in order to make
19 a comparison. I also indicated to you that we cannot
20 agree with Trow's landfill design, per se.

21 Q. You can only change one value at
22 a time, Mr. Petrie?

23 A. In order to provide a meaningful
24 comparison, you can change one variable. I'm saying by
25 changing one variable here are the comparisons.



1 Q. If you wanted to do a meaningful
2 impact calculation you could change more than one
3 variable?

4 A. To do a meaningful calculation,
5 we've done that on page 98.

6 Q. Based on your new design?

7 A. That is correct.

8 MR. ESTRIN: Mr. Chairman, would this be
9 an appropriate time to take a break?

10 MR. LANCASTER: Yes, it would be.

11 --- Recess

12 MR. LANCASTER: Please be seated.

13 MR. ESTRIN: Q. Mr. Petrie, I wanted to
14 try and summarize a few things relative to Site D. I
15 am coming towards the end of that part of my cross-
16 examination on D and I can advise the Board I will be
17 substantially shorter on F. I expect with luck and
18 prudent trimming I might be able to finish my entire
19 cross-examination by the end of tomorrow or possibly
20 sliding into Wednesday.

21 Let us look at page 45 of Exhibit B-618.
22 I would like you to look at the bottom of page 45 --
23 sorry -- did you have a chance to check your data or
24 get to that to see whether or not you wanted to change
25 your 2.3-metres thickness?



1 MR. PETRIE: A. Yes, I did check it.
2 Yes, Mr. Estrin, I did check it. Reviewing the log
3 over the break and reading down for borehole 2-85 of
4 Exhibit H-39A it appears to me that the base of the
5 weathered upper till should lie at approximately two
6 metres below ground. Below that entry at two metres
7 below ground we have no evidence of vertical fractures,
8 less mottled, greenish brown, dense. That is generally
9 consistent with the description as provided by Trow
10 elsewhere for the unweathered upper till recognizing
11 that they have not delineated on each borehole record
12 where they believe the interface between the
13 unweathered and the weathered till lies. That is
14 therefore -- that would be at an elevation of
15 approximately 181.4 which is inconsistent with the
16 elevation that we have interpreted on Figure C.2.4a
17 being B-618-P84.

18 Q. So you want to change the depth
19 on that from 2.3 metres to what?

20 A. The base elevation of the
21 weathered upper till is, as I read this log, would be
22 approximately 181.14 metres in elevation, that being a
23 depth of two metres below ground surface at that point.

24 Q. So -- I'm sorry, I may have
25 missed this. What is it you are saying is the correct



1 value for the unweathered upper till?

2 A. Taking an elevation of 175.83 as
3 the base of the upper till unit in total, 175.83 being
4 the base of the upper till unit in total, subtracting
5 181.14 which is, as I interpreted it over the break, is
6 the base of the weathered upper till gives a total
7 thickness there of unweathered till of 5.3 metres.
8 That is independent of landfilling. That is just the
9 thickness of that point. If one was referring that
10 back to a base of excavation of 179.6 which I believe
11 you indicated was the number to me before the break,
12 then we have a thickness of till beneath that of 3.7
13 metres, that is 179.6 being the base of landfilling,
14 subtracting 175.83 being the base of the upper till, we
15 have a thickness of 3.77, approximately 3.8 metres of
16 upper till at the location of HC2-85, recognizing that
17 lies out the position of landfilling.

18 Q. So, first of all, Mr. Petrie, you
19 would now, upon looking back at the data you have
20 presented to the Board, say that instead of -- taking
21 the information from your cross-section and calling it
22 2.3 metres of unweathered upper till, it is now five-
23 plus metres?

24 A. Five point three was the number I
25 provided. The 2.3 metres was incorrect.



1 Q. That's a substantial change,
2 isn't it?

3 A. It is. Well, it reflects an
4 error.

5 Q. Yes. Mr. Petrie, have a look,
6 since you are re-interpreting your own data here in the
7 way you plotted it at least, if you would, at the
8 Comcor log for CC-OW-2.

9 A. I have that log.

10 Q. That hole -- by the way, where
11 are these?

12 A. CC-OW-2 and HC2-85 are both on
13 the cross-section, yes.

14 Q. Where are they? Are they both
15 beside each other?

16 A. They are beside each other in the
17 centre. One is offset 150 metres from the west.

18 Q. And the log for the CC-OW-2 hole
19 seems to indicate weathering down to about plus nine
20 metres, nine metres anyway?

21 A. It appears to go down to about
22 ten metres as Comcor have interpreted it.

23 Q. So you seem to have some
24 considerable degree of variation in the degree of
25 weathering between those two locations?



1 A. Based on comparing the Comcor
2 logs and the Trow logs, yes.

3 Q. What do we know for sure,
4 Mr. Petrie?

5 A. I beg your pardon?

6 Q. I'm sorry, that was a rhetorical
7 question. I'm just wondering what do we know for sure
8 about Site D. Let us go over what you have to say.
9 You tell me what we know for sure. Let us look at page
10 45 of your report. Could you go back to page 45?

11 A. I have that.

12 Q. At the bottom of the page, would
13 you read out the last paragraph?

14 A. "CRA considers that insufficient
15 data are available to determine a flow
16 direction and horizontal gradient in the
17 lower granular unit."

18 Q. Have you changed your position
19 since you wrote that?

20 A. With respect to the lower
21 granular unit I believe it's not entirely consistent
22 with the picture, yes.

23 Q. I'm sorry?

24 A. I'm in agreement with the
25 statement I've provided on page 45, the bottom



1 paragraph.

2 Q. That there is insufficient data
3 available to determine a flow direction and horizontal
4 gradient in the lower granular unit?

5 A. Yes.

6 Q. That is a chunk of -- a portion
7 of uncertainty on Site D?

8 A. Deep down in the flow system in a
9 portion of the site which we think impinges less on our
10 deliberations regarding landfill.

11 Q. Mr. Petrie, according to you the
12 lower granular unit is the layer that is going to take
13 the contaminants off-site. We don't have a granular
14 unit that goes off-site. Shouldn't we be concerned
15 about the gradient in the lower granular unit? Don't
16 you care about it?

17 A. Yes, we do care about it.

18 Q. You don't know about it?

19 A. I don't have a definite picture
20 of the magnitude of the gradient and the flow direction
21 in that unit.

22 Q. Isn't certainty about something
23 as fundamental as flow direction in a basic unit like
24 this and gradient one of your criteria for site
25 selection if you go back to Section A of your report?



1 Q. But your interpretation ...

2 A. I'm sorry, could you direct me to
3 the page?

4 Q. Look at your Figure C.2.3 on page
5 82.

6 A. We notice the bulk of the -- I
7 beg your pardon -- in general the thickest portions of
8 the unit run roughly along cross-section B-B and that
9 we have -- it thins to the side being the side to the
10 compass direction north or south. On cross-examination
11 I think both Dr. Charlesworth and Mr. Sobanski -- I beg
12 your pardon, I will give you my interpretation that the
13 geometry of this unit in part reflects the position of
14 the bedrock valley at the site. Where we find
15 shallower depths to bedrock we do not appear to find
16 the lower granular unit. So we have geometry for this
17 unit which is elongated roughly to the west, east being
18 roughly along cross-section B-B'.

19 Q. Mr. Petrie, read page 45 of your
20 report at the bottom. You told me you considered the
21 statement there accurate?

22 A. Yes, I do believe there is
23 insufficient data to determine a flow direction and
24 horizontal gradient in the lower granular unit.

25 Q. So in this unit which now appears



1 to be the underdrain to the system rather than the
2 bedrock as you postulated it, we don't know necessarily
3 in which direction it's flowing?

4 A. I've given you the two
5 alternatives. I believe when we have another two or
6 three piezometers screened in that unit we will have a
7 definitive picture. These two or three more
8 piezometers in part proposed, as I understand it,
9 Mr. Sobanski's proposal for the monitoring, to be
10 included within his monitoring program. In other
11 words, the wells which are proposed for monitoring
12 which I would understand would be drilled at or prior
13 to landfill proceeding at this site, were it to proceed
14 at this site, data would be available regarding the
15 direction of flow and the gradient which is the driving
16 force within this unit.

17 Q. Mr. Petrie, I seem to understand
18 from what you are saying that you would apply a
19 different standard of approval at Site D than at Site
20 F. I say that, sir, because it is my clear
21 recollection of your evidence that we must understand
22 Site F in order to approve it. We don't go and approve
23 it according to your evidence and then monitor it and
24 find out about it. Wasn't that the thrust of your
25 evidence about Site F?



1 A. The differences are very
2 pronounced between F and D.

3 Q. Wasn't that your evidence at Site
4 F?

5 A. At F in my opinion we do not even
6 know what the flowpaths are. At D I am indicating that
7 the lower granular unit is the flowpath. I am
8 indicating to you that the hydraulic characterization
9 of that defined flowpath is as yet incomplete.

10 Q. Mr. Petrie, would you answer my
11 question? What was your evidence at Site F? It was to
12 the effect that until you had resolved the
13 uncertainties it was not prudent to approve it; isn't
14 that correct or shall we look at the transcript?

15 A. My evidence at Site F was such
16 that we do not even know what the precise flowpaths
17 are.

18 Q. Mr. Crutcher says he knows where
19 the water is going, it's going to the lake.

20 A. I suggest that that is not a
21 flowpath. The water from Site D would ultimately end
22 up in Lake Ontario I suspect. I do not believe that an
23 appropriate delineation of the contaminant flowpath for
24 a landfill investigation.

25 Q. Do you want to answer my



1 question, Mr. Petrie? What did you tell this Board?

2 What is the onus of proof about Site F?

3 A. In my opinion in Site F I do not
4 believe the contaminant flowpaths have even been
5 defined, let alone their hydraulic characterization.
6 At Site D I believe the flowpaths have been defined. I
7 am saying their hydraulic characterization with respect
8 to that paragraph on page 45, flow direction and
9 gradient within the lower granular unit is incomplete.
10 I also believe that the monitoring program as proposed,
11 as I understand it is being proposed by Mr. Sobanski
12 would provide data such that one can make that
13 conclusion.

14 Q. I take it you don't want to
15 answer my question.

16 A. I believe I have.

17 Q. I've given you every opportunity.
18 We'll go to see what the transcript says for sure.

19 Now, I suggest nevertheless that you are
20 applying a different standard to Site D than Site F.

21 A. No, I disagree.

22 Q. Mr. Petrie, you have stated in
23 your own terms the considerable uncertainty about the
24 flow direction and horizontal gradient in the lower
25 granular unit at Site D on page 45?



1 Q. If no one believes you about the
2 lens, no one should believe you about the fact that
3 it's not going anywhere.

4 MR. McQUAID: Ask questions.

5 MR. ESTRIN: Q. Mr. Petrie, can we
6 assume that the UGU is not a lens or even take your
7 unit over on the First Line, it's prudent to believe it
8 goes somewhere? Where is it going? You don't know?

9 A. I do not know the direction of
10 flow off-site in the upper granular unit, that is
11 correct.

12 Q. I am suggesting, Mr. Petrie, that
13 the criteria you and CRA established for the approval
14 of a landfill site is demonstrably absent at this site
15 based on your own evidence, your own misunderstanding
16 of the data. You changing your opinion with respect to
17 certain matters before the Board demonstrates the
18 degree of uncertainty that exists is such that based on
19 your own criteria Site D ought not to be approved.

20 A. I cannot agree to that.

21 Q. It will be a matter for agreement
22 I am sure.

23 A. I believe it will be.

24 Q. Now there is one other aspect of
25 flow directions in the upper granular unit I want to



1 paragraph.

2 Q. That there is insufficient data
3 available to determine a flow direction and horizontal
4 gradient in the lower granular unit?

5 A. Yes.

6 Q. That is a chunk of -- a portion
7 of uncertainty on Site D?

8 A. Deep down in the flow system in a
9 portion of the site which we think impinges less on our
10 deliberations regarding landfill.

11 Q. Mr. Petrie, according to you the
12 lower granular unit is the layer that is going to take
13 the contaminants off-site. We don't have a granular
14 unit that goes off-site. Shouldn't we be concerned
15 about the gradient in the lower granular unit? Don't
16 you care about it?

17 A. Yes, we do care about it.

18 Q. You don't know about it?

19 A. I don't have a definite picture
20 of the magnitude of the gradient and the flow direction
21 in that unit.

22 Q. Isn't certainty about something
23 as fundamental as flow direction in a basic unit like
24 this and gradient one of your criteria for site
25 selection if you go back to Section A of your report?



1 Certainty, do you recall certainty is a criterion of
2 certain fundamental components?

3 A. The manner of uncertainty
4 reflecting the lower unit is one of the nature of not
5 where it is so much as the but the very few piezometers
6 that were screened in that unit. Its position has been
7 relatively well defined in my mind. There are very few
8 well screens in that unit such that one can be
9 comfortable taking the piezometric data or the water
10 level data from these screens and defining a flow
11 direction and horizontal gradient. That is relatively
12 easy to address in my mind with the installation of the
13 proposed monitoring wells and the installations as I
14 recall, Trow's suggestion that well screens would be
15 put within each of the granular units where
16 encountered or where they are not encountered to be put
17 at that elevation in any event. So we are going to end
18 up with quite a bit of data respecting the piezometric
19 head at the elevation of the granular unit, you were
20 referring to the lower granular unit, or indeed if the
21 unit were there the piezometric head in that unit.
22 Then it would be quite easy to define the flow
23 direction and the horizontal gradient.

24 Q. Mr. Petrie, do you recall the
25 exercise we did today when you coloured up the



1 gradients on those two blowups?

2 A. Yes, I recall that.

3 Q. I think it would be fair to say
4 if you turned around and looked at those exhibits that
5 the lower granular unit must play a different and
6 probably more significant role in the whole system of
7 the strata beneath the upper till. If there is an
8 underdrain to the system it is more likely to be the
9 lower granular unit than the bedrock?

10 A. The lower granular unit does not
11 underlie the site in total but it does appear that the
12 lower granular unit has some relevance to the flow
13 system.

14 Q. We don't know the fate of the
15 water in that unit yet, do we?

16 A. We know it flows either generally
17 northwestward or southeastward, that being the geometry
18 of the unit. I suspect it has to flow along the
19 geometry of the unit. When you look at the water
20 levels at either end of the system there is some
21 inconsistency in the water levels across that unit.

22 Q. Mr. Petrie, this is a unit that
23 you have spread out all over the site, more or less.

24 A. I don't believe I have spread it
25 out all over the site.



1 Q. But your interpretation ...

2 A. I'm sorry, could you direct me to
3 the page?

4 Q. Look at your Figure C.2.3 on page
5 82.

6 A. We notice the bulk of the -- I
7 beg your pardon -- in general the thickest portions of
8 the unit run roughly along cross-section B-B and that
9 we have -- it thins to the side being the side to the
10 compass direction north or south. On cross-examination
11 I think both Dr. Charlesworth and Mr. Sobanski -- I beg
12 your pardon, I will give you my interpretation that the
13 geometry of this unit in part reflects the position of
14 the bedrock valley at the site. Where we find
15 shallower depths to bedrock we do not appear to find
16 the lower granular unit. So we have geometry for this
17 unit which is elongated roughly to the west, east being
18 roughly along cross-section B-B'.

19 Q. Mr. Petrie, read page 45 of your
20 report at the bottom. You told me you considered the
21 statement there accurate?

22 A. Yes, I do believe there is
23 insufficient data to determine a flow direction and
24 horizontal gradient in the lower granular unit.

25 Q. So in this unit which now appears



1 to be the underdrain to the system rather than the
2 bedrock as you postulated it, we don't know necessarily
3 in which direction it's flowing?

4 A. I've given you the two
5 alternatives. I believe when we have another two or
6 three piezometers screened in that unit we will have a
7 definitive picture. These two or three more
8 piezometers in part proposed, as I understand it,
9 Mr. Sobanski's proposal for the monitoring, to be
10 included within his monitoring program. In other
11 words, the wells which are proposed for monitoring
12 which I would understand would be drilled at or prior
13 to landfill proceeding at this site, were it to proceed
14 at this site, data would be available regarding the
15 direction of flow and the gradient which is the driving
16 force within this unit.

17 Q. Mr. Petrie, I seem to understand
18 from what you are saying that you would apply a
19 different standard of approval at Site D than at Site
20 F. I say that, sir, because it is my clear
21 recollection of your evidence that we must understand
22 Site F in order to approve it. We don't go and approve
23 it according to your evidence and then monitor it and
24 find out about it. Wasn't that the thrust of your
25 evidence about Site F?



1 A. The differences are very
2 pronounced between F and D.

3 Q. Wasn't that your evidence at Site
4 F?

5 A. At F in my opinion we do not even
6 know what the flowpaths are. At D I am indicating that
7 the lower granular unit is the flowpath. I am
8 indicating to you that the hydraulic characterization
9 of that defined flowpath is as yet incomplete.

10 Q. Mr. Petrie, would you answer my
11 question? What was your evidence at Site F? It was to
12 the effect that until you had resolved the
13 uncertainties it was not prudent to approve it; isn't
14 that correct or shall we look at the transcript?

15 A. My evidence at Site F was such
16 that we do not even know what the precise flowpaths
17 are.

18 Q. Mr. Crutcher says he knows where
19 the water is going, it's going to the lake.

20 A. I suggest that that is not a
21 flowpath. The water from Site D would ultimately end
22 up in Lake Ontario I suspect. I do not believe that an
23 appropriate delineation of the contaminant flowpath for
24 a landfill investigation.

25 Q. Do you want to answer my



1 question, Mr. Petrie? What did you tell this Board?

2 What is the onus of proof about Site F?

3 A. In my opinion in Site F I do not
4 believe the contaminant flowpaths have even been
5 defined, let alone their hydraulic characterization.
6 At Site D I believe the flowpaths have been defined. I
7 am saying their hydraulic characterization with respect
8 to that paragraph on page 45, flow direction and
9 gradient within the lower granular unit is incomplete.
10 I also believe that the monitoring program as proposed,
11 as I understand it is being proposed by Mr. Sobanski
12 would provide data such that one can make that
13 conclusion.

14 Q. I take it you don't want to
15 answer my question.

16 A. I believe I have.

17 Q. I've given you every opportunity.
18 We'll go to see what the transcript says for sure.

19 Now, I suggest nevertheless that you are
20 applying a different standard to Site D than Site F.

21 A. No, I disagree.

22 Q. Mr. Petrie, you have stated in
23 your own terms the considerable uncertainty about the
24 flow direction and horizontal gradient in the lower
25 granular unit at Site D on page 45?



1 A. I don't believe the word
2 "considerable" appears in that paragraph. I said there
3 was insufficient data.

4 Q. Now, you have told us this
5 morning, from our discussion this morning it is
6 indicated that the gradients are more complex than you
7 had indicated in your evidence?

8 A. I'm not sure we agreed on more
9 complex.

10 Q. They are different than you had
11 indicated in your evidence?

12 A. That I believe to be true.

13 Q. Yes. When you told the Board in
14 your evidence that the flow goes to the bedrock, that
15 we saw this morning isn't consistent with what we see
16 behind us?

17 A. Not everywhere across the site.

18 Q. You have changed your opinion on
19 the stand, not in evidence in chief but under cross-
20 examination as between one cross-examination and the
21 other as to the amount of infiltration at Site D,
22 infiltration at Site D, you've changed it by an order
23 of magnitude. You came to this Board saying 50 to 100
24 millimetres going through the unweathered till and now
25 you've got it down to 0.88 millimetres.



1 A. I do not believe I made reference
2 to a hundred millimetres at Site D.

3 Q. I'm sorry, it was 9.6, I'm sorry.
4 It is still an order of magnitude. Nine point six was
5 your evidence in the report of the infiltration going
6 to the unweathered upper till. You changed your
7 opinion between two different cross-examinations. You
8 told Mr. Tidball it was still 9.6 and when Mr. Hodgson
9 asked you about it and put a lot of things to you, you
10 changed your mind, changed it by an order of magnitude;
11 correct?

12 A. That is correct.

13 Q. You don't know how extensive the
14 UGU is?

15 A. I'm sorry, you were talking about
16 the lower granular unit?

17 Q. Yes, I'm up to the upper granular
18 unit.

19 A. I have an opinion on the extent
20 of the upper granular unit, yes.

21 Q. You don't know the direction of
22 flow in the upper granular unit?

23 A. With the lens under the site the
24 direction of flow will be dominated by the enveloping
25 till which is generally downward.



1 Q. If no one believes you about the
2 lens, no one should believe you about the fact that
3 it's not going anywhere.

4 MR. McQUAID: Ask questions.

5 MR. ESTRIN: Q. Mr. Petrie, can we
6 assume that the UGU is not a lens or even take your
7 unit over on the First Line, it's prudent to believe it
8 goes somewhere? Where is it going? You don't know?

9 A. I do not know the direction of
10 flow off-site in the upper granular unit, that is
11 correct.

12 Q. I am suggesting, Mr. Petrie, that
13 the criteria you and CRA established for the approval
14 of a landfill site is demonstrably absent at this site
15 based on your own evidence, your own misunderstanding
16 of the data. You changing your opinion with respect to
17 certain matters before the Board demonstrates the
18 degree of uncertainty that exists is such that based on
19 your own criteria Site D ought not to be approved.

20 A. I cannot agree to that.

21 Q. It will be a matter for agreement
22 I am sure.

23 A. I believe it will be.

24 Q. Now there is one other aspect of
25 flow directions in the upper granular unit I want to



1 ask you about. Trow did not attempt to present flow
2 directions in the lower granular unit nor did you.

3 A. Correct.

4 Q. Now, let us go to the UGU. Trow
5 on Drawing 18 of Exhibit 39A have presented a
6 potentiometric contour map of the UGU in which they
7 show flow directions in that unit being generally in an
8 easterly direction and I show you a copy of the
9 exhibit, you may have a copy there.

10 A. Somewhere I do but I believe the
11 discussion was that one of the wells was not in the
12 upper granular unit on that figure.

13 Q. Do you want to put up a copy of
14 Drawing 18? I am not going to ask you to write on this
15 one.

16 A. You wish to have it back?

17 Q. Yes. Now, Trow shows on their
18 Drawing 18 flow directions in the UGU's being generally
19 in an easterly direction?

20 A. Correct. However, there was some
21 discussion whether some of the data here were from the
22 upper granular unit wells.

23 Q. I was going to ask you, do you
24 have any confidence in Trow's interpretation?

25 A. Based solely on the data on this



1 table I believe HC4-85, the water level 181.1. I am a
2 bit vague as to my recollection right now. That
3 installation was not in the upper granular unit.

4 Q. I think if you look at your own
5 cross-section B-B you will be able to show that that is
6 the case. It's right behind. If you flip that up you
7 will see HC4-85.

8 A. HC4-85 the 181.12 is within the
9 lower granular unit, however, Trow have recorded 181.1.
10 Presumably they've dropped a decimal place.

11 Q. To get that clear one of the four
12 data points that Trow used was actually in the lower
13 granular unit?

14 A. I believe that to be the case.

15 Q. Even CC-OW-2 is not in the upper
16 granular unit although we did see it responded to the
17 pump test?

18 A. Correct.

19 Q. Trow's map would see to be based
20 on only two reliable data points?

21 A. It would appear that way. I
22 cannot recall exactly how I concluded my review of that
23 map.

24 Q. It would certainly seem that
25 their interpretation is open to re-interpretation.



1 A. I believe that is why I made the
2 statement at the time, correct.

3 Q. Can we agree, Mr. Petrie, that
4 the only piezometers definitely set in the UGU are
5 MB-OW-4, HC2-85 ...

6 A. Can I just make sure? So UGU
7 piezometers ...

8 Q. Yes.

9 A. ... MB-OW-4, HC2-85 and HC2-86.
10 There is another well, HC5-84 which is screened at the
11 same sort of elevation as I see on the cross-section
12 B-B' which I believe is a discussion we had the other
13 day, perhaps earlier today. HC5-84 is screened at that
14 elevation.

15 Q. So you want to rely on that
16 piezometer?

17 A. I'm not sure what you're relying
18 on it for.

19 Q. To determine the gradient in the
20 upper granular unit.

21 A. I don't recall having completed
22 that exercise.

23 Q. Give me your best opinion. Is
24 HC5-84 in the granular unit?

25 A. If it's at the same elevation I



1 believe it would record a piezometric level similar to
2 the upper granular unit, yes. However, there probably
3 is a slightly different pattern fluctuations.

4 Q. Mr. Petrie, I am giving you some
5 data which I believe you have seen before because some
6 of it is in the appendix to your report. It is the
7 actual measurements taken by Geocon in their monitoring
8 of piezometers at Site D.

9 A. Excuse me, can I get a second
10 copy for Mr. Crutcher?

11 Q. Sorry.

12 A. Sorry, what do you mean in their
13 piezometers, the Trow piezometers as monitored by
14 Geocon?

15 Q. You reported some of Geocon's
16 water level measuring data in your report?

17 A. I recall that, yes.

18 Q. So you have obtained, no doubt
19 from Trow, you obtained from Geocon, no doubt through
20 Trow, the actual values?

21 A. No, I am at a loss to recall
22 exactly where we got the data from. I am not sure if
23 Dr. Charlesworth provided it earlier.

24 Q. What this is essentially are the
25 numbers that go behind the hydrographs in Dr. Rowe's



1 report, for example, just the readings for September
2 11th, 1987, the documents I've handed to you?

3 A. September 11th, 1987, I see that
4 on the top, yes.

5 Q. Look at the middle column
6 "Elevations".

7 A. I see it.

8 Q. Then this is the basis for
9 producing the numbers in various of the piezometers on
10 the hydrograph?

11 A. This is the reading for September
12 11.

13 Q. Yes, right, you can go to the
14 graph for September 11th in the Geocon report and see
15 this plotted. Now, the ones I have ticked on the sheet
16 are the three piezometers that I just referred you to,
17 MB-OW-4 and HC2-86 and HC2-85.

18 A. It appears to be the case, yes.

19 MR. ESTRIN: Could we mark this table?

20 MR. LANCASTER: M-731.

21 --- EXHIBIT NO. M-731: Observation Records for Site
22 D, dated September 11, 1987

23 MS CRONK: Excuse me, Mr. Chairman, what
24 was M-730?

25 MR. LANCASTER: A flip chart.

DR. KINGHAM: Did we in fact mark the



1 flip chart?

2 MR. PETRIE: I have no recollection.

3 MR. LANCASTER: It will be M-730.

4 --- EXHIBIT NO. M-730: Flip Chart re Chloride
5 Diffusion Values

6 MR. PETRIE: I am marking as Exhibit
7 M-730 a flip chart with chloride diffusion values on
8 it.

9 MR. ESTRIN: Q. Coming back to these
10 water level data, Mr. Petrie -- Mr. Hodgson would
11 appreciate it if you would move the material hiding
12 flip chart M-730 so he can copy it.

13 Now, what you see on the overhead,
14 Mr. Petrie, is plotted water elevations taken by Geocon
15 and these numbers are rounded and on this is the limits
16 of the upper granular unit as defined first of all by
17 Trow, that is the red line.

18 MR. PETRIE: A. Trow limit of UGU being
19 the red line, yes, I see it.

20 Q. And Geocon's possible maximum
21 extent is taken from their report, the blue line?

22 A. I can believe that, yes.

23 Q. What we have plotted are the
24 water level data for these three piezometers rounded,
25 MB-OW-4, 181.5; HC2-86 being 180.99 rounded to 181 and
similarly for HC2-85, 181.87 rounded to 181.9.



1 A. I see that, yes.

2 Q. Now, Mr. Petrie, if we assume
3 that the UGU is at least as extensive as Trow defined
4 it then one possible and reasonable interpretation of
5 the water level data is that flow within the UGU is
6 towards First Line and it tends towards the wells of
7 Pompa, Chlon and Chaput. If you see the red dots on
8 the left-hand side of this overhead they are meant to
9 represent the approximate locations of those three
10 wells.

11 A. A slightly different place from
12 where they are shown on Exhibit M-438, the extent of
13 the upper granular unit but I understand them to be
14 generally in that area, yes.

15 Q. Would you agree with me that once
16 we have plotted these potentiometric contours the
17 direction of flow is at right angles?

18 A. Correct.

19 Q. So can you draw an arrow
20 indicating, based on those contours, the direction of
21 flow?

22 A. The directions of flow are
23 variable depending on where you approach it. Would you
24 like more than one arrow on there?

25 Q. If you think to be fair to



1 evaluate this, surely.

2 A. I have drawn an arrow.

3 Q. Mr. Petrie, if indeed what you
4 have done is taken the flow towards the end of the
5 unit ...

6 A. I'm sorry, I've taken the flow to
7 the end of the unit.

8 Q. To the edge of the unit?

9 A. It depends on which edge you are
10 referring to, your blue line or your red line.

11 Q. I am talking about yours.

12 A. I've just drawn ...

13 Q. The Trow one for example. So if
14 the red line is the edge of the unit and that was the
15 premise of my question I am saying if the UGU is at
16 least as extensive as Trow have shown then it would be
17 more reasonable to put the flow line a little bit --
18 not ending up right at the edge?

19 A. I was going to draw an arrow
20 right where you see HC2-86. I didn't want to put an
21 arrow on top of it so I extended the line a little bit.
22 Then I asked, given the variable flow directions, where
23 would you like to see the other arrows.

24 Q. Please place the other arrows ...

25 DR. KINGHAM: While he's doing that can



1 you tell us do these potentiometric lines come from
2 evidence we already have, these green lines?

3 MR. ESTRIN: The actual water level
4 information is in Exhibit M-731. This data, some of
5 this data was used, this particular sheet for example
6 was not in evidence. The computer graph that was drawn
7 from this and other data is in evidence.

8 DR. KINGHAM: In Geocon's?

9 MR. ESTRIN: Yes.

10 MR. HODGSON: I don't think that answers
11 the question about the green lines.

12 DR. KINGHAM: I was assuming the answer
13 that the green lines were in evidence in Geocon.

14 MR. ESTRIN: Q. The green lines
15 themselves are not in evidence. I guess I should ask
16 Mr. Petrie does he feel that these green lines are
17 appropriately drawn having regard to the data, I assume
18 as one possible and reasonable interpretation of the
19 water level data?

20 MR. PETRIE: A. The green lines are
21 drawn with a bias to the distribution of the unit, so I
22 would suspect one would draw the lines, the pattern
23 that reflects one's interpretation of the distribution
24 of this unit. If you are referring to the red lines I
25 see potentiometric contours that extend outside the red



1 lines. If you were referring to the blue lines, there
2 is sort of a measure of consistency.

3 Q. So I guess what I'm asking you is
4 are the arrows that you've drawn on there, the purple
5 arrows, drawn having -- as a result of the green
6 contour lines? Is what we have on this overhead one
7 reasonable interpretation of the water level data?

8 A. It is consistent with the
9 interpreted position of that upper granular unit from
10 the red line, although I'm not sure how all the flow
11 converges in one corner but it is reasonable if one
12 were to assume the distribution of the granular unit as
13 you have shown it on this overhead.

14 Q. It would be reasonable
15 particularly if the upper granular unit extends west of
16 First Line?

17 A. That is what you have shown with
18 the red line there.

19 MR. ESTRIN: I wonder if we could mark
20 this.

21 MR. LANCASTER: Seven thirty-two.

22 --- EXHIBIT NO. M-732: Potentiometric Contours UGU
Overhead

23 MR. PETRIE: Marked as Exhibit M-732 the
24 potentiometric contours for the UGU, being the upper
25 granular unit.



1 MR. ESTRIN: Q. Mr. Petrie, we could
2 calculate a gradient off those contours, couldn't we?

3 MR. PETRIE: A. One could, yes.

4 Q. Could you do that?

5 A. Do we have a scale on this
6 drawing? It would help.

7 Q. We can get the information. If
8 you look in your own report, page 87, it is
9 approximately the same scale.

10 A. It would be appropriate...

11 Q. You can take it from Geocon's
12 report, Figure 6, which has a scale of 1:10,000. It
13 fits exactly on the Geocon scale of 1:10,000.

14 A. Yes, it does, a scale of
15 1:10,000. Using the scale of 1:10,000 I have calculated
16 horizontal separation approximately along the middle
17 purple line being the flow direction between the
18 furthest green contours and I understand one to be
19 181.0, the other end to be 181.75 -- I beg your pardon
20 -- 181.75. So taking a 0.75-metre head loss across
21 there that horizontal distance I calculate is
22 approximately 350 metres. That gives a gradient of
23 0.002.

24 Q. Thank you. Mr. Petrie, you in
25 your report have looked at the hydraulic conductivity



1 for the upper granular unit; correct?

2 A. Yes.

3 Q. Looking at page 41 at the bottom
4 and page 42 at the top ...

5 A. I'm sorry, could you refer me to
6 the pages again?

7 Q. Page 41 at the bottom.

8 A. Yes.

9 Q. You say hydraulic conductivity of
10 8.2×10^{-3} centimetres per second was determined by
11 Trow for this unit. Turning the page, the first full
12 paragraph it says:

13 "The hydraulic conductivity calculated
14 by Trow is therefore considered by CRA
15 as conservative."

16 A. I'm sorry, where did you get
17 that? I see.

18 Q. Let us go with the conservative
19 number which you agree is 8×10^{-3} . Mr. Petrie, we
20 have to come up with a value for porosity if we want to
21 get velocity but the point is we have a relatively high
22 hydraulic gradient -- sorry -- we have a relatively
23 high hydraulic conductivity as would be expected in a
24 granular unit; right?

25 A. Yes.



1 Q. We have a gradient and,
2 Mr. Petrie, I am therefore suggesting it would be
3 reasonable to assume a flow?

4 A. One can do that.

5 Q. Did you do that?

6 A. Did I do it?

7 Q. Yes.

8 A. No, I do not recall completing
9 that. I note that Trow had undertaken that exercise
10 as reported on page 88 amongst other pages on which it
11 was reported and Exhibit H-39, that being Table 10
12 where they have the summary of linear groundwater
13 velocities. On that unit, on that page, being page 88,
14 they have the hydraulic conductivity for the granular
15 unit being 8×10^{-3} which is their value for the upper
16 granular unit. They have a horizontal gradient of
17 0.001. It just escapes me where they derived that
18 value from. They have a porosity of 0.3. They have
19 provided the calculations there. The far right column
20 on that table gives a linear groundwater velocity of
21 8.4 metres per year.

22 Q. Mr. Petrie, what do you consider
23 to be the appropriate porosity value to assign?

24 A. I can accept 0.3 for the granular
25 unit.



1 Q. Would you also accept 0.2?

2 A. It is somewhat lower than is
3 commonly used.

4 Q. But it could be in that range?

5 A. It could be. I think the 0.3 is
6 appropriate.

7 Q. Let us do it using both numbers.

8 A. Using an appropriate value and
9 what I consider not an appropriate value.

10 Q. You start with your ...

11 A. I used the number I took from
12 Trow as 0.3 for the granular units. I just did and
13 that is 8.4 metres per year using Trow's hydraulic
14 gradient.

15 Q. No, no, no, no. Use the gradient
16 you just calculated.

17 A. Using 0.002 would give exactly
18 double the velocity which instead of 8.4 would be 16.8
19 metres per year.

20 Q. So, using -- could you please
21 take a clean sheet on the flip chart and summarize this
22 for us?

23 A. Sorry, which am I summarizing?

24 Q. What I would like you to do is
25 put up the top calculation of groundwater velocity,



1 UGU.

2 A. Can I just make a bit of room
3 here?

4 Q. Sure.

5 A. Calculation of velocity in UGU.

6 Q. Sources, Exhibit M-732 and for
7 the gradient?

8 A. Shall I put the gradient value
9 here (indicating); $i = 0.002$.

10 Q. For the hydraulic conductivity we
11 can take from your report, B-618?

12 A. I think we should take it from
13 Trow. We are reporting Trow's numbers here.

14 Q. I would also like you to agree,
15 to indicate that you agreed with it.

16 A. I did. The value was 8×10^{-3} ?

17 Q. Yes, it was 8.2 as reported in
18 your report.

19 A. I rounded it out.

20 Q. You are going to take a porosity
21 of 0.2?

22 A. Zero point three and that again
23 is from H-39.

24 Q. That gives us I think you told
25 us...



1 A. v equals, using those numbers
2 which is double that which was provided by Trow which
3 is 16.8 metres per annum.

4 Q. Can we just indicate in
5 brackets...

6 A. I'm listening. I've just lost my
7 calculator.

8 Q. ...if the porosity was 0.3 what
9 the value would be?

10 A. That is the porosity for 0.3.

11 Q. If it was -- I'm sorry -- if it
12 was 0.2?

13 A. Twenty-four point six. I have
14 indicated for porosity equal to 0.02, $v = 24.6$ metres
15 per annum. Mr. Crutcher gets 25.2. Perhaps you have a
16 number there.

17 Q. Approximately 25?

18 A. I have 24.6.

19 MR. ESTRIN: That is fine.

20 Mr. Chairman, can we give that flip chart a number,
21 please?

22 MR. LANCASTER: Seven thirty-three.

23 --- EXHIBIT NO. M-733: Flip Chart re Calculation of
Velocity in UGU

24 MR. PETRIE: Calculation of velocity in
25 UGU is Exhibit M-733.



1 MR. ESTRIN: Q. So, Mr. Petrie, what I
2 think we can conclude perhaps is that between Exhibit
3 M-732 and M-733 one reasonable interpretation of the
4 data that we have available, that is the gradient
5 information and the velocity calculations is that
6 groundwater in the UGU is not moving easterly as Trow
7 suggested but indeed could well be moving southerly or
8 southwesterly, depending on your compass direction,
9 across First Line at a velocity under natural
10 conditions of 17 metres a year. That is one reasonable
11 interpretation?

12 MR. PETRIE: A. That is assuming
13 continuity of the granular unit and I've not assumed
14 that.

15 Q. If one assumed it?

16 A. If one assume it I believe that
17 is reasonable. I pointed out that I believe Trow in
18 doing their calculations assumed a straight line from
19 the landfill to First Line in which case they took the
20 flow as westerly and in that case they were looking at
21 a flow direction a little more left and right for their
22 impact assessment.

23 Q. If one assumed -- if the porosity
24 happened to be 0.3 the velocity would be as indicated
25 on Exhibit M-733?



1 A. Yes, 16.8 metres per annum.

2 Q. If it was 0.2 it would be 24.6?

3 A. I considered 0.2 not an
4 appropriate number. Trow, I believe they used
5 porosities of 0.3 for the granular units and 0.25 for
6 the till units. I believe 0.2 is not the appropriate
7 number to use for porosity in this case.

8 Q. Mr. Petrie, just a sort of wrap-
9 up on this topic and in particular Exhibit M-732. The
10 interpretation that is there, I suggest could be
11 arrived at by taking Trow data as presented on Drawing
12 18 -- if you put it back up for a moment -- but
13 ignoring the value for HC4-85 which we know to be in
14 the lower granular unit?

15 A. Correct, if you are to assume
16 continuity of that unit.

17 Q. So I am suggesting, Mr. Petrie,
18 that this is reasonable, the interpretation we see on
19 Exhibit M-732 is a reasonable and plausible
20 interpretation of the data for a hydrogeologist who
21 accepts that the UGU may in fact be continuous beneath
22 the site and extending across First Line?

23 A. If you were to assume continuity
24 one might go through this calculation or exercise you
25 have done and come to that same conclusion, yes.



1 MR. ESTRIN: Mr. Chairman, I am about to
2 turn to another topic and I see it is about 4:20. I
3 don't know if we can conveniently cover it in the next
4 ten minutes or not. I'm in your hands.

5 MR. LANCASTER: Perhaps we will leave it
6 at that.

7 DR. KINGHAM: I would just like to see
8 if we can get some better appreciation of the
9 significance, if any, of Exhibit M-730. What I would
10 like is your advice on how we combine what seems to be
11 a lot of information. If we look to Exhibit B-618 on
12 pages 93 and 98 we see that the value chosen is
13 $1.5 \times 10^{-6} \text{ cm}^2$ per second.

14 MR. PETRIE: That is the value reported
15 there.

16 DR. KINGHAM: If we look at Exhibit
17 B-642 ...

18 MR. PETRIE: B-642.

19 DR. KINGHAM: ... wherein diffusion
20 profiles are calculated we find the value $6 \times 10^{-6} \text{ cm}^2$
21 per second ...

22 MR. PETRIE: That is correct.

23 DR. KINGHAM: ... for all of those?

24 MR. PETRIE: Yes.

25 DR. KINGHAM: If we turn to pages 88 and



1 98 of H-39 we find on page 98 a coefficient of
2 molecular diffusion of 1.5×10^{-6} cm² per second being
3 the same value which you used in your exhibit?

4 MR. PETRIE: Correct.

5 DR. KINGHAM: Somewhere along the line
6 we have gotten the impression that that value was a
7 combination of the coefficient of diffusion of 6×10^{-6}
8 times the porosity which we note from page 88 for that
9 unit is 0.25, the 6×10^{-6} multiplied by the 0.25
10 yielding the 1.5×10^{-6} cm² per second for diffusion.
11 I would like to know if we are talking about the same
12 number or a different number and therefore whether
13 there should be or should not be a factor for the
14 difference. I don't know if you can sort out that here
15 and now.

16 MR. PETRIE: It is something I wish to
17 reflect upon over the evening.

18 DR. KINGHAM: I would like to know
19 whether the molecular diffusion coefficient being used
20 is or should be the 1.5×10^{-6} and, if so, does it then
21 include the value for the porosity. Is that really the
22 difference?

23 MR. PETRIE: Yes, but noting that in
24 Exhibit B-642, for example, we were looking at just
25 diffusion, whereas the ones on page 98, for example, of



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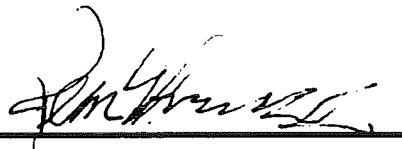


1 the Trow document was within the Ogata-Banks solution
2 for which there is a porosity term incorporated. I
3 have not got clear in my head how that indeed is
4 incorporated.

5 MR. LANCASTER: We will adjourn until
6 9:30 tomorrow morning.

7 --- Adjournment at 4:24 p.m.

8
9 CERTIFIED CORRECT

10
11 
12 P. D. McQueen

13 (page 30350 follows)
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