

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.381, 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 ~~Grand~~ 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 N.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-A01;

- 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 N.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 ~~Chad~~ 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 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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I N D E X

WITNESSES:

ANTHONY J. CRUTCHER (RESUMED)

JOHN M. PETRIE (RESUMED)

Cross-examination by Mr. Hodgson (Cont'd) 28154

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1 IN THE MATTER OF Sections 2 and 3 and 6(3) of the
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8 IN THE MATTER OF Sections 24 and 61(2) of the Ontario
9 Water Resources Act, R.S.O. 1980, c.361, as amended;

- and -

10 IN THE MATTER OF Section 28(3) of, and Regulation 164
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12 c.85, as amended;

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- and -

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19 Affairs, on a request by the Regional Municipality of
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- and -

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R.S.O. 1980 ch.379 in connection with a referral by the
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BEFORE: H. H. Lancaster, Q.C. - Chairman

Dr. D.J. Kingham - Member



Hearing conducted at The Oakville
Granary Commercial Centre, 105 Robinson
Street, Oakville, Ontario, on Tuesday,
April 5, 1988

VOLUME 117

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 and F. Perrier	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



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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
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J.H. Olah for the Halton Region
Conservation Authority

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Per: C.F. Nethercut, CVR



1 --- Upon Commencing at 9:30:

2 MR. LANCASTER: Good morning, please be
3 seated.

4 ANTHONY J. CRUTCHER (Resumed):

5 JOHN M. PETRIE (Resumed):

6 MR. HODGSON: Before I ask any
7 questions, I wanted to indicate for you and Dr. Kingham
8 that
9 Mr. Feenstra has prepared a table of information on
10 infiltration rates for Burlington, Bayview and Site F,
11 and already given copies to the witnesses and he
12 proposes to give out copies to all the other parties.
13 We want their comments back and revise it where
14 necessary, then we will put it to the witnesses. I
15 think we can probably get that done today.

16 MR. LANCASTER: Very well.

17 CROSS-EXAMINATION BY MR. HODGSON (Cont'd):

18 Q. Mr. Petrie, you will recall,
19 Mr. Petrie, that some time in the distant past, I think
20 it was March of 1988, we were talking about page 156 of
21 your report, B-617, and we discussed, and you don't
22 really need to turn it up, but we discussed in the
23 course of that conversation that the numbers that are
24

25



1 proposed for exfiltration at the bottom of 157 might be
2 treated as a hypothesis, namely, the hypothesis being
3 that if Site F is constructed and operated as proposed
4 by Mr. Sobanski and Mr. Hiraishi, that the exfiltration
5 through the bottom of the landfill and into the shale
6 environment beneath the site could be as high as 100
7 millimetres per year.

8 I then suggested to you there were two
9 modes of testing that hypothesis and one mode would be
10 to test the conclusion, that conclusion, 100
11 millimetres, against the available data and the other
12 possibility for testing the hypotheses was to test the
13 assumptions that go into that hypothesis. Do you
14 recall that?

15 MR. PETRIE: A. In general terms, yes.

16 Q. This morning, if we could, I would
17 like to go to testing the assumptions that go into this
18 hypothesis. You will recall when I first started
19 asking you questions about page 156 we discussed those
20 assumptions and I think you agreed with me that the
21 assumptions, or among the assumptions were that you
22 have a zone of rock with a horizontal hydraulic
23 conductivity of 2×10^{-4} ?

24 A. It was a bulk value.

25 Q. This zone is either 15 or 30



1 metres deep?

2 A. Thick, yes.

3 Q. The zone underlies the entire
4 site?

5 A. Correct.

6 Q. The zone extends off-site
7 continuously?

8 A. Correct.

9 Q. I would like this morning, if we
10 could, to test together those four assumptions by
11 examining what we find beneath proposed Site F and see
12 the extent to which it confirms or disconfirms this
13 hypothesis about a unit of rock 15 to 30 metres deep
14 with a horizontal hydraulic conductivity of 2×10^{-4} .

15 Before we really get into this,
16 Mr. Petrie, I am going to hand you a metrestick and I
17 don't want it to become an exhibit and I am not going
18 to wrap you across the knuckles either, but I want you
19 to simply confirm that that is a metrestick and I would
20 like you to perform a couple of tasks for me.

21 Could you please look on this table
22 where we have -- on this table we have part of Exhibit
23 H-478 being boxes 3 and 4 from Exhibit H-478 which are
24 segments of core taken from HC4. Looking first of all
25 at H-478 box 3, this box right here, I would like you



1 to use your metrestick to examine one metre of rock and
2 the segment of rock I would like you to examine is
3 approximately 124.2 to 123.2 metres beneath ground
4 surface?

5 A. You said HC3 and I think you
6 pointed to HC4.

7 Q. I meant HC4, this box.

8 A. As long as I have the correct box.

9 Q. Have you a pen that will mark this
10 rock.

11 A. I have some pens here.

12 Q. Could you come around and I will
13 show you what I would like you to deal with?

14 A. I will see if I have enough cable.

15 MR. LANCASTER: You have indicated that
16 as box 3.

17 MR. HODGSON: This is HC4.

18 MR. PETRIE: We are looking at HC4 for
19 which the top elevation is 125.21.

20 MR. HODGSON: Q. The way these boxes
21 are set up, Mr. Chairman, they all read from the right-
22 hand side from the way which the Board faces them. So
23 the top of the rock in any box starts in this segment
24 and the bottom of the rock finishes in this segment,
25 and then looking at this chunk of rock we have, this



1 borehole rock which goes from 125.21 to 128.86.

2 What we have done is interpreted from
3 the descriptions on the core box, and I would ask you
4 to accept that subject to check, because nothing turns
5 on exactly the elevation of the rock other than to be
6 able to identify it.

7 A. Approximately from 40 to 51 feet
8 below ground.

9 Q. That's right. The segment of rock
10 I want you to look at I will mark with your red pen.
11 Between those two marks, and perhaps I can put a 1 and
12 a 2 on it. I am not sure that this evidence will be
13 here at the end of the hearing.

14 A. Could we have the elevations of
15 that?

16 Q. Assuming I am correct and the top
17 elevation in this box is 125.21, could you measure the
18 rock down to the mark I have put as a 1 and give us an
19 indication of how far below 125.21 that rock surface
20 is?

21 A. Approximately 50 centimetres plus
22 another 45 so 95 centimetres below an elevation of
23 125.21 which sounds like 124.31.

24 Q. 124.31?

25 A. If my mathematics was correct, 95



1 centimetres and does 5 centimetres matter in your
2 discussion?

3 Q. It doesn't. Can you give the
4 Board an approximate elevation of my top marker in case
5 we lose the rock...

6 A. 124.2.

7 Q. Taking that metre of rock from
8 124.2 to 123.2 could you indicate to the Board how many
9 fractures you believe that segment of rock would have
10 had in situ?

11 A. To do that I would count the
12 fractures I see before me and recognizing that this
13 core is two years old, plus. The number I would count
14 would be a maximum indicating that some of those
15 fractures may have been developed subsequent to the
16 core being removed from the borehole. Counting each
17 discontinuity as a unit 1, and recognizing that some
18 are more open and disturbed than others, we have 1, 2,
19 3, 4, 5 and taking the end one makes 6.

20 Q. Six. Would you agree with me that
21 numbers 1 and 6 appear to be the largest
22 discontinuities?

23 A. I do.

24 Q. Would you agree that No. 3
25 contains within it a white band, and what do you call



1 that?

2 A. Probably gypsum but a mineral
3 precipitate.

4 Q. A mineral precipitate, and so 3 is
5 probably a discontinuity as well in situ?

6 A. A discontinuity in situ, yes.

7 Q. Would you also agree with me that
8 fractures 2, 4 and 5 look very much like they are
9 machine breaks?

10 A. Breaks not representing an in situ
11 condition? 4 and 5 look very similar, I would agree
12 with that for 4 and 5, and No. 2 I am not so sure about
13 and I can't be so certain on that.

14 Q. Probably?

15 A. Probably machine breaks, yes.

16 Q. Then you have given us six breaks
17 and probably three of them are machine breaks, and that
18 leaves probably three of them existing in the ground?

19 A. Yes, right.

20 Q. I would like you to look in box 4
21 of this same exhibit at the core from 121.5 to 120.5?

22 A. Again you are referencing for the
23 record HC4?

24 Q. Yes. I will just separate these
25 boxes so it is obvious which box we are dealing with



1 here. The sample of core I would like you to interpret
2 is approximately that segment?

3 A. That segment being where you have
4 the metre rule.

5 Q. And perhaps we can mark that with
6 a red pen. Now, that goes -- what have I got -- can
7 you indicate for the Board, assuming I am correct that
8 the top of the rock in this box is at 121.9, how far
9 below 121.9 is my red mark?

10 A. From the top of the box?

11 Q. The top of the rock.

12 A. The top of the rock. 35
13 centimetres, approximately.

14 Q. So the segment I have shown you
15 reads from approximately 121.55?

16 A. Correct, metres in elevation.

17 Q. We are looking at a metre so it
18 would read to 120.55?

19 A. Correct.

20 Q. For that segment of rock, 121.55
21 to 120.55, could you please examine the material in
22 this box and give this Board an indication of how many
23 discontinuities you find in that segment?

24 A. Again recognizing we are looking
25 at a core that is some two years old and noting there



1 appears to be portions of the rock missing, I don't
2 know they are missing as a function of the drilling
3 process, and I don't believe there were voids in
4 the ground that were 2 or 3 centimetres open, so we may
5 be looking at more rock than that extruded from that
6 unit length.

7 Taking the 1 metre as indicated by the
8 scale, and noting it between your marks, and did you
9 number the marks or shall we number them 1 and 2?

10 Q. Yes.

11 A. Between 1 and 2 we have 1, 2, 3,
12 4, 5, 6, 7, 8, 9, 10, 11, and I am up to 47 metres
13 addressing down the core, 11, 12, 13, 14, 15, 16, 17,
14 18, 19, and some vertical fracturing at a point of
15 about 70 centimetres, 19 and we were at 20, 21, 22, 23,
16 24, 25, 26, 27, 28, so 29. That is just a visual
17 inspection of that length of rock.

18 I might note that some of the portions
19 of the rock have perhaps been ground as the core
20 rotated in the borehole during the drilling operation
21 against portions of the core that were at the bottom of
22 the hole and that obviously were unrotated and so there
23 may have been some grinding of the rock during the
24 drilling process such that we appear to have gaps in
25 the record.



1 Q. The first discontinuity you
2 marked, would you agree that that is likely a machine
3 break?

4 A. The first and the second.

5 Q. The first and the second?

6 A. Or probably the second.

7 Q. Did you get 29? So, that leaves
8 27.

9 A. Correct.

10 Q. Would you agree, and I am marking
11 them, and I will mark this spot with an X, but is that
12 likely a machine break?

13 A. At a point about 42 centimetres
14 down the length of the core, that is likely a machine
15 break.

16 Q. What about at 59 centimetres down?

17 A. Probably a machine break.

18 Q. What about at 65-1/2 centimetres?

19 A. 62 looks a bit more like a machine
20 break but 65 I am not so certain of. It appears to be
21 at an angle to the drilled core and it may be a real
22 break.

23 Q. What other fractures in there do
24 you suspect might be machine breaks?

25 A. Those are the only ones that look



1 like the most probable machine breaks. Do we have a
2 total on that? I see 5 when I count again but I will
3 take your word for 6. Was that your count or your
4 recollection of my counting?

5 Q. Yes. We now have likely 23 in
6 situ fractures and possibly 6 machine breaks?

7 A. Based on my visual impression of
8 that length of core, yes.

9 Q. Is it possible that there are
10 other machine breaks in that metre of core?

11 A. It is possible, yes.

12 Q. You would agree with me that the
13 disadvantage we have on the 5th of April, 1988, is that
14 this core, HC4-85, is approximately 2-1/2 years old --
15 I am sorry, it is 2-1/2 years since it was taken from
16 the ground, and we have already agreed it is older than
17 2-1/2 years?

18 A. It is definitely old but I don't
19 have the data in my head.

20 Q. It was in the latter half of 1985?

21 A. That is my recollection.

22 Q. Now, you will recall, Mr. Petrie,
23 that on Thursday we discussed the idea of developing a
24 confidence level continuum on which we could place
25 reliable data at one end and unreliable data at the



1 other end?

2 A. I recall that.

3 Q. We discussed the possibility of
4 locating along that continuum various bits of data
5 which a careful and thoughtful hydrogeologist would
6 propose more or less confidence on depending on how
7 that data appeared to him or appeared to his judgment,
8 depending on all the factors one might bring to bear in
9 assessing the weight you would place on the data?

10 A. I recall your discussion to that
11 effect, yes.

12 Q. I think you agreed it was a useful
13 exercise?

14 A. In general I agreed with the
15 principle.

16 Q. In fact you and I carried out that
17 exercise, did we not, on the tritium data?

18 A. Yes.

19 Q. Now, would you also agree with me
20 that in addition to analyzing the data we have in order
21 to ask ourselves the question how much confidence can
22 we place on this particular data, don't we also need to
23 do or carry out another exercise. With regard to any
24 particular data is it not also necessary to ask
25 yourself is this data which is organized in a manner



1 that can yield useful information to a hydrogeologist,
2 isn't that something we need to do?

3 A. Are you referring to any data set
4 in particular?

5 Q. I am not. I am referring to each
6 data set. With respect to any particular question you
7 have, don't you have to ask yourself on the data set,
8 is this a data set that is capable of answering the
9 question I am putting to it?

10 A. Correct, yes.

11 Q. That would be true, would it not,
12 in analyzing the geological materials at this site; we
13 have to be careful that the data we were looking at was
14 capable of yielding information that was meaningful to
15 us?

16 A. Yes, correct.

17 Q. At page 23 of your report, B-617,
18 you have prepared fracture frequency profiles?

19 A. Correct, directly from the data
20 available to me.

21 Q. Just looking could we at HC4-85,
22 and looking at the little chart we find in the upper
23 right-hand corner that explains what is going on here,
24 and perhaps you and I could go back through this and
25 explain to the Board. First of all, that little chart



1 on fracture frequency appearing in the upper right-hand
2 corner of page 23 of B-617, that is really taken right
3 out of the Trow report, is it not?

4 A. Out of their appendices in Exhibit
5 H-40A.

6 Q. Appendix 2, page 2, fracture
7 frequency, joint spacing?

8 A. The first page of text or data, so
9 to speak, in Appendix 2, yes.

10 Q. And this data, this method of
11 organizing data, this is a standard method that is used
12 by geologists, is it not?

13 A. I imagine there are a lot of other
14 methods as well, but fracture frequency does lead you
15 to some understanding of the fracture distribution.

16 Q. Specifically focusing on fracture
17 frequency, this method of categorizing fractures is a
18 standard method in geology?

19 A. When I note the scale produced at
20 the top right-hand corner being the number of fractures
21 per metre length, I am not sure if that is standard or
22 not. I am not aware of the standard method of
23 categorizing the number of fractures per metre length
24 in a core. I mentioned there were a variety of
25 categorizations and one would chose one that would



1 satisfy the distribution one has before one.

2 Q. Let's examine the ability that
3 this particular scale has to do just that. Would you
4 agree with me, looking at HC4-85, that none of the rock
5 falls into the first range, that is between .3 to 1
6 fracture per metre?

7 A. That is the second point on the
8 range.

9 Q. I am sorry, the second point on
10 the range?

11 A. Correct.

12 Q. Let's understand this little
13 table. If we have white in the left-hand column, that
14 means that there are fewer than .3 fractures per metre?

15 A. Or approximately fewer than 1
16 fracture per 3 metres of length, yes.

17 Q. If we find black in the first
18 column that means we have between .3 and 1 fracture?

19 A. Per metre length.

20 Q. Looking at HC4, we don't have any
21 rock that falls into that category?

22 A. That is correct.

23 Q. If two columns are black, that
24 means that the rock has between 1 and 3 fractures per
25 metre or core length?



1 A. That is correct.

2 Q. Looking at HC4-85, what we are
3 looking at is we want to identify those segments in
4 column 3 that are white, and those segments in column
5 that are white suggest we have rock at those particular
6 depths that have between 1 and 3 fractures per metre?

7 A. I am counting that as column 2.

8 Q. But the white is in column 3?

9 A. Yes, but that is 3 to 20 fractures
10 per metre length. I am taking the column as between 2
11 vertical lines.

12 Q. So am I. Without looking at HC4
13 and looking back at the fracture frequency, don't we
14 have four columns?

15 A. We have four columns.

16 Q. Can we number them across the top?

17 A. We can. From the left?

18 Q. One, 2, 3 and 4.

19 A. Correct.

20 Q. When we have -- we have columns 1
21 and 2 black and column 3 is white and that means we
22 have rock with between 1 and 3 fractures per metre,
23 right? Do you have an overhead of this?

24 A. Yes, I do.

25 Q. Let's put that up? Maybe we can



1 all focus on what we are talking about. I could
2 indicate while we are waiting that Mr. Crutcher was
3 seen Thursday afternoon at the end of the hearing
4 photographing these new exhibits and I thought we had
5 an expert spy in our midst, but it turns out he was an
6 amateur spy and he confessed he had never done this
7 before, but he was successful and has actually got good
8 colour reproductions of each one of these cross-
9 sections. I tell you that so you are invited to ask
10 him for copies and I hope that when he offers to give
11 them to you he will give them to everyone else as well.

12 DR. KINGHAM: On the subject of
13 photographs, I would remind you that the Environmental
14 Assessment Board photographer might appear after lunch
15 this afternoon to take some photos for the annual
16 report of the Environmental Assessment Board of a
17 hearing in process.

18 MR. HODGSON: I take it he wants none of
19 the rabble here, just the Board and the exhibits?

20 MS. CRONK: Did you have a specific time
21 in mind for an objection?

22 MR. LANCASTER: We should have the
23 charts back up on the wall to make it look good. The
24 Board wishes to look intelligent at that time.

25 MR. PETRIE: You are not alone.



1 MR. HODGSON: Q. Could I just ask you
2 with a red pen to number those columns in the fracture
3 frequency across the top with the one on the left-hand
4 side being 1. Would you agree with me that when
5 columns 1 and 2 are black and columns 3 and 4 are
6 white, that that means that each metre of rock has
7 between 1 and 3 fractures?

8 MR. PETRIE: A. When columns 1 and 2
9 are black there is between 1 and 3 fractures per metre
10 length.

11 Q. Correct. Looking at HC4 where we
12 see column 3 as white, that means that the rock beside
13 or at those elevations, has between 1 and 3 fractures
14 per metre?

15 A. Correct.

16 Q. Have you got a pen that is like a
17 highlighter? Could you mark in yellow on HC4, and you
18 will need to mark on that exhibit, so is there a
19 yellow ...

20 A. You mean one of these?

21 Q. It must be a plastic marker.

22 A. Okay.

23 Q. Can you highlight the open spaces
24 in column 3 on HC4?

25 A. The open spaces in column 3 on



1 HC4?

2 Q. Yes.

3 A. Shall I put a circle around them?

4 Q. Just fill in the space. What I
5 want you to do is colour in that space, just the column
6 3 space and not the column 4 space. You have coloured
7 in column 3 in a colour that is somewhere between
8 yellow and orange on this overhead, page 23, and I
9 don't think it was marked, and perhaps we should mark
10 it as a separate exhibit.

11 I guess it would be B-617-23. Is that
12 how we have been doing it? Was that P-23A?

13 MR. PETRIE: B-617-23A being the
14 overhead for Figure B.2.2 of Exhibit B-617.

15 ---EXHIBIT NO. B-617-23A: Figure B.2.2 from
Exhibit B-617

16 MR. HODGSON: Q. Could you please
17 indicate for the Board if you could, could you estimate
18 approximately what portion of the total run of rock we
19 find in HC4 is rock that has between 1 and 3 fractures
20 per metre and perhaps before you make an estimate I
21 could assist you in this way. I eyeballed it and got
22 one number and then I took out a ruler and I measured
23 off the core log in HC4-85 that appears in Exhibit 40-
24 A, Tab 2.

25 I actually measured with a ruler the



1 number of millimetres or centimetres, whatever, of core
2 that is logged as between 1 and 3 fractures per metre
3 and took that as a proportion of the whole. Is that a
4 reasonable way to estimate the proportion of rock in
5 that way, and can one measure off the core log?

6 MR. PETRIE: A. Yes, that is exactly
7 what the exhibit before you is done from.

8 Q. Can I suggest to you, subject to
9 check, that when you measure the runs that you have
10 coloured up in orange on this exhibit, B-617-23A, that
11 approximately 30 per cent of the core has between 1 and
12 3 fractures per metre and can you accept that subject
13 to check?

14 A. I can, subject to check, yes.

15 Q. I didn't carry out the same
16 pedantic exercise for the segment of core that has more
17 than 20 fractures per metre, but would you agree with
18 me that where we find in column 4 under HC4 black, we
19 are now looking at rock that has more than 20 fractures
20 per metre and that is what the black in column 4 tells
21 us?

22 A. Column 4. The black in column 4
23 is greater than 20 fractures per metre, yes.

24 Q. The most fractured rock is rock
25 that shows up with the black in column 4?



1 A. Extending across to the right-hand
2 side of the legend adjacent to that borehole, yes.

3 Q. Eyeballing that black highly
4 fractured rock from column 4, could you estimate for
5 us, please, what percentage of the total rock is or has
6 20 or more fractures per metre?

7 A. It is a little difficult just
8 eyeballing it, but relative to the 30 per cent which I
9 believe was your number for the yellow, it looks like
10 less than 30 per cent.

11 DR. KINGHAM: Did you say 30 per cent
12 for the yellow or 20?

13 MR. HODGSON: I said 30 per cent for the
14 yellow.

15 DR. KINGHAM: Thank you.

16 MR. HODGSON: Q. Would you agree it is
17 approximately 10 per cent and does that seem like an
18 appropriate ...

19 MR. PETRIE: A. Perhaps, yes.

20 Q. Now, assuming our numbers of 30
21 per cent for rock that is fractured between 1 and 3
22 fractures and 10 per cent of the core has more than 20
23 fractures per metre, would you agree with me that that
24 means that approximately 60 per cent, and I am
25 obviously not pinning you down on these numbers, but



1 approximately 60 per cent of the core length has
2 between 3 and 20 fractures per metre?

3 A. Yes.

4 Q. So, what we are talking about now
5 is where we see in column 4 white and we don't see
6 white in column 3 beside it, we are looking at rock
7 that has between 3 and 20 fractures per metre?

8 A. Correct.

9 Q. Now going back to Exhibit H-478,
10 boxes 3 and 4, you agreed with me, I believe, that that
11 first run of core in box 3 at 124.2 to 123.2 has three
12 fractures?

13 A. I believe we counted six and said
14 three were machine breaks and three were probably in
15 situ fractures, yes.

16 Q. So that segment of core would fall
17 into column 3, between 3 and 20 fractures?

18 A. Yes.

19 Q. Looking in the next box at the
20 core from 121.55 to 120.55, it was your view that what
21 we find in that run of core is approximately 23
22 fractures that are not machine breaks?

23 A. That is my recollection, yes.

24 Q. Would you agree with me that if we
25 slid this metrestick up so as to take in more competent



1 rock and eliminate a few fractures, we would now have
2 the metrestick across a segment of rock that had 20
3 fractures or fewer?

4 A. Noting that we have omitted some
5 at the bottom end and added one at the top, it would
6 appear that your number is approximately correct, yes.

7 Q. Perhaps we could agree to mark
8 with a green pen where the metrestick is now sitting?
9 Would you please measure the top of this segment of
10 rock I am indicating for you, and keeping in mind that
11 the top of the previous one was 121.55 and how much
12 higher than 121.55 is the green mark?

13 A. You have moved the metre scale up
14 11 centimetres.

15 Q. We are now at 121.66?

16 A. Correct.

17 Q. We are looking at a segment of
18 rock from 121.66 to 120.66?

19 A. That is correct.

20 Q. You would agree that that segment
21 of rock has fewer than 20 fractures per metre?

22 A. We appear to have taken 5
23 fractures off at the bottom end and added one at the
24 top end, and could you relate that back to the original
25 number we had?



1 Q. We were at 23 and if you take off
2 5 and add one...

3 A. We have less than 20 as per that
4 metre length, yes.

5 Q. We are at approximately 19. So we
6 could all now look at these two runs of rock, one at
7 124.2 down a metre, and one at 121.66 and down a metre,
8 and would you agree that those two segments of rock
9 both fall into this category of between 3 and 20
10 fractures per metre?

11 A. Correct. The only comment I would
12 have is I don't know where the person logging the
13 boreholes started his metre runs in counting the number
14 of fractures per metre.

15 Q. I appreciate that, and I am not
16 going to test you against the person who logged the
17 hole, I am only going to test you against yourself. I
18 am really asking you what we have is one category and 2
19 metres of rock and you would agree with me, would you
20 not, that those two metres or rock core are very
21 different but fall into the same category?

22 A. Correct.

23 Q. In fact 60 per cent of this whole
24 core was logged with that single category, 3 to 20
25 fractures per metre, and that means that 60 per cent of



1 this whole core could either look like the segment from
2 124.2 to 123.2 or the segment from 121.66 to 120.66?

3 A. There is quite a bit of room in
4 between, but it could look like that, yes.

5 Q. Would you agree with me that that
6 category of 3 to 20 fractures per metre is too broad?

7 A. I would like to make one point
8 first if I might. The data I have presented on page 23
9 of Exhibit B-617 came directly from Trow, and we took
10 the data as they provided it to see as I was critiquing
11 their report at this point, does the data they provide
12 support the conclusions they draw and I came to some
13 conclusions based on that.

14 Were I logging the core and assigning a
15 fracture frequency distribution, and on the hindsight I
16 now have before me, I would have chosen a different
17 distribution I feel, but how that distribution was
18 selected in the field and how they selected it before
19 they went into the field, I do not know.

20 Q. I must confess I don't know either
21 and I suspect there are others in this room who would
22 now not log the core this way. Would you agree with me
23 that it is unfortunate that the core was in fact logged
24 with one category into which more than at least 60 per
25 cent of this particular core falls?



1 A. Correct.

2 Q. Just eyeballing HC6 and HC8 it
3 would appear that at least 60 per cent of at least each
4 of those cores also falls into this one category of
5 between 3 and 20 fractures per metre?

6 A. They appear to have a similar
7 relationship, yes.

8 Q. Aren't we in this position,
9 Mr. Petrie, that this distribution or this fracture
10 frequency distribution is a crude instrument because it
11 doesn't provide us with enough resolution to really
12 understand what is happening in this rock bore based on
13 this fracture distribution?

14 A. I would not agree entirely.

15 Q. Do you want to qualify that
16 answer?

17 A. Yes. Where we have fracture zones
18 of greater than 20 per metre length, I note they are
19 relatively discrete zones and it is my opinion that the
20 person logging that took quite a bit of comfort in
21 defining the elevations of those. I also note that
22 some of those zones as you see before you on the
23 exhibit, Figure B.2.2, are the thickness of a pen line
24 and relating that back to the log we notice they have
25 described what they have called intensely fractured



1 zones as a relative word, greater than 20 fractures per
2 metre length, and for zones as thin as 5 to 10
3 centimetres, and when we are dealing with a block of
4 rock over which there is variable fracture, the
5 location of discrete intensely fractured zones is of
6 some significance.

7 I agree with your earlier statement that
8 the scale chosen may not be the most appropriate, but
9 it does indicate the position of the more intensely
10 fractured zones, and by intensely fractured, one may
11 assume -- that is a different discussion, but they are
12 also the more conductive zones or more transmissive
13 zones.

14 Q. I accept that it indicates areas
15 where there are -- there is intense fracturing, more
16 than 20 fractures per metre, and it also to some extent
17 indicates areas where the fracturing is relatively
18 unintensified, between 1 and 3 fractures per metre?

19 A. It does indeed. So, perhaps it is
20 useful to use that rendition provided by Trow or as we
21 have reproduced here to say that the end members of the
22 fracture domain and the less fractured and more
23 intensively fractured recognizing that the middle
24 portions of that domain are not so well defined.

25 Q. It would be helpful, would it not,



1 if the middle portions of the domain, that is the
2 segments of rock logged between 3 and 20 fractures per
3 metre, it would be helpful if we had a little greater
4 resolution within that single category?

5 A. It would although I would offer a
6 cautionary note to the effect of what is the difference
7 between, say, 5 and 10 fractures per metre length?
8 Granted the numerical difference is 2, but trying to
9 relate that and to reflect the hydraulic conductivity
10 of the rock mass, and I am not sure what that would
11 give to you and going through the exercise you have
12 undertaken there, i.e., moving the metre scale up or
13 down a portion of the rock mass, you could arrive at
14 the conclusion that that definition was very sensitive
15 to where you took your metre increments.

16 Be that as it may, the end members, that
17 is the much less fractured and the much more intensely
18 fractured portions I think are relatively well
19 described by this logging process.

20 Q. Going back to the segment of core
21 in box 3, between 100 -- if I had a good memory I
22 wouldn't have to do this -- but between 124.2 and 123.2
23 metres...

24 A. HC4.

25 Q. HC4. Wouldn't you agree that the



1 opportunities for horizontal flow through that rock are
2 limited basically to what appears now, 2-1/2 years or
3 so after the core was taken from the ground, to be at
4 most 2 fractures of any significance at all?

5 A. I believe we said 3, but one was
6 questionable.

7 Q. Looking at the third one, the
8 third one has gypsum in it?

9 A. Correct.

10 Q. And it doesn't appear to be a very
11 thick break, does it?

12 A. I would suspect its capacity to
13 transmit water is limited, yes.

14 Q. Looking at this run of core, 124.2
15 to 123.2, the opportunities for horizontal flow through
16 it are limited, are they not?

17 A. They are indeed.

18 Q. What about the opportunities for
19 vertical flow through it?

20 A. One cannot derive direct
21 relationships of vertical flow from observing
22 horizontal fractures. One is obviously looking for
23 vertical fracture connection and I do not see the
24 definition of vertical fractures in that one length of
25 borehole. However, it is not particularly easy to find



1 good vertical fractures in a vertical borehole.

2 Q. Looking at the evidence we have
3 before us, wouldn't you agree with me that the vertical
4 hydraulic conductivity across that unit is probably
5 very low?

6 A. You are making assumptions
7 regarding the incidence of vertical fracturing and the
8 continuity of this unit as you called it. If we are
9 just looking at that piece of rock per se, yes, yes, it
10 is low.

11 Q. Looking at the piece of rock from
12 121.66 to 120.66, we have agreed it falls into the same
13 category of between 3 and 20 fractures. I am already
14 losing the green mark. Have you a better pen? Would
15 you agree that the opportunities for flow through this
16 segment of rock in either the horizontal or vertical
17 are substantially greater?

18 A. With respect to horizontal, yes,
19 and with respect to vertical I cannot be particularly
20 precise. However, given that there is more horizontal
21 fracturing, then the magnitude of the vertical
22 fracturing could be less and still provide significant
23 flow.

24 Q. Could you come around and advise
25 the Board, please, on just what kind of thickness the



1 smallest fractures in fact have?

2 A. Could you indicate to me ...

3 Q. I am interested in this run of
4 core at approximately 30 centimetres from the top of
5 this run of core in box 4 we have been talking about,
6 but there is a piece of rock?

7 A. Indeed.

8 Q. Does that look like the rock that
9 came out of the ground and does it look like it was
10 fractured in the earth?

11 A. The piece of rock you have given
12 to me to describe is approximately 5 centimetres thick
13 at its thickest, and almost pinching out at the other
14 portion of its cross-sectional area and it is ground
15 top and bottom in some fashion and possibly by a
16 rotating drill core. Does it look like it came out of
17 the earth? Is that your question? Is that how it
18 looked when it came out of the ground?

19 Q. Does it look like it is about the
20 thickness it was in the ground?

21 A. I noted there was some marks of
22 some sort which may indicate a component of grinding
23 and it may be the approximate thickness that came out
24 of the ground.

25 Q. The approximate thickness?



1 A. Approximately, but I could not
2 speculate as to what the exact thickness would have
3 been.

4 Q. Would you agree with me as between
5 that piece of rock that you have just described at 30
6 centimetres and the run of core we looked at in box 3
7 from 124.2 to 123.2 that there is more likely to be
8 hydraulic connections between the layer above and below
9 this, this small fracture at 30 centimetres in box 4?

10 A. Non-fractured.

11 Q. Whatever it is?

12 A. I am a bit confused. You are
13 trying to say there is a degree of vertical ...

14 Q. Let me start over and see if I can
15 frame this question properly.

16 Would you agree with me that we are more
17 likely to find hydraulic connection between the layer
18 above -- between the space above and the space below a
19 particular unit of fractured rock where that fractured
20 rock is thin than we are where the fractured rock is
21 thick?

22 A. Yes.

23 Q. Just looking at the run of core in
24 HC4, this whole middle column of core, would you agree
25 with me we have approximately a metre and a half of



1 core with vertically no fracturing to it?

2 A. You are referring to the middle
3 length of core in this box?

4 Q. Yes.

5 A. It appears to be a metre and a
6 half in length and what was the number of fractures you
7 asked me to comment on?

8 Q. I didn't ask about the number of
9 fractures. It is not difficult, is it, to believe that
10 that unit of rock that was found in HC4 in and around
11 124.2, that metre and a half thick sediment of rock
12 with how many fractures does it have from top to
13 bottom?

14 A. Counting from the top end of the
15 middle run of core in box 3 of HC4, there are 1, 2,
16 plus the number we had between the two marks indicated
17 on the core, and I have lost my number and we had 6,
18 and we thought 3 ...

19 Q. We got it down to 3.

20 A. One was a mineral precipitate and
21 not likely to be particularly transmissive.

22 Q. Would you agree these two
23 fractures above 124.2, that is this one and this one,
24 are likely machine breaks?

25 A. Are likely, yes.



1 Q. So what do we have? In this whole
2 run of core we have two significant fractures and one
3 layer of gypsum?

4 A. So that comes to three in situ
5 discontinuities as I was saying, yes.

6 Q. Would you agree that it is
7 possible that that run of material is laterally quite
8 extensive beneath Site F?

9 A. I couldn't make that assumption
10 based on that piece of core.

11 Q. But it is possible, is it not?

12 A. It is also equally possible it is
13 not continuous.

14 Q. "Equally possible."

15 A. I believe so.

16 Q. Would you agree with me looking
17 back at box 4 that this metre of material we have
18 talked about from 121.55 -- 121.66 to 120.66, there
19 could well be greater hydraulic connection between
20 those fractures in that run than there is in that unit
21 of core down the middle of box 3?

22 A. I believe when you first phrased
23 the question you said vertical connection.

24 Q. I mean vertical connection.

25 A. Over the one metre interval you



1 have referred to laterally from box 4 of HC4 there is
2 probably more vertical connection within that one metre
3 interval than within the corresponding one metre
4 interval you referred me to in box 3.

5 Q. Now, going back to our discussion
6 about B-617-23A, you agreed with me, I think, that
7 having 60 per cent of the core fall into one category
8 of between 3 and 20 fractures did not provide
9 sufficient resolution. Would you agree with that?

10 A. I believe I did and I also added
11 the qualifier that I am not sure what a difference of
12 five fractures per metre versus ten fractures per metre
13 may indicate. In other words, I am not sure that
14 better resolution would give you a much more clear
15 picture of the hydraulic relationships within this
16 rock.

17 Q. Would you agree with me that the
18 two metres of rock we have been talking about in boxes
19 3 and 4 in H-478 both fall into the same category, that
20 it would be helpful if we understood better the
21 difference between the metre we looked at in box 3 and
22 the metre we looked at in box 4?

23 A. Yes.

24 Q. At the moment, just looking at the
25 information we have on B-617-23A, we don't have that?



1 A. With respect to the 2 metre
2 intervals you described, we do not.

3 Q. Mr. Petrie, could I ask you to
4 turn up a copy of Exhibit H-206?

5 A. I have that.

6 Q. Could you turn please to the last
7 page of that exhibit?

8 A. A page "Percent RQD For Boreholes
9 Shown on Figure 2?"

10 Q. Yes..

11 A. I have that.

12 Q. We have here what are called rock
13 quality designation profiles. Do you agree?

14 A. Yes.

15 Q. Keeping that page open, would you
16 also please turn up in Appendix 2 of H-40A at page 2,
17 and do you see the explanatory sheet to the core log?

18 A. I do.

19 Q. Do you see reading for column 16
20 on the right-hand bottom side of the page that we have
21 the rock quality designation?

22 A. We do indeed under column 16.

23 Q. The RQD is another standard
24 technique for categorizing core that comes out of a
25 borehole; is it not?



1 A. It is a standard technique, yes.

2 Q. Just so we all understand, do you
3 agree that the method used here is the standard method,
4 that is to say the RQD is the total length of those
5 pieces of sound core which are 10 centimetres or
6 greater in length in a core run expressed as a
7 percentage of the length of that core run?

8 A. That is my understanding.

9 Q. What that means is if you took --
10 let's talk about a metre of rock for a second -- and as
11 the core run we are talking about and calculating a RQD
12 for. If you have a metre of rock core and every piece
13 that came out of it was more than 10 centimetres, and
14 suppose every piece in a metre -- let's not use a metre
15 as it is too small. Let's take a three metre segment
16 of rock and so that's 300 centimetres?

17 A. Yes.

18 Q. In 300 centimetres of rock if
19 every piece came out at 11 centimetres, would you agree
20 with me that the RQD for that core length of 3 metres
21 would be 100 per cent?

22 A. I note it uses the words "core
23 runs" so we will take your 300 centimetres as a core
24 run and it would have an RQD of 100 per cent.

25 Q. The RQD then is an instrument that



1 gives us an indication of how many pieces of rock come
2 out of a core run that are longer than 10 centimetres?

3 A. It does.

4 Q. You would agree with me that just
5 looking at this metre from 121.66 to 120.66 that we
6 have a fair number of pieces that are not 10
7 centimetres in length?

8 A. I am sorry, could you direct me to
9 which piece of core?

10 Q. In box 4 where the metre stick is
11 sitting between the two green marks and would you agree
12 we have some segments of core that are not 10
13 centimetres in length?

14 A. We do.

15 Q. Ten centimetres is 4 inches
16 approximately?

17 A. Approximately.

18 Q. Where we have a piece of core that
19 is less than 4 inches long and which is something
20 between 33 and 39 centimetres where we have a piece,
21 and I am holding it in my hand, and that is
22 approximately 6 centimetres long?

23 A. Approximately.

24 Q. Could you find a piece of rock
25 that is 10 centimetres long?



1 A. You may have one at the bottom
2 end, noting from the scale. That is approximately 10
3 centimetres.

4 Q. Perhaps we could remove this for a
5 moment. Would you agree that between 84 and 94
6 centimetres in the segment of rock we have been
7 discussing in box 4 we have a piece of core that is
8 approximately 10 centimetres in length?

9 A. Approximately, yes.

10 Q. Would you pull that piece out and
11 stand it on the table here? We can put it back later,
12 so help me remember where it goes?

13 A. I will.

14 Q. Perhaps you should put an arrow on
15 it, with the arrow pointing up?

16 A. The top of a piece of rock is
17 pointing to the bottom of the box, as I understand it,
18 from looking at it.

19 Q. The RQD means, does it not, that
20 you count the number of pieces of rock in a run that
21 are the length of that piece that you have got sitting
22 on your table which is 10 centimetres or more?

23 A. Correct.

24 Q. And then you measure the total
25 length of those pieces of rock that are 10 centimetres



1 or more?

2 A. Correct.

3 Q. And you calculate that against the
4 total run of the core?

5 A. Divided by the core run length.

6 Q. And the percentage developed is
7 the RQD profile -- RQD for that run of core?

8 A. Correct.

9 Q. Would you agree with me just
10 looking at that run of material we have in box 4 that
11 the RQD gives us another opportunity for finer
12 resolution in analyzing the kind of material that came
13 out of these boreholes?

14 A. I don't think I would agree with
15 the finer resolution, but it gives you an opportunity
16 of using another method for examining the rock, yes.

17 Q. Let's do it this way, Mr. Petrie.
18 Just with your eyeballs does the piece of core between
19 124.2 and 123.2 and the piece of core between 121.66
20 and 120.66, do those two appear to have the same RQD to
21 you?

22 A. Using the eyeball method, no.

23 Q. But they fell within the same
24 category of between 3 and 20 fractures per metre?

25 A. As I recall it, yes.



1 Q. And we agreed that that category
2 was too broad?

3 A. We agreed it didn't provide the
4 most precise definition of fracture frequency within
5 the rock.

6 Q. Wouldn't you agree looking at
7 those two segments of core that the RQD provides us
8 with an opportunity to distinguish between those two
9 pieces of core?

10 A. It is another tool one can use to
11 examine that, yes.

12 Q. Just so we understand, RQD is
13 another tool we can use to examine it, but it has this
14 problem, does it not. You have agreed with me that if
15 we had a core run of 3 metres and every piece in it was
16 11 metres long, we would have an RQD of 100 per cent?

17 A. 11 centimetres?

18 Q. 11 centimetres long.

19 A. If we had a length of rock and
20 every piece 11 centimetres long, then that would be an
21 RQD of 100 per cent.

22 Q. If we had a core run of 3 metres
23 and we didn't have a single fracture, the RQD would be
24 100 per cent?

25 A. If we had a length of core in



1 which the fracture spacing was 9 centimetres with no
2 pieces of rock greater than 10 centimetres, then I
3 believe there would be an RQD of zero. I am just noting
4 that an average fracture spacing of 11 versus 9 in this
5 hypothetical block of rock, the 3 metre length we are
6 addressing, that gives us an RQD that ranges over the
7 full scale of the RQD, i.e., zero to 100 per cent.

8 Q. So RQD is again something that can
9 be a bit crude?

10 A. It is a bit crude.

11 Q. It can be a bit crude?

12 A. It can be a bit crude.

13 Q. But it can also in the context we
14 are dealing with it here help us to understand which
15 runs of rock appear to be more competent than other
16 runs of rock?

17 A. It can give you an indication,
18 yes.

19 Q. So if we could, let's look at the
20 RQD for HC4. First of all what we ought to do,
21 Mr. Chairman, and Mr. Petrie, we ought to get out the
22 borehole log for HC4-85 under Tab 2. Mr. Petrie, I
23 want you to help me carry out an exercise so we can
24 demonstrate something to assist both you and the Board.
25 You will notice under the RQD per cent in column 16



1 that we have, starting at 131.3 metres, RQD's of 69,
2 76, 59?

3 A. I have turned the page to 59, yes.

4 MR. ESTRIN: I am sorry, where are we?

5 MR. HODGSON: I am on the borehole log
6 for HC4-85.

7 MR. PETRIE: Column 16.

8 MR. HODGSON: Q. Starting in the second
9 page of that borehole log dealing in the shale as
10 opposed to the till. Would you, Mr. Petrie -- the
11 third box of core we have on the table here is between
12 125.21 and 121.86 metres?

13 MR. PETRIE: A. Could you give those
14 numbers again or should I replace this piece of rock.

15 Q. Leave it out. I would like to
16 look at it. I am looking at box 3 and the core run we
17 have in box 3 is between 125.21 and 121.8?

18 A. As it reads there.

19 Q. We could, could we not, by
20 subtracting from the core log starting at 131.30 figure
21 out what segment of core in box 3 is logged on this
22 log?

23 A. Yes.

24 Q. Perhaps if we subtract 125.21 from
25 131.30, what do we get?



1 A. I believe the 131.30 is the
2 elevation of the top of the rock from the coring
3 record.

4 Q. Subtracting those elevations we
5 can figure out where this particular core run begins?

6 A. We ought to be able to, yes.

7 Q. Will you accept, subject to check,
8 looking at the second page ...

9 A. The first page of the core log?

10 Q. The second page of ...

11 A. Starting at a depth...

12 Q. Let's number the pages.

13 A. Certainly.

14 Q. Borehole log HC4-85 and the first
15 page in the till is page 1 and then number from there.
16 Looking at page 3 in the middle of the page?

17 A. Yes.

18 Q. Do you see a 59 under RQD?

19 A. Under column 16, I do.

20 Q. Do you see a line above that?

21 A. I do.

22 Q. I think I figured out yesterday
23 and I would ask you to take this subject to check, but
24 that line represents the core -- the line divides a
25 core run obviously because the RQD is for the run below



1 it.

2 A. I think the line indicates the
3 beginning of a core run?

4 Q. Yes. That line is at 125.20.
5 Would you accept that subject to check?

6 A. I would indeed.

7 Q. If that line is at 125.20 would
8 you agree that what we are looking at in box 3 right
9 here in front of us is the core that has an RQD of 59?

10 A. At the top end of that box it is
11 the beginning of the run marked with an RQD of 59, yes.

12
13 Q. In fact Mr. Petrie if you will
14 accept this subject to check, the RQD's logged on here
15 have been logged for each box of core?

16 A. That would be my understanding,
17 yes.

18 Q. In fact we have got all the boxes
19 for HC4-85 sitting on the floor over there and so what
20 we can now do is walk down from box to box and compare
21 the RQD with what we see in the box?

22 A. One could, yes.

23 Q. And also going back to the last
24 page under Exhibit 206, we have an RQD profile for HC4-
25 85?



- 1 A. We do.
- 2 Q. Do you see that the top, in that
- 3 profile, the top little line is at about 69?
- 4 A. Using the eyeball method, yes.
- 5 Q. Corresponding with the first RQD
- 6 on the core log on page 2?
- 7 A. Correct.
- 8 Q. In fact it might be helpful for
- 9 everyone if we wrote down the numbers right beside the
- 10 line so it would read 69 for the first box, and for the
- 11 second -- or the second vertical line is at 76?
- 12 A. Yes.
- 13 Q. And the third one is at 59?
- 14 A. Correct.
- 15 Q. The fourth one is at 49?
- 16 A. Correct.
- 17 Q. The fifth one is at 100?
- 18 A. It looks like that, yes.
- 19 Q. And the sixth one is at 57?
- 20 A. Yes.
- 21 Q. The seventh one is at 87?
- 22 A. I see it.
- 23 Q. The eighth one is at 72?
- 24 A. Correct.
- 25 Q. Would you accept subject to check



1 that what we have is an RQD for box 3 of 59 per cent?

2 A. I am sorry, an RQD for box 3 of 59
3 per cent?

4 Q. Yes.

5 A. If I am with you, yes.

6 Q. An RQD for box 4 of 49 per cent?

7 A. I am sorry.

8 Q. Box 4 is the next one down the
9 core?

10 A. Which was box 3? I thought you
11 said 69.

12 Q. I said 59 per cent for box 3.

13 A. I beg your pardon.

14 Q. On page 3, do you see that?

15 A. I was on the wrong page, 59 per
16 cent for box 3.

17 Q. At the top of page 4 we see the 49
18 and that is for box 4?

19 A. Subject to your checking, yes.

20 Q. Subject to your checking because
21 it must be yours?

22 A. Subject to my checking your ...

23 Q. It is every lawyer's ambition to
24 give the evidence but none of us every get the
25 opportunity and it would be a disastrous process if we



1 did. Now, can we just look at these boxes of core for
2 a minute. We have in box 3 a lot of competent rock,
3 would you agree. Just look in front of you. This is
4 box 3 and would you agree there is a lot of competent
5 core in box 3?

6 A. Relative to box 4 in a general
7 sense, yes.

8 Q. And box 4 has a lot more fractured
9 material than box 3?

10 A. Correct.

11 Q. Looking again now at the RQD
12 profile would you agree with me that in HC4-85 the
13 three boxes of core with the worst or lowest RQD are
14 boxes 3 at 59, 4 at 49 and 6 at 57?

15 A. Three, 4 and 6, yes.

16 Q. Now, looking then at 59. Sorry,
17 looking at box 3. We have a run of core in box 3 that
18 is a metre and a half long, I think you told us, with 2
19 or at most 3 fractures occurring in situ?

20 A. Correct.

21 Q. And yet that box of core has only
22 got an RQD of 59?

23 A. Correct.

24 Q. And we have 1, 2, 3, 4, 5 other
25 boxes of core, 5 other runs of core from HC4-85 all of



1 them with RQD's higher than box 3?

2 A. Correct.

3 Q. That suggests that we have got
4 five other boxes with more competent rock than we find
5 in box 3?

6 A. Based on the RQD's.

7 Q. Based on the RQD's?

8 A. Yes.

9 Q. Now, as you pointed out, the RQD
10 is also a bit of a crude instrument?

11 A. Yes.

12 Q. I think it would be useful if you
13 took the RQD profile and went over to the other boxes
14 and examined for a minute what we find in the other
15 boxes. Now, I don't want to move everybody over there
16 and I don't want the hearing to go over and back so
17 could we take two minutes and all compare what we see
18 in the boxes with the RQD profiles and then we can come
19 back and I will ask some questions.

20 MR. LANCASTER: Fine.

21 MR. PETRIE: Which document should I
22 take over?

23 MR. HODGSON: The RQD profile.

24 ---(Off the record discussion)

25 MR. HODGSON: Q. Mr. Petrie, looking at



1 these boxes and recognizing that two of them are
2 elsewhere in the hearing room, I would just like you to
3 indicate for the Board box 5 is the box that is
4 indicated as having an RQD of 100?

5 MR. PETRIE: A. Yes.

6 Q. Looking at box 5, could you advise
7 the Board whether or not you can agree that virtually
8 every one of the fractures we see in that box is a
9 machine break?

10 A. The majority appear to be machine
11 breaks, but I have one quick question noting the run
12 elevations being 118.8 to 115.69; do we have all the
13 core in the box?

14 Q. Apparently some of it was taken by
15 CRA.

16 A. That was an 8 centimetre length so
17 I note we have two trays filled for 10 metres -- I beg
18 your pardon -- approximately 3 metres. One thing I
19 note is the incidence ...

20 Q. Three metres is about 10 feet?

21 A. I don't know the length of the
22 box.

23 Q. Let's measure it. Five feet.

24 A. We appear to have about 4-1/2 feet
25 per run and I am noting that the two runs -- we have



1 one metre and if you could move this scale down we have
2 1.33 metres in the first run, 1.46 so let's call it
3 1.47 so 2.8 metres and the depths appear to correlate
4 with the run lengths. Your question was...

5 Q. Would you agree that virtually all
6 the fractures in this box are machine breaks?

7 A. That appears to be the case.

8 Q. Looking at box 7, box 7 has the
9 next highest RQD at 87?

10 A. It does.

11 Q. Would you agree that virtually all
12 the features we see in box 7 appear to be machine
13 breaks? This is what is known, Mr. Petrie, as a field
14 trip.

15 A. A large number of those breaks
16 seem to be machine breaks.

17 Q. Would you agree looking at boxes 5
18 and 7, the two you just examined closely, the RQD
19 percentages correlate highly with runs in the very
20 competent rock with very few breaks that are not
21 machine breaks?

22 A. Based on those numbers, yes.

23 MR. LANCASTER: I notice it is five
24 after eleven, so it seems like a good time for a break.

25 ---Recess



1 MR. LANCASTER: Please be seated.

2 MR. HODGSON: Q. Now, Mr. Petrie, I
3 think you have agreed with me that the fracture
4 frequency profile is a crude instrument but it yields
5 some information.

6 MR. PETRIE: A. It yields some
7 information.

8 Q. And the RQD profile is also a
9 crude instrument but it yields some information?

10 A. It may be even more crude but it
11 does yield information.

12 Q. In particular it yields some
13 information to distinguish runs of core that may fall
14 into a single category in the fracture profile, 3 to 20
15 fractures per metre, which appear to get sorted out a
16 bit better by the RQD profiles?

17 A. And conversely the fracture
18 frequency profile helps you to sort out core runs for
19 which one value of the RQD is provided.

20 Q. I am sorry, say that again?

21 A. You intimated I believe in your
22 question that the RQD ...

23 Q. The thing you added, I didn't
24 understand what you added?

25 A. The converse is also true, that



1 the fracture frequency profile helps detail the RQD
2 profile, given that the RQD profile is over a run
3 length and the fracture frequency profile as indicated,
4 the thinnest units encountered appear to be less than 5
5 centimetres.

6 Q. So you agree then that each one of
7 these is a tool to assist the hydrogeologist in
8 interpreting -- assisting the geologist because we are
9 discussing geology at this point, but to assist the
10 geologist in interpreting the core that has been
11 extracted from the ground?

12 A. Yes, to assist the geologist.

13 Q. Now, given that we have looked in
14 HC4 and discovered a correlation between a high RQD
15 and -- let me rephrase the question. Would you agree
16 with me based upon what we have discussed about boxes
17 3, 5 and 7, that the RQD seems to suggest that where we
18 find even a modestly high RQD like 59, it is possible
19 that we will find and indeed in boxes 5 and 7 did find
20 cores that are long and competent?

21 A. I am not with the gist of your
22 question. I thought you referred to box 3 initially.

23 Q. Box 3 is in front of us.

24 A. Could you repeat the question for
25 box 3?



1 Q. Box 3, or boxes 3, 5 and 7, each
2 contain, do they not, runs of core with very few in
3 situ fractures?

4 A. Within portions of those boxes,
5 yes.

6 Q. In fact you agreed with me when
7 you were looking at box 5 and 7 that there appear to be
8 very few fractures in those boxes that are not machine
9 breaks?

10 A. That is my recollection.

11 Q. So we have in those two boxes, 5
12 and 7, long runs of very competent core?

13 A. Long relative to the length of the
14 core run, yes.

15 Q. We have a long run of very
16 competent core in box 3 in front of us?

17 A. Again, relative to the length of
18 the core run.

19 Q. Could I ask you now to refer to --
20 in Exhibit H-206 to page 2?

21 A. The one headed up contents?

22 Q. Yes. Do you see under 3 a
23 distinction for dipping joints, vertical joints, ground
24 up core, clay mud seams, slickensides and vugs?

25 A. I do.



1 Q. What are slickensides?

2 A. It is essentially a scratch
3 feature on a surface of rock which indicates there has
4 been in a relative sense movement between the two
5 blocks of rock that bound that surface.

6 Q. So the rock has fractured and
7 moved along the fracture?

8 A. Yes. I am not making comments
9 regarding the amount or direction of movement, but
10 there is evidence of movement.

11 Q. A vug.

12 A. A vug is an isolated crystal
13 growth within a mass and it may be a void or may it be
14 infilled with mineral precipitates.

15 Q. Suggesting some movement of water?

16 A. The difficulty with using vugs is
17 that often they are isolated occurrences and there may
18 be some natural void in the rock and mineralized water
19 entered the void and precipitated, but it does not
20 indicate to my mind transmission of water.

21 Q. What about ground up core and clay
22 mud seams?

23 A. What I don't know from that
24 description is are we implying there is some movement
25 of the rock and this is sort of a fault gouge or are we



1 indicating the rock had some inherent structural
2 weakness, that over the eons translated to a sort of
3 disintegration of the rock. I do not know. I am not
4 sure if the person describing this intended to describe
5 one sort of origin or the other.

6 Q. A clay mud seam would appear to be
7 an important discontinuity, would it not?

8 A. Given that they are there, it
9 would be important with respect to providing a
10 description of the rock.

11 Q. Would you agree that dipping
12 joints and vertical joints are important to log?

13 A. Yes.

14 Q. It would appear from the logs that
15 appear in Exhibit 206, the logs towards the back ...

16 A. Pages 4 onward?

17 Q. Yes. In fact these various
18 boreholes, and perhaps you could turn up the log for
19 borehole HC4-85?

20 A. Page 4?

21 Q. Yes.

22 A. And onwards.

23 Q. These logs show that the core has
24 been logged for slickensides, clay mud seams, fracture
25 joints and vugs?



1 A. I am not entirely sure where you
2 get that, and if you look at page 5 ...

3 Q. Just one moment.

4 A. You referred to Exhibit 206.

5 Q. Yes. Counting from the front --
6 it would be simpler if we did this counting from the
7 back, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
8 the fifteenth page from the back?

9 A. Fifteen pages from the back.

10 Q. There is a page at the top which
11 says drawing No. 3, borehole HC4-85?

12 A. I have the fifteenth page from the
13 back, which is drawing 3, borehole HC4-85.

14 Q. Moving backwards still, there are
15 two more pages for HC4-85?

16 A. We come to drawing 1 for HC4-85.

17 Q. Looking at the extreme left-hand
18 column under symbol it would appear that the vugs,
19 slickensides, ground up core, clay mud seams, vertical
20 joints and dipping joints have been logged?

21 A. It would appear so.

22 Q. Would you agree with me that given
23 the crudeness of the RQD and the fracture frequency
24 profile that it was also useful to look at the major
25 discontinuities and see where they fall within the



1 indicating the rock had some inherent structural
2 weakness, that over the eons translated to a sort of
3 disintegration of the rock. I do not know. I am not
4 sure if the person describing this intended to describe
5 one sort of origin or the other.

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7 an important discontinuity, would it not?

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9 would be important with respect to providing a
10 description of the rock.

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12 joints and vertical joints are important to log?

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15 appear in Exhibit 206, the logs towards the back ...

16 A. Pages 4 onward?

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18 boreholes, and perhaps you could turn up the log for
19 borehole HC4-85?

20 A. Page 4?

21 Q. Yes.

22 A. And onwards.

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24 been logged for slickensides, clay mud seams, fracture
25 joints and vugs?



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2 get that, and if you look at page 5 ...

3 Q. Just one moment.

4 A. You referred to Exhibit 206.

5 Q. Yes. Counting from the front --
6 it would be simpler if we did this counting from the
7 back, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
8 the fifteenth page from the back?

9 A. Fifteen pages from the back.

10 Q. There is a page at the top which
11 says drawing No. 3, borehole HC4-85?

12 A. I have the fifteenth page from the
13 back, which is drawing 3, borehole HC4-85.

14 Q. Moving backwards still, there are
15 two more pages for HC4-85?

16 A. We come to drawing 1 for HC4-85.

17 Q. Looking at the extreme left-hand
18 column under symbol it would appear that the vugs,
19 slickensides, ground up core, clay mud seams, vertical
20 joints and dipping joints have been logged?

21 A. It would appear so.

22 Q. Would you agree with me that given
23 the crudeness of the RQD and the fracture frequency
24 profile that it was also useful to look at the major
25 discontinuities and see where they fall within the



1 vertical segment of core?

2 A. It would assist.

3 Q. These are major discontinuities
4 being logged here?

5 A. I am not entirely sure how you are
6 using the word discontinuity, but recognizing a change
7 in rock in some fashion as being a discontinuity, yes.

8 Q. Would you agree with me looking at
9 page 35 in H-40?

10 A. I have it.

11 Q. Looking at page 35 in H-40, it
12 would appear that those same discontinuities have been
13 presented on this Figure 2?

14 A. I noted initially that the legend
15 is not the same and I am not entirely sure what you
16 mean by the same discontinuity.

17 Q. These slickensides, clay mud seams
18 and fracture joints have been plotted up on Figure 2?

19 A. Figure 2 of H-40 where we have
20 slickensides, clay mud seams and fracture joints, yes.

21 Q. As a very rough correlation, Mr.
22 Petrie, looking at all 8 boxes of core and recognizing
23 that the 8 boxes of core are old and have been jostled
24 about, can you indicate for the Board approximately how
25 many zones you can pick out quickly with your eye as



1 zones that one would identify as possibly zones for the
2 horizontal transport of water. I think you and I just
3 did this during the break?

4 A. I am now recalling the number of
5 10 or 11 per cent and that number, Mr. Hodgson asked me
6 at the break if I could walk through those cores and
7 identify the number of portions of the core which on my
8 visual inspection are the fractures in the length of
9 core which may provide for more significant horizontal
10 groundwater flow, and recognizing that the core is old,
11 and some of the points of the core are intensely
12 fractured over small intervals and some are less
13 intensely fractured over longer intervals, but I think
14 we came up with the number 11.

15 Q. Yes.

16 A. Mr. Hodgson indicates the number
17 was 11.

18 MR. McQUAID: What was the number?

19 MR. PETRIE: Eleven which was the number
20 of more pronounced discontinuities or the more
21 intensively fractured zones within the coring record
22 for HC4.

23 MR. HODGSON: Q. Just looking at the
24 log, or looking at the distribution of fracture joints
25 on Figure 2 on page 35 of H-40, can you correlate the



1 number you came up with from a quick look with the
2 number logged in the field by the geologists who
3 prepared the core log for this borehole?

4 MR. PETRIE: A. Noting that the upper
5 part of the borehole was augured down to a depth of 132
6 as I recall and so we are not counting the top portion
7 of the hole...

8 Q. That's fair.

9 A. ...there are 14 portions of
10 borehole HC4 that are indicated as I read the legend of
11 fracture joints and I believe I counted this zone
12 called CMS as well and some horizontal lines which look
13 like to be one pencil width thick and I am not sure if
14 they are fracture joints or not but I would assume so.

15 Q. Would you agree with me that now
16 we have had a close and intense look at the core for
17 HC4-85, that it would be useful to correlate data on
18 gradients, chloride and tritium with what we see in the
19 cores to see whether or not they tell us a story?

20 A. Yes.

21 Q. Let's start with the data we have
22 on packer tests. You will recall during your evidence
23 in chief that it was your opinion that the packer tests
24 at Site F give a more reliable indication of the
25 hydraulic conductivities at Site F than do the Hvorslev



1 tests?

2 A. That was my recollection, yes.

3 Q. We have intentionally on this
4 figure you see left off any Hvorslev tests and the
5 numbers you will see, subject to check, are the numbers
6 for the packer tests done in the boreholes indicated at
7 Site F?

8 A. I recall they were only done on
9 three boreholes and I see, 4, 3 and 6 indicated thus
10 and that appears to be correct.

11 MR. HODGSON: Could we mark that as the
12 next exhibit?

13 MR. LANCASTER: H-667.

14 ---EXHIBIT NO. H-667: Chart-packer test
15 results at Site F

16 MR. HODGSON: This can be called packer
17 test results at Site F.

18 MR. PETRIE: Exhibit H-667?

19 MR. LANCASTER: Yes.

20 MR. HODGSON: Q. Before we continue and
21 focus on the packer tests, I think I should indicate to
22 you that the green zones indicated on the figure are an
23 attempt to interpret zones of shale that were greater
24 than one metre thick without a major discontinuity,
25 keeping in mind what we see on Figure 2 of H-40?

MR. PETRIE: A. Am I to infer that



1 these dark zones, and I am referring, for example, to
2 HC5-85 which is juxtaposed by green on either side, the
3 dark zones are not coloured in in green?

4 Q. That is right. We will come back
5 to talking about those green zones, but I wanted to
6 indicate to you what they are meant to represent and
7 that is indicated as well on the legend. Looking at
8 the packer test results in this borehole, I think you
9 will find, and I would ask you to accept this subject
10 to check, that those packer test results conveniently
11 correlate with the boxes of core so that the top packer
12 test is for box 2 of the core from 128.3 to 125.2
13 metres and now it is possible for us to glance over at
14 box 2 of core material and you can see even at this
15 distance, can you not, that box 2 contains some
16 portions of broken up rock and some portions of
17 competent rock?

18 A. I can't see from here, but that is
19 my recollection, yes.

20 Q. The packer test results for that
21 run of core was 1.2×10^{-3} ?

22 A. That is the number recorded.

23 Q. That correlates, does it not, with
24 your interpretation of the pumping well results for a
25 similar elevation in HC3-85?



1 A. We are now referring to a
2 different borehole and they are at similar elevations,
3 yes.

4 Q. That would appear to be a zone of
5 relatively high horizontal permeability?

6 A. Correct.

7 Q. You would also agree that that
8 packer test result doesn't tell us what the vertical
9 permeability of that zone is?

10 A. It does not.

11 Q. It could be an order or two orders
12 of magnitude lower, could it not?

13 A. It could.

14 Q. The second packer test, if you
15 will accept this subject to check, occurred between
16 125.2 and 122.2 metres and that corresponds more or
17 less with what we see in box 3 right here before the
18 Board in HC4?

19 A. As I recall that is the one that
20 was omitted from the appendix.

21 Q. That's right.

22 A. It was entered in later and noting
23 that the other ones at 122.2, the bottom of the upper
24 packer test and the top of the lower packer test right
25 at 125, I think it is fair to assume that that



1 represents that interval, so we are looking at 122.2 to
2 125.2 and was that the number you mentioned?

3 Q. Yes. Would you accept subject to
4 check that that is the core with the few millimetres
5 give or take, that is the core in box 4 of H-478 right
6 here on the table?

7 A. Can you point to which box?

8 Q. This box, box 3, this box.

9 A. You are referring to the middle
10 core run on box 3?

11 Q. The whole core run on box 3. The
12 whole core run on box 3 coincides, does it not, with
13 the interval at which that packer test was done?

14 A. I don't have that information
15 before me but I can take that subject to check.

16 Q. I think it is important so let's
17 check it now. The packer test result was between 125.2
18 and 122.2. Does that sound correct?

19 A. I indicated it was not in the
20 appendices and it was my assumption that it was at that
21 point. We may have been provided with the information
22 during the hearing and I can't recall. We were
23 provided with a value, but it wasn't my recollection we
24 were provided with the vertical interval.

25 Q. I had written in my copy 125 to



1 122?

2 A. Then maybe indeed we were.

3 Q. I believe that was the evidence at
4 the time.

5 MR. McQUAID: What appendix?

6 MR. HODGSON: The packer test result is
7 in Appendix 11 in Exhibit H-40A.

8 MR. PETRIE: I believe as we indicated
9 earlier, box 3 of HC4 has a top elevation of 125.2, and
10 I didn't put the elevation on the bottom but it looks
11 like about 122.0. That was the interval identified.

12 MR. HODGSON: Q. Right.

13 MR. PETRIE: A. Right.

14 Q. Looking at box 3 and taking the
15 metrestick, would you agree that if we are going to
16 talk about the interval that was tested we should take
17 off approximately 20 centimetres?

18 A. That means I am trying to relate
19 the elevation of the top...

20 Q. ...of the packer test.

21 A. I thought we said that was 125.2,
22 and that is the top elevation I have.

23 Q. The packer test was at 125, but do
24 you have it at 125.2?

25 A. I misheard you.



1 Q. I think the packer test was at 125
2 and would you accept that subject to check from
3 Mr. Sobanski's evidence?

4 A. I can accept that.

5 Q. Not a whole lot turns on it, but I
6 wanted to point out that we would take some of the rock
7 off the top?

8 A. Yes, and if we were taking 125 as
9 top of the packer test interval.

10 Q. But it would include, would it
11 not, this segment of core in the box that is the green
12 segment of core which is somewhat broken up?

13 A. It would include the green segment
14 of core you indicated, yes.

15 Q. All I want to suggest is that this
16 packer test was done over an interval in which there is
17 some very long runs of what appear to be competent rock
18 and also over an interval in which there appears to be
19 some fracturing?

20 A. It does.

21 Q. The uptake was zero?

22 A. That is the uptake that was
23 reported.

24 Q. I believe it was Mr. Sobanski's
25 evidence that that might represent a horizontal



1 hydraulic conductivity of 1×10^{-8} ?

2 A. I don't recall if it was
3 Mr. Sobanski or Mr. Feenstra's but I do recall a
4 discussion to that effect.

5 Q. Would you accept that that is a
6 reasonable approximation of the horizontal hydraulic
7 conductivity when the packer test is a zero uptake?

8 A. Assuming there were no concerns
9 with the nature of the test procedure, taking a zero
10 result; that is reasonable to consider with that block
11 of rock, to have a horizontal hydraulic conductivity of
12 1×10^{-8} centimetres per second.

13 Q. But it could be lower?

14 A. It could be.

15 Q. It could be as low as 1×10^{-9}
16 centimetres per second?

17 A. Given that you are trying to
18 equate a value of zero with a hydraulic conductivity,
19 one can't be certain of that, but it could be.

20 Q. What we could be looking at here
21 is a block of rock that has very little ability to
22 transmit water?

23 A. Horizontally, yes.

24 Q. Would you agree with me that if
25 the horizontal conductivity might be as low as $1 \times 10^{-}$



1 9, the vertical hydraulic conductivity could be that
2 low or even as low as 1×10^{-10} ?

3 A. For that block of rock and
4 starting with your assumption, yes.

5 Q. To complete it and looking at the
6 packer test results, we see for the next box of rock,
7 which is approximately 122.2 to 119.1, I believe that
8 is the interval given -- yes, on H-40A on what is
9 really page 1, that really corresponds give or take
10 about 30 centimetres with the block of rock we find in
11 box 4 before us?

12 A. You were referring to the first
13 page of Appendix 11 when you said H-40A?

14 Q. Yes.

15 A. In a general sense that is the
16 same elevation, yes.

17 Q. Would you agree with me that box 4
18 has a lot more fracturing in it than box 3?

19 A. I believe we agreed on that
20 earlier, yes.

21 Q. The horizontal hydraulic
22 conductivity is only 1.6×10^{-5} ?

23 A. That is the number reported.

24 Q. The vertical hydraulic
25 conductivity could be lower and likely is lower?



1 A. Than 1.6×10^{-5} , it could and
2 likely is.

3 Q. Would you agree therefore that
4 looking at HC4-85 that it would appear that water or
5 leachate above 125 metres would have a very difficult
6 time indeed in getting down across the units of rock we
7 see in that borehole below 125 metres given these
8 packer test results?

9 A. Water would have a difficult time
10 moving directly down that profile. I say directly down
11 and across that zone indicated in your Exhibit H-667
12 and marked with a red zero, yes.

13 Q. Can I ask you to turn around and
14 look at another exhibit on the wall behind you and
15 perhaps we could mark this as the next exhibit. This
16 is vertical gradients on Site F and the data has been
17 taken directly from your report B-617 Appendix A and it
18 has been presented simply by being colour coded. Is
19 this H-668?

20 MR. LANCASTER: H-668.

21 ---EXHIBIT NO. H-668: Chart-vertical gradients
at Site F

22 MR. HODGSON: Q. It has been colour
23 coded...

24 DR. KINGHAM: Before you go too far into
25 these exhibits, we went over the ground of where the



1 9, the vertical hydraulic conductivity could be that
2 low or even as low as 1×10^{-10} ?

3 A. For that block of rock and
4 starting with your assumption, yes.

5 Q. To complete it and looking at the
6 packer test results, we see for the next box of rock,
7 which is approximately 122.2 to 119.1, I believe that
8 is the interval given -- yes, on H-40A on what is
9 really page 1, that really corresponds give or take
10 about 30 centimetres with the block of rock we find in
11 box 4 before us?

12 A. You were referring to the first
13 page of Appendix 11 when you said H-40A?

14 Q. Yes.

15 A. In a general sense that is the
16 same elevation, yes.

17 Q. Would you agree with me that box 4
18 has a lot more fracturing in it than box 3?

19 A. I believe we agreed on that
20 earlier, yes.

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22 conductivity is only 1.6×10^{-5} ?

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5 leachate above 125 metres would have a very difficult
6 time indeed in getting down across the units of rock we
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10 moving directly down that profile. I say directly down
11 and across that zone indicated in your Exhibit H-667
12 and marked with a red zero, yes.

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14 look at another exhibit on the wall behind you and
15 perhaps we could mark this as the next exhibit. This
16 is vertical gradients on Site F and the data has been
17 taken directly from your report B-617 Appendix A and it
18 has been presented simply by being colour coded. Is
19 this H-668?

20 MR. LANCASTER: H-668.

21 ---EXHIBIT NO. H-668: Chart-vertical gradients
at Site F

22 MR. HODGSON: Q. It has been colour
23 coded...

24 DR. KINGHAM: Before you go too far into
25 these exhibits, we went over the ground of where the



1 geologic divisions were drawn from in B-617s diagrams on
2 page 23 and we were told they came from the geological
3 information of Trow and indeed it does correspond
4 rather completely to Figure 2. The dashed line on your
5 base map do not correspond to either Figure 2 or to
6 Mr. Petrie's exhibit and can you tell me what those
7 dashed lines mean?

8 MR. HODGSON: They were meant to
9 correspond with the hydrostratigraphic lines on H-220
10 and as interpreted also by Mr. Petrie and not in this
11 cross-section, but in the cross-sections he presents
12 where he deals with the hydrostratigraphic data as
13 opposed to the geological data.

14 MR. PETRIE: Can I put up that cross-
15 section to make sure we are speaking about the same
16 thing?

17 DR. KINGHAM: And I would like to
18 suggest it might be useful, at least on 667 and 668 so
19 we can focus on the zones we are talking about, to mark
20 the bottom zone which I understand you to mean the
21 highly fractured shale with an HFS and then above it
22 WFS so we remember which zone is which on those dotted
23 lines.

24 MR. HODGSON: Before we do that,
25 Dr. Kingham, I am really not focusing, although those



1 background lines are there because they are on H-220,
2 and really this cross-section or this base map is just
3 a blow-up of H-220 with some additional boreholes
4 projected into it, I am not focusing on those dotted
5 lines and I wasn't asking this witness any questions
6 about just where those lines should fall.

7 DR. KINGHAM: You have transposed those
8 lines but they have no significance right now.

9 MR. HODGSON: I am not addressing them
10 right now and I was really addressing this witness to
11 interpret data without regard to those lines and I am
12 simply asking him to look at the data itself and tell
13 us what it means. I am reminded that H-220 -- we have
14 also moved the wells so they are distributed properly
15 in a north-south direction and so they appear in their
16 proper relationships to one another. They were all
17 kind of jammed together on H-220.

18 MR. PETRIE: Am I to understand you have
19 drawn an approximately north-south cross-section
20 through the site and projected the wells at right
21 angles to that cross-sectional alignment?

22 MR. HODGSON: Q. Yes.

23 MR. PETRIE: A. Thank you.

24 Q. Looking at H-668 would you first
25 agree with me that a vertical gradient higher than 0.1



1 is a strong vertical gradient?

2 A. In a general sense, yes. It
3 depends on the scale of observation -- that's not quite
4 correct -- it depends upon what materials one is
5 dealing with and the flow system one is dealing with.

6 Q. But generally a hydrogeologist
7 would consider a vertical gradient of 0.1 or greater as
8 a strong downward gradient?

9 A. It is definitely a downward
10 gradient of significance.

11 Q. For your information and for the
12 information of the people at the back of the room, the
13 colour coding is to suggest that where the downward
14 gradients are greater than 0.5 they are done in red and
15 where they are between 0.1 and 0.5 they are presented
16 in green and where the downward gradients are less than
17 0.1 they are presented in blue, and where the gradient
18 is upward they are presented in yellow.

19 There is only one colour for an upward
20 gradient and three colours for a downward gradient.
21 Would you agree with me that in HC4 we find downward
22 gradients from top to bottom in that hole?

23 A. That is correct.

24 Q. We find very strong downward
25 gradients at the bottom half of the hole?



1 A. Greater than 0.5, yes.

2 Q. We find strong downward gradients
3 at the top of the hole?

4 A. Being less than 0.5 we have
5 gradients of 0.1 to 0.5, yes.

6 Q. Would you agree that where we find
7 strong downward gradients, that suggests to a
8 hydrogeologist and with no other information that we
9 have a high permeability contrast?

10 A. In a general sense, yes.

11 Q. In fact just interpreting from
12 HC4-85, don't those downward gradients suggest that the
13 water is hung up at the top of the system and is trying
14 to drive down to the bottom and it is having some
15 difficulty getting there?

16 A. Yes, just on the gradients.

17 Q. It suggests there is very little
18 direct hydraulic connection between the top and the
19 bottom of HC4-85.

20 A. I am not sure it would suggest
21 that. You are taking a steep gradient to reflect an
22 indirect connection and I don't know the magnitude of
23 any hydraulic connection between the top and the bottom
24 of the borehole.

25 Q. If the water that is hung up at



1 the top of the system had a way of getting down to the
2 bottom of the system then the gradients wouldn't be
3 strong, would they, the downward gradients?

4 A. When you say a way of getting
5 down, I believe you are implying a high degree of
6 hydraulic connection. Where the gradients are steep,
7 it appears that the hydraulic connection is not as
8 direct as where the gradients are less steep.

9 However, I can't make assumptions based
10 on those hydraulic gradients of the nature of any
11 hydraulic connection between the top of the borehole
12 and the bottom. I don't know what is the vertical
13 hydraulic conductivity and where the vertical fractures
14 are that may provide conduits for the movement of
15 water.

16 Q. Don't those strong vertical
17 gradients suggest there is very little hydraulic
18 connection between the top and the bottom of the
borehole?

19 A. Less than where the gradients are
20 less steep.

21 Q. Isn't it possible to take those
22 strong vertical gradients and correlate it with the
23 geological information we have been examining in HC4
24 and conclude very easily that it would be very
25 difficult for water at the top of the borehole to get



1 to the bottom of that borehole?

2 A. Moving directly down the borehole
3 one can make those sort of conclusions.

4 Q. Directly or indirectly,
5 Mr. Petrie, if it can get down indirectly it will get
6 down indirectly, won't it?

7 A. Correct, but an indirect
8 connection implies in my mind not high hydraulic
9 conductivity connection and therefore we need a more
10 pronounced driving force to push it. So when we have
11 steep gradients one would expect a lower hydraulic
12 conductivity than where you have less steep gradients,
13 and recognizing you don't have a value for the vertical
14 hydraulic conductivity within this system, we have been
15 basing it on the assumptions of the degree of
16 anisotropy.

17 Q. Finally looking at the chlorides in
18 that borehole, we see we have chlorides at 8,970 at the
19 bottom of the borehole?

20 A. Correct.

21 Q. Suggesting the water at the bottom
22 is a little older than the water at the top?

23 A. Again we have the discussion of
24 the potential for mixing and what does that number
25 mean? I would suggest it is probably older.



1 Q. It is probably ...

2 A. ...older at the bottom than at the
3 top.

4 Q. Can we take the three pieces of
5 data we have for HC4-85 where we have strong vertical
6 gradients, we have got substantial portions of core
7 that are very competent and we have got high chlorides
8 at the bottom, and doesn't that suggest to you that
9 water at the top of the system is going to take a long
10 time to get down to the bottom of the system at HC4-85?

11 A. Implicit in your assumptions I
12 think you are relating hydraulic conductivity to time
13 of travel and we don't have a measure of the vertical
14 hydraulic conductivity. If we are looking at some
15 vertical fracture connection in this system, then water
16 may move down those fractures quite quickly. The mass
17 of water may be less than is moving into the shallower
18 portions of the borehole, but I find it difficult to
19 relate time directly in the manner you have described.

20 If we were dealing with uniform clay
21 strata, for example, then hydrogeologists are typically
22 more comfortable in drawing those sorts of conclusions
23 and if that clay was fractured in some manner he would
24 be less comfortable making those conclusions. We are
25 dealing here with fractured rock for which I cannot



1 give an indication of the extent both vertically and
2 laterally of any sort of vertical fracture connection
3 within the system.

4 Q. You and I agreed last Wednesday
5 that we are dealing here with fractured and unfractured
6 rock?

7 A. In the vertical profile that is
8 cored, most definitely.

9 Q. You are not suggesting are you
10 that the core cannot be interpreted because we don't
11 know what is going on one foot away?

12 A. I am indicating one can't
13 assumptions regarding vertical fracturing from vertical
14 boreholes and I believe I indicated that last week as
15 well.

16 Q. We can look for vertical
17 fracturing in a vertical borehole, can't we?

18 A. One can, but obviously you don't
19 get the same comfort with respect to looking at a
20 vertical borehole and horizontal fractures.

21 Q. Is there anything about this piece
22 of core taken from somewhere in 120 -- below 125.2 to
23 suggest any vertical fracturing?

24 A. In that piece of core, no, there
25 is not.



1 Q. That came right from the middle of
2 packer test where we got zero uptake, right?

3 A. I believe that is the zone you
4 indicated.

5 Q. Doesn't that suggest that it would
6 be very difficult indeed for leachate parked above this
7 segment of rock to get down below this segment of rock?

8 A. I don't believe you can draw that
9 conclusion.

10 Q. What conclusion can you draw?

11 A. As I indicated before, I do not
12 know the magnitude or extent of any vertical fracturing
13 within the system and you are asking me to make
14 assumptions regarding horizontal fracturing in a
15 vertical borehole and trying to relate that to the
16 vertical profile, but I cannot. I also note for the
17 vertical profile you indicated, as I recall, the
18 chloride levels are low on either side of that vertical
19 piece you indicated, and such that if one were to take
20 your hypothesis of flushing in younger water, then the
21 water has got to that point and I am not suggesting it
22 went vertically through the piece of core you
23 indicated, but it is my opinion we have some vertical
24 fracture connection of some sort such that water by-
25 passes that specific piece of rock you indicated.



1 Q. One possibility is vertical
2 fracturing and another possibility is water coming from
3 somewhere north of the system, is it not?

4 A. North or upslope, yes, and how did
5 it get into the system? One can only speculate again
6 on vertical hydraulic conductivities and vertical
7 fracture connections and I believe that that is
8 somewhat speculative in that we do not have test data
9 regarding the value for vertical hydraulic conductivity
10 and we do not have a good physical description of
11 vertical fracturing within the system.

12 Q. Don't you agree that from the
13 horizontal hydraulic conductivity data we have we can
14 extrapolate some vertical hydraulic conductivities?

15 A. Again it is the area over which
16 you want to extrapolate it where I believe we differ.
17 For the piece of rock in question you have suggested a
18 vertical hydraulic conductivity and I have said, yes,
19 it was probable, and I forget the numbers we discussed,
20 but my concern is over what lateral extent can one feel
21 comfortable that that hydraulic conductivity is a
22 reasonable value.

23 My opinion is, I do not know, and I am
24 not sure I could glean that from the Trow document H-40
25 and in fact I am not even sure they discuss vertical



1 permeabilities in their report, their report being H-
2 40. I believe the discussion of vertical
3 permeabilities came about when Mr. Feenstra measured
4 anisotropy and we had the second model introduced which
5 incorporated a discussion of vertical hydraulic
6 conductivities, or the model used values for the
7 vertical hydraulic conductivity.

8 Q. I think you will find the value
9 assigned to the massive shale, the weakly fractured
10 shale is a vertical hydraulic conductivity but we can
11 come back to that at a later point in our discussion.
12 Could we go to HC6-85 and could you turn up the core
13 log for that hole?

14 A. And you are in H-40A?

15 Q. Yes. Could I ask you to accept,
16 subject to check, that the segments for RQD set out in
17 column 16 in this log for the shale correspond more or
18 less with the boxes of core we see on the floor over
19 there and also the box of core we have on the table
20 which is the segment from 118 to 115?

21 A. Subject to check.

22 Q. Box 2.

23 A. Subject to check, yes.

24 Q. Just looking at these then, in box
25 1, over on the floor over there, we have an RQD of 63?



1 A. Am I looking at the record or the
2 box?

3 Q. I am looking at both.

4 A. I can't see the box.

5 Q. Can you see the 63?

6 A. I see an entry under column 16 on
7 the second page for HC6-85 a 33 for a little bit and
8 then a long section for which the value of 63 is
9 applicable.

10 Q. For box 2 we have an RQD of 98?

11 A. I am just entering the boxes on my
12 record. Box 1 is 63 and box 2 is 98?

13 Q. Yes. Box 2 is the box we have on
14 the table.

15 A. I don't know.

16 Q. Will you accept that, subject to
17 check?

18 A. Yes. I can.

19 Q. Would you also accept because you
20 need to be looking also, and it is difficult with so
21 many pages, but you need to be looking at page 2 under
22 Appendix 11 of H-40A because we have packer test
23 results for this well all the way down the hole.
24 However, those packer test results are transposed onto
25 H-667 beside you. Would you accept subject to check



1 that those packer test results also correspond more or
2 less with the boxes of core?

3 A. I can do that.

4 Q. This works out very neatly.

5 Almost nothing in life ever does, but this did. So,
6 for the first box of core we have an RQD of 63 and a
7 packer test result of 6×10^{-5} ?

8 A. We do.

9 Q. In box 2 we have an RQD of 98?

10 A. Yes.

11 Q. And a packer test result of zero
12 uptake?

13 A. Yes.

14 Q. In box 3 we have an RQD of 97 and
15 another packer test result of zero uptake?

16 A. Yes.

17 Q. Let's look at boxes 2 and 3. Can
18 you see box 2 in front of you, this box right here in
19 the middle?

20 A. "Right here in the middle?"

21 Q. Yes, right here in the middle.

22 That's it. Will you agree with me that except for the
23 first 20 or 30 centimetres in this core that what we
24 have is a run of rock with very few in situ fractures?

25 A. Yes. Based on the distance I am



1 looking at, the first 30 centimetres are more fractured
2 than the remaining and the remainder without having
3 close inspection have what appear to be some sort of
4 machine breaks.

5 Q. So we have another example of a
6 box of rock in which we have got a run of rock that is
7 virtually competent from top to bottom and in this case
8 it might be for as much as 8 feet?

9 A. It might be as much as 8 feet.
10 There is a gap of an inch or so up there, but I suspect
11 that is an open core and doesn't reflect a void in any
12 fashion.

13 Q. I have asked my colleagues to
14 bring over box 3 for which we had an RQD of 97?

15 A. Were we looking at box 4?

16 Q. It is box 2.

17 A. Box 2. And this is box 3?

18 Q. This is box 3.

19 A. Correct.

20 Q. This is an exhibit your counsel
21 put into evidence when he cross-examined Mr. Sobanski,
22 but I am sorry, I have forgotten the number?

23 A. It is box 3.

24 Q. Would you agree with me that in
25 box 3 we have another run of what appears to be very



1 competent rock?

2 A. Again just on first inspection a
3 lot of the fractures are probably machine breaks.
4 Perhaps the middle run, the portions where there are
5 breaks, they may not be machine breaks but maybe in
6 situ breaks.

7 Q. Again, we have got zero uptake in
8 this box of rock?

9 A. I am sorry, I must refer back to
10 the data, but that is box ...

11 Q. ...3.

12 A. And you are equating box 3 to the
13 third packer test interval and the third packer test
14 interval gives a value of zero so it appears to be
15 thus, yes.

16 Q. Can you refer to H-668?

17 A. Yes.

18 Q. In HC6-85 we have from the top
19 very high vertical hydraulic -- I am sorry, very high
20 vertical gradients?

21 A. Very high being greater than
22 downward than in HC6 which is coloured red, yes.

23 Q. Can you give the Board an
24 indication of where the bottom of that gradient at 0.5
25 or greater is located?



1 A. With respect to elevation?

2 Q. Yes.

3 A. Certainly. 117 metres above sea
4 level approximately.

5 Q. 117 metres above sea level and
6 that would place it, would it not, about 1.3 metres
7 from the top of box 2 which is this box and which
8 starts at 118.3?

9 A. Yes.

10 Q. So, the highest vertical gradient
11 we have was measured in a unit of rock that terminates
12 partway into box 2?

13 A. Recognizing the delineation of the
14 change in gradient, the change being the red number to
15 the blue number, is a function of the screen elevation,
16 yes.

17 Q. Then we have a weaker vertical
18 gradient down another approximately one-third of the
19 borehole?

20 A. Correct.

21 Q. And stronger vertical gradients at
22 the bottom of the borehole?

23 A. Again stronger than the blue zone,
24 yes.

25 Q. Would you agree with me that those



1 vertical gradients suggest very little hydraulic
2 connection between the top and bottom of this borehole?

3 A. Again you are relating the
4 gradients to the incidence or otherwise of vertical
5 fracturing and I am not entirely in agreement with
6 that, because I do not know what is the vertical
7 connection in this system.

8 Q. Would you agree the water at the
9 top of the system is hung up there and can't get down
10 very easily?

11 A. I agree with you some of the water
12 is hung up there if we were looking at less water
13 penetrating to depth than which can move laterally,
14 that is the picture you can see before you on the
15 gradients. You have a certain volume of water to put
16 it in crude terms at a location where the downward
17 gradients are less steep indicated by the blue zone and
18 it would be my expectation that not all of that water
19 can move vertically directly downward, yes.

20 Q. The fact we have strong vertical
21 gradients doesn't mean that water is only moving
22 vertically, does it?

23 A. No, that is correct.

24 Q. There could be horizontal movement
25 of the water?



1 A. Correct.

2 Q. In fact the head on the system or
3 the vertical head on the system would be pressuring the
4 horizontal flow?

5 A. The vertical head --

6 Q. The vertical head could be driving
7 the water horizontally as well as vertically?

8 A. I don't know what you mean by
9 vertical head. Do you mean the head that the water
10 level at a point can push water down and/or laterally
11 or any combination thereof?

12 Q. Yes.

13 A. Most definitely.

14 Q. That is a concept you are working
15 on at page 156 of your report where you gave a 6 metre
16 mound in the landfill so you would have a bigger
17 driving head to drive more water laterally in this
18 rock?

19 A. It was not precisely for that
20 reason, no.

21 Q. But that is what it accomplished?

22 A. I beg your pardon, that is what it
23 does accomplish, yes.

24 Q. Looking at HC6-85 where we see a
25 high vertical gradient at the top we have a high



1 driving head there and we have a strong driving head?

2 A. The driving head is the water
3 level elevation and the elevation of the water table is
4 independent of the gradients underneath it in the
5 context we are discussing. I am not entirely sure I
6 follow your question.

7 Q. I am trying to understand how
8 those strong vertical gradients move water in the
9 system beneath them and I am suggesting that the strong
10 downward gradient also can have a component of lateral
11 flow to it?

12 A. That I have agreed to, yes.

13 Q. Indeed if the vertical hydraulic
14 conductivities are very low and there is a lot of head
15 on the system, water that has moved into the system
16 will be pushed out the side, will it not, if the
17 horizontal hydraulic conductivities are higher than the
18 vertical hydraulic conductivities?

19 A. That is a fair representation,
20 yes.

21 Q. So, the high vertical gradients
22 suggest that we have got some low permeability
23 materials in this core, HC6?

24 A. Yes.

25 Q. And we can see them on this table?



1 A. We see sections of rock which are
2 of lower permeability than others and we have various
3 results from the pressure packer tests, yes.

4 Q. If there is water in the system,
5 and if it is having difficulty moving vertically, it
6 will be pushed horizontally, will it not?

7 A. Given the geometry of the
8 fractures, et cetera, the inclination would be for some
9 of it or much of it to go horizontally.

10 Q. Would you agree with me that at
11 least in the upper portions of this borehole that where
12 it is pushed horizontally it would be pushed back out
13 to the surface of the bedrock right on-site?

14 A. I am sorry, but "this borehole" is
15 HC6?

16 Q. HC6-85.

17 A. You are indicating the blue zone
18 where the downward gradient is 0.1 is the zone
19 dominated by lateral flow ...

20 Q. I am suggesting anywhere where we
21 have lateral flow the water will be pushed out the side
22 right on-site?

23 A. No, I don't agree with that.

24 Q. In the upper portions of the
25 borehole?



1 driving head there and we have a strong driving head?

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3 level elevation and the elevation of the water table is
4 independent of the gradients underneath it in the
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4 independent of the gradients underneath it in the
5 context we are discussing. I am not entirely sure I
6 follow your question.

7 Q. I am trying to understand how
8 those strong vertical gradients move water in the
9 system beneath them and I am suggesting that the strong
10 downward gradient also can have a component of lateral
11 flow to it?

12 A. That I have agreed to, yes.

13 Q. Indeed if the vertical hydraulic
14 conductivities are very low and there is a lot of head
15 on the system, water that has moved into the system
16 will be pushed out the side, will it not, if the
17 horizontal hydraulic conductivities are higher than the
18 vertical hydraulic conductivities?

19 A. That is a fair representation,
20 yes.

21 Q. So, the high vertical gradients
22 suggest that we have got some low permeability
23 materials in this core, HC6?

24 A. Yes.

25 Q. And we can see them on this table?



1 A. We see sections of rock which are
2 of lower permeability than others and we have various
3 results from the pressure packer tests, yes.

4 Q. If there is water in the system,
5 and if it is having difficulty moving vertically, it
6 will be pushed horizontally, will it not?

7 A. Given the geometry of the
8 fractures, et cetera, the inclination would be for some
9 of it or much of it to go horizontally.

10 Q. Would you agree with me that at
11 least in the upper portions of this borehole that where
12 it is pushed horizontally it would be pushed back out
13 to the surface of the bedrock right on-site?

14 A. I am sorry, but "this borehole" is
15 HC6?

16 Q. HC6-85.

17 A. You are indicating the blue zone
18 where the downward gradient is 0.1 is the zone
19 dominated by lateral flow ...

20 Q. I am suggesting anywhere where we
21 have lateral flow the water will be pushed out the side
22 right on-site?

23 A. No, I don't agree with that.

24 Q. In the upper portions of the
25 borehole?



1 driving head there and we have a strong driving head?

2 A. The driving head is the water
3 level elevation and the elevation of the water table is
4 independent of the gradients underneath it in the
5 context we are discussing. I am not entirely sure I
6 follow your question.

7 Q. I am trying to understand how
8 those strong vertical gradients move water in the
9 system beneath them and I am suggesting that the strong
10 downward gradient also can have a component of lateral
11 flow to it?

12 A. That I have agreed to, yes.

13 Q. Indeed if the vertical hydraulic
14 conductivities are very low and there is a lot of head
15 on the system, water that has moved into the system
16 will be pushed out the side, will it not, if the
17 horizontal hydraulic conductivities are higher than the
18 vertical hydraulic conductivities?

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20 yes.

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22 suggest that we have got some low permeability
23 materials in this core, HC6?

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2 of lower permeability than others and we have various
3 results from the pressure packer tests, yes.

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5 and if it is having difficulty moving vertically, it
6 will be pushed horizontally, will it not?

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8 fractures, et cetera, the inclination would be for some
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11 least in the upper portions of this borehole that where
12 it is pushed horizontally it would be pushed back out
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18 where the downward gradient is 0.1 is the zone
19 dominated by lateral flow ...

20 Q. I am suggesting anywhere where we
21 have lateral flow the water will be pushed out the side
22 right on-site?

23 A. No, I don't agree with that.

24 Q. In the upper portions of the
25 borehole?



1 A. There is a component of lateral
2 flow and we still have vertical gradients and I do not
3 know where the water goes. I also note with respect to
4 HC6-85 that we have till on the surface, such that it
5 may preclude the discharge of water at that point. We
6 would also expect to see vertical gradients perhaps,
7 indicating discharge zones and I am not sure we see
8 that.

9 Q. I am indicating to you an area
10 approximately one inch into the blue zone below the red
11 zone on HC6-85?

12 A. I see that.

13 Q. Just hypothesizing, at that point
14 there is a horizontal fracture with a higher
15 permeability than the vertical permeability of the
16 material below it. Would you agree that water pushed
17 horizontally in that fracture would emerge at the top
18 of the bedrock on-site?

19 A. No, I cannot speculate that it
20 will move laterally from that point. Where it goes I
21 do not know.

22 Q. Does it go up?

23 A. I do not know. We have till
24 mantle on the site so it is unlikely to go up and I
25 have indicated before that I think the pattern of flow



1 will be strongly controlled by the fracture geometry
2 and if that fracture geometry has a downward slope in
3 some fashion or is intercepted by some vertical
4 fracturing, then the pattern of flow may be more
5 downward, but I do not know and it would be speculation
6 on my part because I have no evidence of that.

7 Q. Could we go to HC3-85?

8 A. Where do we go to?

9 Q. Let's start with the borehole log.
10 Just picking off the RQD numbers so we have them before
11 us ...

12 A. We are in H-40A?

13 Q. Yes.

14 A. Could you relate that to the box
15 runs again?

16 Q. I will relate it in this way.
17 What we have on the table from HC3 is a segment of core
18 from 124.53 to 121.48 metres and that I believe ...

19 A. I believe you indicated 124?

20 Q. 124.53 to 121.48, and that I
21 believe correlates with a segment of core that has an
22 RQD of 98?

23 A. I am sorry, I was just getting
24 depths below ground for that information. Could you
25 repeat your last statement?



1 Q. That correlates with a box of core
2 that has an RQD of 98?

3 A. I see the 98 and we are looking at
4 nearly 16 metres below ground and noting ground level
5 is about 140 so that takes us down to about 124 which I
6 believe is approximately the number you indicated.
7 Now, which box was that?

8 MR. HODGSON: Now we need to mark the
9 segment of core from HC3 and it is the only segment of
10 core we haven't marked from HC3. It is indicated on
11 the box that it is the core or the distance down the
12 borehole in feet and it has been translated and it is
13 51.8 feet to 61.8 feet which I believe correlates with
14 a vertical height, or vertical depth of 124.53 to
15 121.48 metres, and that can be interpreted from the
16 borehole log on the third page where it is indicated
17 there is an RQD of 98.

18 Q. Would you accept that subject to
19 check?

20 MR. PETRIE: A. Yes, I can.

21 Q. Just so we understand what we are
22 dealing with here, picking out the RQD from this
23 borehole, we have 72, 60, 53, 98, 77, 88, 88 and 80?

24 A. I see numbers to that effect, yes.

25 Q. We can also now correlate this



1 information with the packer test results which we see
2 presented on HC3-85?

3 A. We can.

4 Q. Can you accept subject to check
5 that the first three RQD numbers, 72, 60 and 53,
6 coincide with the interval from 132.82 to 124.6, where
7 the average packer test result as presented on H-667 is
8 9×10^{-4} . That's 132.82 to 124.6.

9 A. It appears thus, yes.

10 Q. That packer test result coincides,
11 does it not, with your interpreted permeability for
12 that same unit from a pumping test of 2×10^{-4} ?

13 A. I would have to refer specifically
14 to the elevations, but I recall they were juxtaposed
15 and that is my recollection.

16 Q. I will come back to that in a
17 minute because I think you will find it does coincide.
18 Now, looking at HC3-85, the box of material we have on
19 the table. Did we give this a number, this box of core
20 from HC3-85?

21 MR. LANCASTER: No. That will be H-669.

22 ---EXHIBIT H-669: Box or rock core from
HC3-85 (51.8 to 61.8 feet)

23 MR. HODGSON: Q. Looking at H-669 ...

24 MR. PETRIE: A. You've lost me. Oh,
25 the rock. I did a 360 degree turn and couldn't find



1 it.

2 Q. I am going fast, but I don't want
3 to belabour this forever. Would you agree that what we
4 find in H-669 is another example of some very competent
5 rock material?

6 A. There are a few fractures per
7 metre length, yes, with one sort of quasi-broken zone
8 of some fashion and a vertical fracture of some fashion
9 perhaps at a depth of 51.8.

10 Q. A vertical fracture of about what
11 length?

12 A. It appears to be oblique to the
13 borehole alignment, so I don't have an indication of
14 its total length.

15 Q. The length on here is what?

16 A. Four centimetres.

17 Q. In this run of core, how many
18 fractures do you see that you believe were in situ.
19 You are looking at the wrong box.

20 A. My apologies.

21 Q. Isn't that a vertical fracture
22 (indicating)?

23 A. A vertical fracture of some
24 fashion and the end of the core appears to be not a
25 machine break and there is a point in the middle length



1 of that run which appears to be not -- definitely not a
2 machine break, but the others I am not sure of.

3 Q. Would there appear to be two
4 horizontal fractures in the whole run of core?

5 A. There could indeed be.

6 Q. Would you agree that we have got a
7 run of very competent rock material?

8 A. In that vertical profile, yes.

9 Q. Looking at the packer test results
10 from H-667, would you agree subject to check that the
11 packer test for that same interval of rock is
12 3×10^{-6} ?

13 A. Assuming your elevations are
14 correct, yes.

15 Q. A horizontal hydraulic
16 conductivity?

17 A. That is correct.

18 Q. That doesn't tell us anything
19 about the vertical conductivity of that material?

20 A. It does not.

21 Q. The vertical conductivity of that
22 material, just looking at it, could be 3 to 4 orders of
23 magnitude lower than that, could they not?

24 A. It is strongly anisotropic and it
25 could be.



1 Q. Looking at the gradient
2 information we have for this borehole we find that
3 across the same interval of rock we have a very strong
4 downward gradient, over 0.5?

5 A. I am sorry, which vertical
6 interval?

7 Q. Looking at HC3-85 and we are
8 looking at the interval of rock for which we have a
9 packer test result of 3×10^{-6} , being from 124 down to
10 121 metres, and would you not agree that below 124
11 metres on HC3-85, we have a very strong downward
12 vertical gradient of 0.5 or greater?

13 A. That portion of the rock is
14 coloured red but I wish to qualify it now that I
15 understand the gist of your question; the vertical
16 gradients are measured between well screens and so in
17 calculating the gradient it is an average value between
18 the well screens for which it is calculated. For the
19 well screens in question we are looking at HC3,
20 piezometer 1 at the very bottom, the base of the red
21 zone, and piezometer 2 described as being at the
22 intercept of the red and blue zones and we may indeed
23 have less strongly downward gradients in between there
24 and obviously stronger gradients over another portion
25 of the rock. It is somewhat speculative to take that



1 gradient over a large vertical interval of the rock and
2 say that that indeed is the gradient across that as it
3 is the average gradient.

4 Q. The average gradient across the
5 interval of rock that includes the rock we can see with
6 our eyes between 124 to 121 metres is a strong vertical
7 gradient?

8 A. Correct.

9 Q. Suggesting the water above the
10 system is hung up and can't get down?

11 A. Suggesting that some of the water
12 is hung up and doesn't get down.

13 Q. The weaker vertical gradient we
14 have in that whole borehole comes where we have the
15 packer test result of 9×10^{-4} ?

16 A. Correct.

17 Q. I suggest that also, subject to
18 check, is where the pumping test result indicates a
19 lower -- a higher hydraulic conductivity?

20 A. That is my recollection.

21 MR. HODGSON: Mr. Chairman, this would
22 be convenient, and we could go back to the pumping
23 tests after lunch.

24 MR. LANCASTER: We will adjourn until
25 two o'clock.
---Luncheon adjournment at 12:30 p.m.



1 ---Upon resuming at 2:00 p.m.

2 MR. LANCASTER: Please be seated.

3 MR. HODGSON: Q. Mr. Petrie, I think
4 when we broke we were looking at HC3-85 and I just
5 wanted to have you confirm that it would appear from
6 the core log in H-40A that the segment of the box of
7 rock we have on the table, H-669 taken from HC3-85, is
8 the box of rock with the lowest -- sorry, the box with
9 the highest RQD?

10 MR. PETRIE: A. Correct.

11 Q. However, it would also appear,
12 would it not, if we looked down the core log for those
13 areas of the core, we see two columns of white and two
14 columns of white means we have rock with between 1 and
15 3 fractures per metre?

16 A. We are adjacent to box 3 and I
17 think I see one column of white.

18 Q. Not just adjacent to box 3 but
19 throughout the core. Let's just go through it. On
20 page 3 of the log above box 3 we see a short, not quite
21 a metre length where we have fully 3 columns open,
22 which means we have .3 fractures per metre?

23 A. Let me just check my legend. I
24 believe that to be the case.

25 Q. At the bottom of box 3 we have the



1 segment with 1 to 3 fractures per metre?

2 A. The bottom of the box or the
3 bottom of the page?

4 Q. The top of the next page and
5 coding this to the metre intervals shown, between 18.3
6 and 18.8 where we have a segment where we have fewer
7 than -- between 1 and 3 fractures per metre?

8 A. It looks like 18.9, but yes.

9 Q. Across the page and over on the
10 next page rather between intervals 24.2 and 24.8 we
11 appear to have another segment with only 1 to 3
12 fractures per metre?

13 A. Yes.

14 Q. At the bottom of that page between
15 26.7 and 27.3 it is the same?

16 A. Yes.

17 Q. And if you go to the next page,
18 between 29.5 and 30.2?

19 A. 30.2 and I think it should be
20 30.3.

21 Q. I am reading instead of thinking
22 which is always a problem. Between 29.5 and 30.2 we
23 have between 1 and 3 fractures per metre?

24 A. I think it is 30.3, but yes.

25 Q. You would agree that although the



1 highest RQD is in the box we see on the table, HC3-85,
2 the reality is we have some other segments of core as
3 indicated on this core log that appear to be segments
4 of fairly competent rock?

5 A. And we get lower RQD's because
6 where we have less competent rock we also have in some
7 places more fractured rock, yes.

8 Q. Thank you. We were talking about
9 gradients and we were talking about hydraulic
10 conductivities in this hole and you will recall in HC3-
11 85 we have three packer tests. I would also like to
12 concentrate on the results of the pumping tests. This
13 was pumping test PW-2 in HC3-85?

14 A. It was adjacent to HC3-85 and I
15 don't believe it was in.

16 Q. But it was related to HC3-85?

17 A. Related geographically, yes.

18 Q. I am showing you yet another
19 cross-section and I wonder if we could put it up beside
20 H-667 and it will have to sit over top but they can
21 overlap so we can see it from H-667, HC3-85 and we can
22 see the results of pumping test No. 2 on this cross-
23 section. Could we mark this, Mr. Chairman?

24 MR. LANCASTER: H-670.

25 ---EXHIBIT NO. H-670: Chart-Pumping Test Results
PW-2, at Site F



1 MR. HODGSON: Q. We have found a new
2 use for Mr. Crutcher's camera.

3 MR. PETRIE: A. Was this is H-670?

4 Q. Yes. Mr. Crutcher has agreed to
5 have copies of the cross-sections which he has already
6 photographed, he will make them available to all
7 parties and the Board and I presume we could probably
8 prevail on him to do that with the new ones as well,
9 and I am sure some method of sharing the expense can be
10 arranged.

11 Will you, accept, Mr. Petrie, subject to
12 check, that this cross-section depicts information that
13 relates to pumping test results in PW-2, and perhaps we
14 should do some of that check right now. Can you pull
15 out your copy of H-85, the pumping test results?

16 A. One of the interrogatory
17 documents.

18 Q. The Canadian Environmental Law
19 Association interrogatory responses and it is page 52
20 of that document.

21 DR. KINGHAM: Can you tell us what page
22 52 is as that is not a numbered document.

23 MR. HODGSON: It isn't. It is in
24 Addendum 5, well construction details and it is the
25 third page after the title page, Addendum 5.



1 MR. HODGSON: Q. We have found a new
2 use for Mr. Crutcher's camera.

3 MR. PETRIE: A. Was this is H-670?

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5 have copies of the cross-sections which he has already
6 photographed, he will make them available to all
7 parties and the Board and I presume we could probably
8 prevail on him to do that with the new ones as well,
9 and I am sure some method of sharing the expense can be
10 arranged.

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12 check, that this cross-section depicts information that
13 relates to pumping test results in PW-2, and perhaps we
14 should do some of that check right now. Can you pull
15 out your copy of H-85, the pumping test results?

16 A. One of the interrogatory
17 documents.

18 Q. The Canadian Environmental Law
19 Association interrogatory responses and it is page 52
20 of that document.

21 DR. KINGHAM: Can you tell us what page
22 52 is as that is not a numbered document.

23 MR. HODGSON: It isn't. It is in
24 Addendum 5, well construction details and it is the
25 third page after the title page, Addendum 5.



1 DR. KINGHAM: Site F PW-2 pumping test
2 results and that is page 52.

3 MR. HODGSON: That's how I numbered it,
4 Mr. Chairman, or Dr. Kingham. We have been referring
5 to these all along, but they are also in H-84 in
6 Addendum I, the second page in Addendum I and I may
7 have confused everyone because I suspect now that I
8 look at it I am looking at H-84 instead of H-85, but it
9 is a photocopy of exactly the same page.

10 Q. Mr. Petrie, I would like to
11 indicate to the Board and see if you agree that at PW-2
12 the well pumped is the well marked as PW-2?

13 MR. PETRIE: A. I am assuming the well
14 pumped was marked PW-2 and I notice it is also marked
15 as TW5-86 and I see on your Exhibit H-670 that you have
16 entered PW-2 directly over the entry for TW5.

17 Q. 19.5 metres more or less to the
18 south a second monitoring well was drilled, OW2?

19 A. Correct which is labelled on the
20 figure I am looking at as TW6-86.

21 Q. That is projected in there as well
22 on that figure?

23 A. It is indeed.

24 Q. That is the solid blue line just
25 to the right of the well marked as PW-2?



1 A. It appears thus.

2 Q. Then, three other wells, in
3 addition to monitoring OW-2, three other wells were
4 monitored, HC5, HC4 and HC3?

5 A. I don't read that from the first
6 table you referred me to, but I note on this figure,
7 and I believe we are in Exhibit H-85, they have
8 indicated geographic distances to a number of
9 boreholes. I do not know if one is supposed to
10 conclude that those boreholes were monitored or not
11 during the test interval. I note that the tabulated
12 data you referred to first, we have entries adjacent to
13 the installation for HC3 being piezometers A, B and C
14 which I understand to be 1, 2 and 3.

15 Q. I believe the evidence in chief,
16 and perhaps you could take this on faith, but all the
17 wells shown on the plan view which is from page 52 from
18 H-85 were in fact monitored?

19 A. I can accept that subject to
20 check, although I don't know where to check. I don't
21 have the information.

22 Q. It will have to be in the
23 transcript, and, if not, we don't have the evidence,
24 but nothing turns on it for the moment.

25 A. I can accept that.



1 Q. What I am interested in knowing
2 from you is in a 24-hour pumping test it is probably
3 not likely there will be a response in HC4 and HC5 in
4 any case, is it?

5 A. I do not know.

6 Q. At any rate do you agree there was
7 a response during this pumping test at HC3?

8 A. There was a response recorded at
9 HC3, yes.

10 Q. Those responses if you could just
11 turn around and indicate, those responses are in the
12 upper two piezometers -- I am sorry, there are 5
13 piezometers at HC3-85 and they are shown there?

14 A. Yes, there are 5 piezometers.

15 Q. And piezometer No. 2 had a total
16 drawdown of 6.08 metres?

17 A. Piezometer B and if we could check
18 with the figure if that is indeed piezometer 2. It
19 appears it probably is.

20 Q. Piezometer 3 had a drawdown of
21 5.26 metres?

22 A. I see 5.26 and I see it for HC3-C,
23 but I am noting the screen positions for those wells
24 recorded there and they appear to centre on about an
25 elevation of about 126 for piezometer C and eyeballing



1 this drawing I don't believe this piezometer centres on
2 126. I am just noting your entry of 5.62 -- pardon,
3 5.26, and comparing that to the elevation you have
4 provided on H-670 and relating that back to the screen
5 elevations before us in Exhibit H-85 which I believe
6 you will recall is page 52.

7 It also appears that HC3-B is a little
8 higher on your Exhibit H-670 than the elevations
9 provided again on H-85, page 52. I also note there is
10 an entry on that page, 52, for HC3-A, the bottom
11 piezometer, and you have a piezometer at that
12 approximate elevation indicated but you have no entry
13 for the drawdown recorded.

14 Q. We can cross-check that. If you
15 look at Appendix 4 of H-40A the vertical elevations for
16 piezometer 3 are given as 130.2 to 128.7?

17 A. Appendix 4, piezometer HC3-85 and
18 for piezometer 1.

19 Q. Piezometer 3.

20 A. Piezometer 3. The screen setting
21 looks like 128.7 to 130.2 and I notice that is not the
22 same entry recorded on page 52. There is an
23 inconsistency between those data sets.

24 Q. I agree. However, relating them
25 in relative terms, the first piezometer is set right at



1 111.3 to 109.8?

2 A. Those numbers are consistent
3 between the two documents.

4 Q. The second two don't jibe exactly
5 but it would appear that B and C are in fact
6 piezometers 2 and 3?

7 A. It would appear they are intended
8 to be.

9 Q. In fact there are two more
10 piezometers above those?

11 A. There are two more at higher
12 elevations, yes.

13 Q. If you can accept for the moment
14 that piezometers B and C are piezometers 2 and 3, we
15 have a response in piezometer 2 of a little over 6
16 metres and a response in piezometer 3 of a little over
17 5 metres?

18 A. Correct.

19 Q. And no response in piezometers 4
20 and 5?

21 A. There is no entry made and we are
22 following your belief that that indicates there was
23 zero response.

24 Q. Mr. Petrie, if we could continue
25 and we could come back to this after the break, but we



1 have the original data sheet for this and it suggests
2 that in fact piezometers 4 and 5 were also measured and
3 there was no response, so until I can get that for you
4 after the break can you accept that so we can continue
5 that they were monitored and there was no response in 4
6 and 5?

7 A. I can accept that, although as I
8 pointed out we did not have the information and the
9 reason I believe this interrogatory was provided to us
10 was to provide that information. There is a notation
11 on the front requesting the tabulated drawdown data
12 because we found it difficult to work with the graphs
13 and you are indicating to me that there is now more
14 data. Is that correct?

15 Q. That is correct.

16 MR. McQUAID: There seems to be an awful
17 lot of things to check and a lot of things to be
18 produced. Is Mr. Hodgson undertaking that that is the
19 case and the data will so indicate?

20 MR. HODGSON: Yes.

21 Q. Now, Mr. Petrie, let's for a
22 moment look at the data for piezometer 1.

23 MR. PETRIE: A. HC3-A, is that what you
24 mean by piezometer 1?

25 Q. Yes.



1 DR. KINGHAM: Where are you reading HC3-
2 A from?

3 MR. PETRIE: I thought I was on page 50.

4 MR. HODGSON: That's not on page 50 but
5 in H-84, Addendum H.

6 MR. PETRIE: I was on H-85. Can I get
7 H-84? Now Addendum I. I see Addendum H.

8 MR. HODGSON: My copy does not have that
9 data sheet in it, but it is in H-84, and Mr. McQuaid
10 advises it is in both.

11 DR. KINGHAM: I have to advise it is
12 neither of the Board's copies.

13 MR. PETRIE: Neither?

14 DR. KINGHAM: Neither H-84 nor H-85.
15 Addendum I in H-84 has pumping test 1, pumping test 2,
16 pumping test 3 and then it goes to Addendum J.

17 MR. McQUAID: I think it is in Addendum
18 H.

19 MR. HODGSON: Addendum H.

20 DR. KINGHAM: Addendum H of H-84, PW-2,
21 now we have it.

22 MR. HODGSON: We are looking at the
23 responses in HC3, A, B and C.

24 DR. KINGHAM: Right.

25 MR. HODGSON: Q. Looking at HC3-A which



1 I think the witness agrees appears to be the piezometer
2 at the bottom of HC3-85.

3 MR. PETRIE: A. Correct, HC3-1.

4 Q. There was a response in that
5 piezometer of .25 metres?

6 A. That is the tabulated entry and I
7 believe in chief when I addressed the graph depicting
8 that plot I was not entirely clear that that
9 represented a good hydraulic connection between that
10 point and the pumping well.

11 Q. You will recall we gave you some
12 data on this particular reading about the first or
13 second day on which you were on the witness box?

14 A. I do recall getting that and I
15 also recall requesting it earlier via these
16 interrogatories and it was not provided at that point
17 in time.

18 Q. This data sheet ...

19 MR. McQUAID: Have you copies?

20 MR. HODGSON: Copies were given out.

21 Q. I want your assistance, Mr.
22 Petrie, in interpreting this result at the bottom of
23 HC3-85. You will notice that the result has not been
24 plotted on H-670.

25 MR. PETRIE: A. It was provided in the



1 graphs which was the only information I had as part of
2 Appendix 10 of H-40A and it was indicated on page 9 of
3 those graphs. It is indicated by the small circle
4 referenced in the legend and looking at the graph one
5 can note that those small circles are found at the
6 uppermost portions across the graph.

7 I believe I also indicated there were
8 only five data points and the response was small and I
9 would not confidently interpret that to be a direct
10 hydraulic connection.

11 Q. In fact, looking at the second
12 page of this latest exhibit which I guess is H-671...

13 MR. LANCASTER: H-671.

14 ---EXHIBIT NO. H-671: Monitoring well data
15 for HC3-85A

16 MR. HODGSON: H-671 being the data
17 sheet I gave out.

18 Q. Looking at page 2 it would appear,
19 would it not, that the first drawdown notice at the
20 bottom of the piezometer was after 200 minutes and is
21 that how we read that?

22 MR. PETRIE: A. I am reading the time
23 as 1:00 p.m. and it looks like 60 minutes and we have a
24 column headed elapsed time.

25 Q. Sixty minutes?

A. It doesn't indicate minutes but it



1 seems reasonable to understand that that is minutes.

2 Q. At the end of the test it was read
3 again and it was down .25?

4 A. The fifth reading during the test
5 interval at approximately the end of the pumping period
6 indicates a drawdown of .25 and I understand that that
7 is metres.

8 Q. Then, it was monitored during the
9 recovery period?

10 A. There are five entries for
11 recovery during the recovery period for a total period
12 of time of 120 minutes of elapsed time since the
13 pumping stopped.

14 Q. And there was no recovery?

15 A. For a period of 120 minutes. One
16 might note that for 120 minutes during the pumping
17 interval there was a drawdown of only 0.01 or a bit
18 more.

19 Q. Looking at Exhibit H-668, would
20 you agree that between piezometers...

21 A. Excuse me, 668?

22 Q. Yes, between piezometer 2 and
23 piezometer 1 there is a very high vertical gradient?

24 A. You have indicated in red the
25 average vertical gradient across the borehole from



1 piezometer 2 to 1 is in excess of 0.05, yes.

2 Q. Cross-checking that against your
3 Appendix A for HC3-85...

4 A. Can I catch up with you please?

5 Q. That's not the idea at all.

6 DR. KINGHAM: Can you allow us to catch
7 up with you. Appendix A?

8 MR. HODGSON: Appendix A of Mr. Petrie's
9 Exhibit B-617.

10 MR. PETRIE: We are HC3-85.

11 MR. HODGSON: Q. I read about a
12 computerized courtroom last week and I meant to cut it
13 out and pin it up on my door. It is clear that if we
14 had a computerized courtroom we could get back and
15 forth to these things very quickly providing some of us
16 could be taught how to use a computer. I include only
17 myself in that comment. Between piezometer 2 and
18 piezometer 1 we have a head drop of, is it 10 metres or
19 9 metres?

20 MR. PETRIE: A. We note there is an
21 inconsistency -- Dr. Kingham noted when he was
22 eyeballing this data between the water levels recorded
23 for December '85 through to March of '86 for piezometer
24 1, it is my expectation, and I don't have it as fact,
25 but the water levels for March '86 and April '86 being



1 in the mid-120 metres in elevation represent the field
2 data and the values being the 137s and in some fashion
3 they are erroneous.

4 Q. Accepting what you are saying,
5 there is a very substantial head difference between
6 piezometer 2 and piezometer 1?

7 A. That is correct, as you have
8 indicated on H-668 with the red marking.

9 Q. Would you agree that it is very
10 unlikely given that head differential between
11 piezometer 2 and piezometer 1 that this small amount of
12 suggested response at piezometer 1, PW-2, is in fact a
13 response to PW-2 only?

14 A. No, I would not.

15 Q. Would you agree, or would not
16 agree?

17 A. I would not agree with you.

18 Q. I am asking -- I am not sure what
19 you have agreed to?

20 A. I have not agreed to your
21 question. Your question was do I agree and my answer
22 was, no, I do not agree.

23 Q. Let me rephrase it. I am asking
24 you to agree that the response in the first piezometer
25 measured during the pumping test was not in fact a



1 response to the pumping test given what we know about
2 the recovery data, the lateness of the response if it
3 was a response at all and the head difference across
4 that unit?

5 A. And I am not agreeing with you.

6 Q. Why not?

7 A. There are a number of points that
8 come to mind when we look at this data. I first
9 indicated at that point in time I only had the graph
10 before me and the graph I am referencing is page 9,
11 Exhibit -- I beg your pardon, Appendix 10, Exhibit H-
12 40A and I noticed five data points across that graph.
13 They were indicated by the circle across the graph at
14 the top and looking at the legend we notice that it has
15 been calculated that transmissivity values and TS and K
16 values have been calculated by the person who undertook
17 this analysis.

18 I note the T value which is recorded as
19 1.8×10^{-4} metres squared per second is much higher
20 than the T values recorded elsewhere on that page and
21 from my recollection higher than most of the values
22 recorded anywhere else. I concluded one cannot
23 reasonably extrapolate a very small drawdown to reflect
24 highly transmissive aquifer conditions. That to me is
25 most reasonable.



1 The question now in my mind is what does
2 a small change in pressure, recognizing that these are
3 piezometers we are dealing with and water pressures,
4 what does a small change in pressure at the base of HC3
5 mean when an induced pressure change, i.e., a pumping
6 test has been conducted at a higher elevation?

7 The only other information we have is
8 two sets, and one set is that which you have just
9 provided on H-671 and as I indicated -- let's walk
10 through this table again -- under elapsed time during
11 the pumping phase which I take to be the first five
12 data entries on this table we have a small change of
13 drawdown after 60 minutes of pumping, 0.01. By the
14 time we get to 1425 which is approximately 24 hours,
15 i.e., 23 hours later, we have a drawdown of 0.25.

16 The value of 0.01 within the uncertainty
17 attached to measuring water levels may also be a zero
18 value. It is a one centimetre change which is small.
19 However, a 25 centimetre change I think is a real
20 measurement. I have not said that is directly a
21 reflection of pumping, but I am saying that I believe
22 that 0.25 can reasonably be measured in the field to
23 reflect a water level change.

24 Now, I look down at the recovery
25 information at the bottom and I note we only have data



1 for 120 minutes. For that 120 minutes we have zero
2 recovery or, i.e., the water levels appeared to have
3 stayed at 0.25. I am now left in my mind with the
4 question of what does a 25 centimetre change in water
5 level mean which has occurred after in excess of one
6 hour and less than 24 hours after pumping started when
7 we compare that to the recovery data for which we only
8 have recovery data for two hours, 120 minutes.

9 I cannot be as definitive as I would
10 like. Obviously had there been a more extensive data
11 suite recording up to the 24-hour period, i.e., for the
12 same length of time as pumping occurred and zeroes had
13 been entered in for all that time, the zero being the
14 drawdown, one might reasonably conclude there were some
15 erroneous measurements in the system somewhere and it
16 could not be reasonable to extrapolate back to a
17 pumping response.

18 However, I only have data for two hours
19 and after two hours from interpreting the top graph, we
20 are only starting to have a subtle change in drawdown
21 and I am calling one centimetre subtle.

22 The second point I wish to comment on is
23 that you have indicated to me as you interpret Exhibit
24 H-84 that where we have no data entry there is zero
25 drawdown. By that we were referring to piezometers 4



1 and 5 at HC3. We note that 4 and 5 lie above the
2 interval stressed by pumping. We note also there are
3 strong downward gradients -- let's use the words
4 downward gradients across the borehole recognizing
5 there are differences in the gradient.

6 If I stress this interval I might
7 reasonable expect to see the drawdown above that point
8 given that the gradients are directed downward to the
9 stressed interval. But, I don't see it, and I see some
10 sort of response, albeit a questionable response at
11 depth and a question that leads me to conclude is, (1),
12 how representative are the vertical gradients when we
13 have extrapolated them across approximately a 15 metre
14 interval, are the gradients much more complex within
15 the system than that, and why did we not get a response
16 above it?

17 The question that is unanswered in my
18 mind is do we have some measure of hydraulic connection
19 to depth? I do not know. With reference to the
20 comment I made on the gradients, I notice on Exhibit H-
21 668 that you have taken the gradients for the HC
22 boreholes, and I think you would have ended up with a
23 much more colourful picture, if I can use that word,
24 had you taken all the gradient data from one of these
25 other exhibits you put before me, and I don't know if



1 we need to get it out, being M-435 or some such number
2 -- M-437, Mr. Crutcher reminds me.

3 We are dealing with a much more complex
4 distribution of vertical gradients within the system
5 and I find it difficult to interpret pumping test data
6 within the vertical plane and I do not know what it
7 means.

8 To get back to your initial point, we
9 have a .25 metre drawdown after 24-hours of pumping at
10 a point and you are asking does that not reflect
11 pumping, and I cannot indicate because I do not know.

12 Q. But we have, you agree, a very
13 strong vertical gradient between piezometer 2 and
14 piezometer 1?

15 A. Indicated by the red values of
16 greater than 0.5, it is stronger.

17 Q. Suggesting the water in piezometer
18 2 had a lot of trouble in getting to piezometer 1?

19 A. In general terms, yes.

20 Q. And 0.5 in fact is a very strong
21 vertical gradient is it not?

22 A. Correct, but the magnitude of the
23 vertical gradient does not preclude some sort of
24 fracture connection. What it does preclude is a strong
25 fracture connection and we are back to what is the



1 distribution of vertical fracturing at this site and
2 what is the nature of the interconnection vertically
3 through this system. I cannot give an answer to those
4 questions.

5 Q. If there is hydraulic connection
6 and there is response during the pumping of PW-2, you
7 would also expect there to be some response during the
8 recovery period, or change during the recovery period,
9 would you not?

10 A. Correct, and I noted that given
11 that it took an hour for the response to be first seen
12 in the pumping period it would be my expectation that
13 you would have the same period of time before you would
14 see it in the recovery period.

15 Q. But you had two hours in the
16 recovery period and you don't see anything?

17 A. The difference is the value of one
18 centimetre and, as I indicated, I think there is reason
19 to have some doubt that one can measure a centimetre as
20 reliably as one would like in the field.

21 Q. The question is how much
22 confidence do we put in this information that there was
23 a response, a measured response in HC3-1, given that
24 vertical gradient and given, I suggest also, the real
25 possibility that you have already mentioned that



1 measurement errors in the field can occur?

2 A. I indicated that I felt the 0.25
3 value was harder to relate to a measurement error. The
4 crux of the argument you are proposing is what is the
5 vertical connection through this system and this is the
6 only information we have to give some indication of
7 what the vertical response through the system is.

8 I cannot give you a conclusive answer
9 that that indicates a total error or some measure of
10 response. What I can conclude is what I believe I did
11 conclude in chief, that with reference to graph 9 from
12 Exhibit H-40A, that the calculated transmissivity on
13 that page does not reflect the hydraulics of the
14 system.

15 Q. Can we go please to borehole HC5
16 and first of all we have on the table a segment of core
17 from HC5 logged between 114.74 and 111.69 metres, and
18 perhaps that could be the next exhibit?

19 MR. LANCASTER: Yes, H-672.

20 ---EXHIBIT NO. H-672: Box of rock core from
HC5-85 (111.69 to 114.74 metres)

21 DR. KINGHAM: Perhaps while we are doing
22 that perhaps someone could clarify or perhaps
23 Mr. Petrie could clarify it, but when we discussed the
24 water level data from which the vertical hydraulic
25 gradients were calculated, we did talk about that



1 remarkable change in the recorded value from the 9th of
2 March, 1986 to the 24th of March, 1986 and here I am
3 referring to Appendix A of Exhibit B-617 and you said
4 at the time those were dubious values and therefore the
5 gradients were dubious, but have you confirmed that
6 now?

7 MR. PETRIE: This is not my data. I
8 took the data directly from H-85 as provided. I also
9 have not requested of Trow a clarification of that. I
10 could indeed do that. If one had a water level of 137,
11 at that elevation it contrasts strongly with the other
12 water levels at that general elevation being at depth
13 in this system, and I am not sure that that is an
14 appropriate elevation.

15 DR. KINGHAM: Are you saying the values
16 from the 21st of December, 1985 through to the 9th of
17 March, 1986 may be questionable ones rather than the
18 last two?

19 MR. PETRIE: Correct, because then we
20 would essentially have very little vertical gradient
21 but I would note at HC4, the first piezometer, and that
22 is also on the page you have open, the water levels are
23 generally in the low 120's and noting to the left on
24 that table at screen elevations of 106 to 107 metres
25 above sea level, which is approximately the level we



1 have at HC3-1, the bottom piezometers at HC4 and HC3
2 are at similar elevations and I would not have expected
3 more than in this case a 15 metre water level
4 difference between those two piezometers.

5 However, it would be prudent to check
6 with Mr. Sobanski or Trow and verify the data they have
7 provided.

8 DR. KINGHAM: As it stands now we don't
9 know whether the earlier data is in question and
10 therefore the hydraulic gradients would be much lower
11 across that unit, or whether the last data is in
12 question in which case the gradients are as they are
13 shown here?

14 MR. PETRIE: That is correct. I base
15 my interpretations on the last data being the correct
16 data and the steep hydraulic gradients being correct.
17 However, as you point out, I will approach Trow and get
18 a clarification on that data entry.

19 DR. KINGHAM: Thank you. I am sorry,
20 Mr. Hodgson.

21 MR. HODGSON: Well, in fact, it is our
22 view that the witness is quite correct about that, the
23 likely accurate readings are the last two and the
24 earlier ones are in error.

25 Q. Mr. Petrie, I am showing you a



1 segment of rock, HC5-86, and I have marked it H-672.

2 MR. PETRIE: A. HC5-85? And could you
3 give me those elevations?

4 Q. 114.74 to 111.69.

5 A. Thank you.

6 Q. I believe, and I would ask you to
7 take subject to check, that this corresponds with
8 RQd's, the third and fourth RQD's set out on the core
9 log at elevation 114.74 which appears to be at about
10 the 11 metre mark in the core log?

11 A. There are scratched entries given
12 over the days which give me a slightly different
13 position but perhaps I could check. We have a ground
14 elevation of 125.87 and you said 114.74.

15 Q. Yes.

16 A. 11.13 is the number I get and yes
17 we are in agreement.

18 Q. That corresponds pretty much to
19 the line above RQD at 59.9?

20 A. It does indeed.

21 Q. It would include all of that
22 segment 59.9 and all of the segment marked 82.9 with
23 the bottom level reading at about 14.2?

24 A. I can take your 14.2 subject to
25 check but you indicated the elevation you gave me



1 covers the two entries for RQD, 59.9 and the other
2 being 82.9.

3 Q. Yes.

4 A. Yes.

5 Q. First of all, can you confirm by
6 leaning across here that once again in a core box we
7 have a run of core that appears to have very few
8 fractures that are not machine breaks?

9 A. Can you point out which one?

10 Q. I am pointing out the centre
11 piece, also there is a piece on the far side. Perhaps
12 you should go around?

13 A. Is this the box you are looking
14 at?

15 Q. HC5-85 and looking at the top of
16 the core run which is right here on the right-hand side
17 of the Chairman, we have a run of about a metre. Would
18 you agree that that metre, it would appear that all the
19 breaks are machine breaks?

20 A. At first glance, no, and I am not
21 sure where your one metre interval is. Do we have the
22 scale? You are indicating a piece of rock which is 92
23 centimetres and that is approximately a metre and with
24 reference to the breaks ...

25 Q. Isn't this 100 centimetres? Isn't



1 100 centimetres a metre?

2 A. I was noting to here.

3 Q. I had the whole thing.

4 A. You are taking exactly the one
5 metre length.

6 Q. Roughly the first metre of rock.
7 What I want to know is to what extent do we have
8 machine breaks in that?

9 A. The bottom of the rock appears to
10 be a machine break and the first fracture is and the
11 second one does. The third does not, although I am not
12 entirely sure what sort of fracture it is. The fourth
13 I am not entirely sure again. The fifth one most
14 probably is as is the sixth and seventh and the eighth,
15 again most probably, the ninth at an approximate depth
16 of 65 centimetres below the start of this core run, I
17 am not sure. The tenth and eleventh most probably are.
18 The twelfth most probably is not. It appears to be a
19 more open fracture with a few pieces of rock in it.
20 The twelfth one is highly erratic, perhaps a machine
21 break, although that seems inconsistent with some of
22 the other machine breaks and that is all we have in
23 that length of rock.

24 Q. Looking at the length of rock in
25 the middle of the box?



1 A. The middle run?

2 Q. The middle run. Could you give us
3 an indication of that looking at it, the first metre
4 and then measure down to wherever it is fractured?

5 A. I don't know what the base
6 represents but the first fracture appears to be a
7 machine one. The second appears the same and the third
8 and the fourth appears likewise. The fifth one is not
9 a machine break. The sixth one is a rather strange
10 break with a vertical fracture across it and I hesitate
11 to guess what it is.

12 Q. What is the length of that
13 vertical fracture?

14 A. As we see it here, only a few
15 centimetres. When I am saying vertical, I am saying
16 approximately parallel to the core of the borehole
17 although it could be a few degrees off the borehole
18 orientation. Now we are coming to 68 centimetres on
19 the profile -- 65 centimetres into the profile, and
20 possibly that is a machine break, perhaps even
21 probably, but I am not sure.

22 Then is No. 8 -- that was No. 9 and No.
23 10 is a machine break, No. 11 is possibly a machine
24 break and that is the first metre. What was the second
25 part of the question?



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Crutcher, Petrie
cr ex (Hodgson)

1 Q. I can't see, but is there an area
2 where the end is fractured?

3 A. Toward the end and past the 1
4 metre interval, yes, there are some broken parts and
5 bits of rock and some of them individually wrapped and
6 there is a thin rubblely zone.

7 Q. Can we measure down to where the
8 thin rubblely zone begins?

9 A. It appears to be at the position I
10 have drawn here and if you note the 1 metre you will
11 find it is 1 metre 25 below the upper portion.

12 Q. For the rest of that 1.25 metres
13 what do we have in the way of machine breaks versus in
14 situ breaks?

15 A. For the rest? From the 1 metre to
16 the 1.25 there are some cracks which appear to go right
17 through but they don't appear to be machine breaks and
18 there are some void spaces of some sort but the rock
19 does not really come apart at that point, but perhaps
20 it is just jammed at this point and there are some
21 broken pieces which look like a machine break.

22 Taken from that 1 metre we have another
23 six fractures and they appear to be machine breaks
24 although the patterns are a little different from the
25 other machine breaks with these marginally open areas



1 and they do not appear to be broken across there.

2 Q. So for that 1.25 metres of rock
3 how many fractures do you have that are likely in the
4 in situ material?

5 A. Could you make an entry of all of
6 that please, Mr. Crutcher?

7 MR. CRUTCHER: Four or five.

8 MR. PETRIE: Four or five from
9 recollection.

10 MR. HODGSON: Q. If we could quickly,
11 looking at the core log for HC3-85 and perhaps we
12 should number the pages so we can find where we are?

13 MR. PETRIE: A. This is HC5?

14 Q. HC5-85.

15 A. The first page being the one with
16 the log coring record?

17 Q. Yes.

18 DR. KINGHAM: You are numbering the
19 borehole log, the boreholes well by well?

20 MR. HODGSON: Yes.

21 MR. PETRIE: So I have an entry ...

22 MR. McQUAID: There is a sheet number,
23 sheet 1 of 5.

24 MR. HODGSON: I know and that is
25 confusing because the previous page is excluded.



1 MR. McQUAID: So sheet 1 of 5 would be
2 page No. 2.

3 MR. HODGSON: That's right.

4 MR. PETRIE: We end up with a total of 6
5 pages.

6 MR. HODGSON: Q. Can we run down this
7 borehole. We have agreed that the box of core we
8 looked at with -- or that you have just described for
9 us, has an RQD or the RQD's for the whole box are 59.9
10 and 82.9?

11 MR. PETRIE: A. Those are the numbers
12 entered in column 16 on this page.

13 Q. Above that we have RQD's that are
14 lower, 33.6 and 26.3?

15 A. We do indeed.

16 Q. Below that we have RQD's that go
17 from 46.8 to zero to 45.6 and then they start to climb,
18 61.8, 100, 86.8, 66.5, 96.1 and 89.5?

19 A. I have 66.4 and I believe there
20 may be a number missing adjacent to the depth of 25
21 metres, given that that appears to be a new core run
22 and then we have 96.1 and then over the page I see
23 89.5.

24 Q. Also eyeballing that core we have
25 significant segments of that core where the fracture



1 frequency is between 1 and 3 fractures per metre?

2 A. I will just refer to the legend
3 again.

4 Q. That means there are two white
5 columns?

6 A. There are definitely some lengths
7 of the borehole which have two white columns open under
8 No. 14, yes.

9 Q. In fact two-thirds of page 4, more
10 than two-thirds of page 5 and most of page 6 are in
11 fact runs of core with fracture frequencies of between
12 1 and 3 per metre?

13 A. In a general sense, yes.

14 Q. Would you agree with me that these
15 higher RQD's and these lower fracture frequencies
16 correlate to rock that has significant runs of
17 competent rock in them?

18 A. In a general sense. We reviewed
19 the RQD's for this site and as I recall we plotted them
20 against the elevations and then tried to relate them to
21 as we understood it the hydrostratigraphic zones from
22 H-220 and we did not come up with clear correlations.
23 In some places we ended up with dramatically different
24 RQD's in the vertical profile at any one borehole and,
25 yes, both those RQD's lay within only one



1 hydrostratigraphic rock zone.

2 As I indicated before, I think the RQD
3 is a rather crude measure and while it may be -- I
4 believe you asked me to agree it is a standard method
5 and I did agree to do so, but I am not sure it is a
6 standard method by which a hydrogeologist evaluates the
7 hydraulics of a rock and I think we agreed it is a
8 method a geologist would use to evaluate rock
9 integrity.

10 Q. I am trying to use the RQD to
11 suggest to you that what we find in each of these
12 boreholes, each one of these boreholes is significant
13 runs of competent rock. We have looked and we can see
14 all the rock in HC4 and HC6 and in fact in those two
15 boreholes we see significant runs, do we not?

16 A. We do indeed.

17 Q. Those correlated with high RQD's?

18 A. In a general sense and I pointed
19 out there was a number of inconsistencies and there was
20 a good amount of pronounced fracturing...

21 Q. I know we have fracture intervals
22 but we also have competent rock, do we not?

23 A. I am agreeing with that.

24 Q. We have it again in this borehole
25 HC5-85, don't you agree?



1 A. We do.

2 Q. If we could correlate some more
3 data we happen to have for this borehole, you will see
4 on H-668 behind you that the gradient data suggests
5 that we have got strong vertical gradients from top to
6 bottom in this hole, would you not agree?

7 A. I am sorry, HC5?

8 Q. HC5-85. All the gradient data or
9 all the gradients are above 0.1?

10 A. Excuse me. All the gradients are
11 above 0.1, yes.

12 Q. We also have at the bottom of this
13 well high chlorides, very high chlorides, 11,600?

14 A. I am relating that back to H-659
15 where we have high chlorides at 11,600, correct. We
16 reviewed this the other day but I just recalled
17 something. I am not sure where you got the numbers for
18 HC9-85, because it indicates it is from H-40 and I
19 didn't see those numbers, but I just make that
20 observation.

21 Q. We will look it up and check it
22 for you. Looking again at HC5-85, and considering the
23 core which we have been looking at and which we have
24 been studying through the RQD and the fracture
25 frequency and the high chlorides at the bottom of that



1 borehole and the high gradients all the way down that
2 borehole; it would appear again that there is not much
3 in the way of hydraulic connection between the top and
4 the bottom of that borehole?

5 A. Again, the gradients are steep and
6 I don't see the lower gradients we get at the other
7 boreholes and presumably there is the flow in the
8 vertical profile that may dominate at this hole and
9 relative to the other three we have addressed, HC4, HC3
10 and HC6 where we had some shallower downward gradients
11 which indicated a zone of probable horizontal flow or
12 more pronounced horizontal flow; but I do not see that
13 in HC5.

14 Q. Let's go, please, to HC8. If we
15 go to HC8...

16 A. The borehole record?

17 Q. The borehole record, first of all,
18 and we might as well number these pages as well.
19 Again we have a box of core for HC8 and I would ask it
20 be marked as the next exhibit.

21 MR. LANCASTER: H-673.

22 ---EXHIBIT NO. H-673: Box of rock core from
23 HC8-85 (106.10 to 110.31 metres)

24 MR. HODGSON: This box of core is
25 between 110.31 and 106.10.



1 MR. PETRIE: Could you repeat the
2 numbers?

3 MR. HODGSON: Q. 110.31 to 106.10.

4 MR. PETRIE: A. Seven and a half to
5 approximately 11 metres below ground.

6 Q. Are you able to correlate that
7 with page 2 of the core log?

8 A. I just subtracted the elevations
9 you gave me from the ground surface elevation and noted
10 we are looking at about 7.7 metres below ground to
11 about 11.9 metres below ground and I note for the 7.7
12 that that is approximately adjacent to the entry where
13 we have an RQD of 43 and the 11.9 is down in the middle
14 of the portion, the lower portion of that record where
15 the RQD of 45 is appropriate. I suspect I am missing
16 an RQD value because that rock run seems a little
17 longer than the others.

18 Q. Are we agreed that the RQD's of
19 this box roughly correspond to 43 and 45?

20 A. Those are the numbers I see before
21 me.

22 Q. Could you come around and look at
23 the core run in Exhibit H-673, please? Again, the core
24 begins or the top of the core is on our right-hand side
25 and the bottom of the core is at the end of the box



1 toward the Board at the left-hand column?

2 A. Where it is entered 60 in there.

3 Q. Could we look at just this last
4 segment of core, the last run, if you can accept this,
5 is this 1.25 metres and does that seem right. Can you
6 measure it please?

7 A. 1.37 metres, Mr. Hodgson.

8 Q. Would you give an indication to
9 the Board of how many of the fractures we see in the
10 core before us were likely in situ?

11 A. The base of the section appears to
12 be an in situ fracture and the next one appears to be
13 an in situ. I might point out I have had some
14 experience looking at cores today trying to guesstimate
15 between in situ fracturing and machine fracturing and
16 that is not something I have had much exposure to
17 before and for all the cores that is.

18 The bottom is indicated as probably a
19 real break and an in situ one and the first fracture in
20 appears the same and the second one appears to be a
21 real fracture and the third one appears to be a machine
22 break. The fourth one may be a real beak. I will
23 count the base of the section as fracture 1, so
24 fracture 1 and 2 appear to be real, 3 a machine break,
25 4 and 5 machine breaks -- 4 a machine break and 5 I am



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8 I also note there is a vertical break in
9 the rock at this point and the very end of this section
10 has another broken chip on it which may be an in situ
11 break.

12 Q. Is the vertical break an in situ
13 break?

14 A. It may be, I don't know. It is a
15 strange machine break.

16 Q. Have we got more than a metre of
17 rock that appears to be unbroken in the ground?

18 A. I believe we had 1.37 metres of
19 rock and I don't recall which breaks I said were the
20 machine breaks, but I think most of them were machine
21 breaks.

22 MR. CRUTCHER: Two in situ and three
23 vertical.

24 MR. PETRIE: And the two at the bottom
25 of the section -- I can't remember which was the other



1 one, but there might only be one break in close to a
2 metre where the breaks are probably machine breaks.

3 Q. Now, we have identified the RQD
4 for this box of material as 43 and 45?

5 A. That is correct.

6 Q. Would you agree, save and except
7 the second box away which has an RQD of 35, that all
8 the other runs of core were logged having RQD's higher
9 than 45?

10 A. I see a 43 for the first one or is
11 that the one we are dealing with?

12 Q. Yes.

13 A. Other than the 43 and 45 we see
14 and one occurrence of 35, the other RQD's exceed those
15 values.

16 Q. In fact we have got one at 98, one
17 at 93 indicating again a couple of boxes of very
18 competent rock?

19 A. With respect to the number of
20 lengths of core over the 10 centimetres which don't
21 have a fracture, yes.

22 Q. Have you not already seen that
23 where we find a high RQD we find long runs of unbroken
24 core?

25 A. In a general crude sense we have



1 MR. HODGSON: Thank you.

2 MR. LANCASTER: Thank you, ten minutes.

3 ---Recess

4 MR. LANCASTER: Please be seated.

5 MR. HODGSON: I wanted to indicate for
6 the record and my friends that I believe this witness
7 is quite correct in saying that the interrogatories
8 clearly request pumping test data which he has not been
9 provided with, and for that I apologize to this Board.
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11 didn't know it had been asked for, but I certainly see
12 it should have been provided before and it will now be
13 provided and I will simply have to delay that portion
14 of my cross-examination relating to it until this
15 witness has it and has an opportunity to look at it.
16 We will make every effort to get it to everybody
17 including the Board sometime tomorrow. I cannot
18 promise it earlier than that.

19 MR. LANCASTER: That would be pretty
20 difficult to do.

21 MR. HODGSON: If it was short and there
22 was a photocopy place down the road, it might not be
23 too difficult to do, but it is not short.

24 Q. Now, Mr. Petrie, could I ask you
25 to turn up your copy of the plan view of Site F



1 Q. In your experience as a
2 hydrogeologist, have you ever come across a situation
3 where there were no inconsistencies?

4 A. I have not, and I have also not
5 dealt at great length with a complex site in which the
6 fracture geometry to my mind has not been delineated
7 and I am asked to make interpretations regarding what
8 it all means.

9 MR. LANCASTER: Mr. Hodgson, would this
10 be an opportune time?

11 MR. HODGSON: It would if I can make
12 one reference because we are leaving HC8-85.

13 Q. Could I ask you to refer to the
14 profile, the RQD profile which you will find at the
15 back of H-206?

16 MR. PETRIE: A. I see it, yes.

17 Q. And I would suggest to you that
18 the RQD profile confirms what we see in Exhibit H-673,
19 that we have down this borehole runs of very competent
20 rock.

21 A. The RQD profile is the RQD
22 profile, yes. Are you asking me to confirm ...

23 Q. What we have in borehole HC8-85
24 are runs of very competent rock?

25 A. In portions of the rock, yes.



1 from HC4 must travel vertically through even more rock
2 than any leachate that escapes at HC4-85?

3 A. Well, I ...

4 Q. There is a vertical elevation and
5 another 29 metres of rock between the base of the
6 landfill at the top of Site F and the base of the
7 landfill at HC4-85, right?

8 A. Correct.

9 Q. Leachate that escapes the leachate
10 collection system at the top of the landfill and which
11 is making its way vertically through the rock just to
12 get to HC4-85 must travel vertically 29 metres?

13 A. Yes.

14 Q. Right. In order to get to HC11 at
15 79 metres it must travel vertically 91 metres?

16 A. HC11 is an elevation of 79 and
17 that looks about right.

18 Q. 91 metres?

19 A. 89.

20 Q. 89 metres?

21 A. Give or take approximately 90.

22 Q. From HC4-85 to HC11-85 it has got
23 to travel 40 and 20 or 60 metres?

24 A. Which were the two numbers you
25 just said, 4 and 11?



1 borehole and the high gradients all the way down that
2 borehole; it would appear again that there is not much
3 in the way of hydraulic connection between the top and
4 the bottom of that borehole?

5 A. Again, the gradients are steep and
6 I don't see the lower gradients we get at the other
7 boreholes and presumably there is the flow in the
8 vertical profile that may dominate at this hole and
9 relative to the other three we have addressed, HC4, HC3
10 and HC6 where we had some shallower downward gradients
11 which indicated a zone of probable horizontal flow or
12 more pronounced horizontal flow; but I do not see that
13 in HC5.

14 Q. Let's go, please, to HC8. If we
15 go to HC8...

16 A. The borehole record?

17 Q. The borehole record, first of all,
18 and we might as well number these pages as well.
19 Again we have a box of core for HC8 and I would ask it
20 be marked as the next exhibit.

21 MR. LANCASTER: H-673.

22 ---EXHIBIT NO. H-673: Box of rock core from
23 HC8-85 (106.10 to 110.31 metres)

24 MR. HODGSON: This box of core is
25 between 110.31 and 106.10.



1 MR. PETRIE: Could you repeat the
2 numbers?

3 MR. HODGSON: Q. 110.31 to 106.10.

4 MR. PETRIE: A. Seven and a half to
5 approximately 11 metres below ground.

6 Q. Are you able to correlate that
7 with page 2 of the core log?

8 A. I just subtracted the elevations
9 you gave me from the ground surface elevation and noted
10 we are looking at about 7.7 metres below ground to
11 about 11.9 metres below ground and I note for the 7.7
12 that that is approximately adjacent to the entry where
13 we have an RQD of 43 and the 11.9 is down in the middle
14 of the portion, the lower portion of that record where
15 the RQD of 45 is appropriate. I suspect I am missing
16 an RQD value because that rock run seems a little
17 longer than the others.

18 Q. Are we agreed that the RQD's of
19 this box roughly correspond to 43 and 45?

20 A. Those are the numbers I see before
21 me.

22 Q. Could you come around and look at
23 the core run in Exhibit H-673, please? Again, the core
24 begins or the top of the core is on our right-hand side
25 and the bottom of the core is at the end of the box



1 toward the Board at the left-hand column?

2 A. Where it is entered 60 in there.

3 Q. Could we look at just this last
4 segment of core, the last run, if you can accept this,
5 is this 1.25 metres and does that seem right. Can you
6 measure it please?

7 A. 1.37 metres, Mr. Hodgson.

8 Q. Would you give an indication to
9 the Board of how many of the fractures we see in the
10 core before us were likely in situ?

11 A. The base of the section appears to
12 be an in situ fracture and the next one appears to be
13 an in situ. I might point out I have had some
14 experience looking at cores today trying to guesstimate
15 between in situ fracturing and machine fracturing and
16 that is not something I have had much exposure to
17 before and for all the cores that is.

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17 at 93 indicating again a couple of boxes of very
18 competent rock?

19 A. With respect to the number of
20 lengths of core over the 10 centimetres which don't
21 have a fracture, yes.

22 Q. Have you not already seen that
23 where we find a high RQD we find long runs of unbroken
24 core?

25 A. In a general crude sense we have



1 | seen that, yes.

2 Q. Correlating that data to other
3 data we have at borehole HC8-85, we have from about 25
4 per cent of the way down the borehole to the bottom of
5 the borehole a vertical gradient?

6 A. We have vertical gradients in
7 every borehole.

8 Q. I am sorry, a downward gradient.

9 A. I understand. From -- you said
10 about two-thirds of the way up from the bottom to the
11 base where we have a downward gradient and you have
12 entered the green colour and the legend indicates that
13 that is a downward gradient of a magnitude of 0.1 to
14 0.5.

15 Q. In fact if we look at B-617 under
16 Appendix A for the gradient computations which you have
17 presented, we have between piezometer 1 and piezometer
18 4 a vertical gradient of 0.351?

19 A. Sorry, I haven't found the page
20 number. HC8 between piezometers 3 and 4.

21 Q. Between piezometers 1 and 4?

22 A. Between 1 and 4 we have three
23 entries, 0.279, 0.280 and 0.327 all being negative
24 values and all indicating a downward gradient.

25 Q. Could you read those again. I



1 read them as .4, .4, .3, and .3.

2 A. Can we start again? HC8 and the
3 vertical gradient between which piezometers?

4 Q. First of all you computed the
5 vertical gradients for various intervals and you have
6 one computation between -- the vertical gradient
7 between piezometer 1 and piezometer 4?

8 A. Correct.

9 Q. Isn't that vertical gradient you
10 calculated 0.327?

11 A. At the far right-hand side and I
12 indicated there were three entries and the far right-
13 hand one being for the date of the 15th of April, '86
14 is negative 0.327.

15 Q. Across four piezometers you have
16 calculated a vertical gradient of 0.327?

17 A. Correct.

18 Q. That I suggest is a strong
19 downward gradient?

20 A. Correct.

21 Q. Then we have the peculiarity at
22 least on the data on H-668 that in HC8-85 we have an
23 upward gradient at the top?

24 A. Yes.

25 Q. And we are also downslope from the



1 other piezometers at this point, are we not?

2 A. We are lower down on the site ...

3 Q. ...than the other boreholes?

4 A. Yes, all the other on-site
5 boreholes, of the HC on-site boreholes.

6 Q. At HC8-85 we have chlorides,
7 reading from the top, of 6300, 7300, 9800 and 24,000?

8 A. Yes. I believe this was the
9 installation where there were some inconsistencies with
10 respect to the chloride numbers for the rock.

11 Q. That was HC5. I think you will
12 find the chloride numbers correspond quite nicely to
13 the tritium numbers?

14 A. Sorry. Something was in the back
15 of my mind that the chloride rock concentrations you
16 provided as an exhibit to me the other day noted there
17 were some inconsistencies or I pointed it out and you
18 agreed. I don't recall the exhibit number, but the
19 exhibit of chloride concentration.

20 Q. H-660.

21 A. As developed from the rock data?

22 Q. Yes.

23 A. Yes, I have it. May I make a
24 comment with respect to this?

25 Q. Certainly.



1 A. At HC8, looking at Exhibit H-660
2 where we have an entry being chloride in the shale
3 being in milligrams per kilogram, and looking down the
4 column looking for HC8 we have an entry of 60 for the
5 first entry being sample 3, and we note that that
6 corresponds as per the method calculated above to a
7 porewater concentration of 1400 and in going down to
8 the very bottom we have an entry for chloride in the
9 shale of 18 which corresponds to a chloride in
10 porewater again per the method described on this
11 exhibit as 430 milligrams per litre.

12 We noted, and I noted that there are
13 inconsistencies or exceptions and you noted that also.
14 We did not at that time try and relate that to the
15 chemistry of the rock or the water in any fashion with
16 respect to your exhibits. I am noting that while the
17 chlorides in this borehole are generally in excess of
18 5000 and the tritium values are all less than the
19 values delineating...

20 Q. The tritium values you will see up
21 there?

22 A. ... pre and post-1952 water, i.e.,
23 all the tritium values indicate older water, and these
24 two instances of chloride levels in the rock which
25 would suggest that the porewaters at those locations



1 have lower chloride concentrations.

2 Q. But the water that was sampled had
3 very high chloride concentrations?

4 A. The water that was sampled came
5 from different intervals over which the calculated
6 values are provided, yes.

7 Q. They were very high?

8 A. They were in excess of 5000, I
9 believe.

10 Q. Again, don't we have the situation
11 even where we find upward gradients at HC8, given the
12 fact we also find high chlorides and low tritium, don't
13 we have at HC8, relating the gradient data to the
14 chloride data to the tritium data to the geological
15 data, a strong suggestion of a very sluggish flow
16 system at HC8?

17 A. Again I would point out the
18 inconsistencies I have just addressed. There are two
19 sections of that core for which the chloride
20 concentrations in the shale are markedly in contrast.
21 I might also point out that when we initially looked at
22 this data I was bearing in mind the section of the Trow
23 report, being H-40, that addressed the chloride
24 concentration in the shale and if I could indicate to
25 you a portion of the text being on page 66 of H-40, and



1 I am referring to the second complete paragraph and the
2 complete paragraph says:

3 "In order to assess the potential of the
4 shales to be a source for direct
5 diffusion to chlorides, cores were
6 analyzed at HC7, HC8 and HC12 for
7 natural chloride content. Appendix
8 3(iv) shows the results of these
9 analysis. The chemical data shows no
10 correlation between in-situ shale and
11 groundwater chloride concentration."

12 When I read that I was of the opinion that Trow had not
13 placed great weight on that data for their interpretive
14 thoughts on this site and I was critiquing the report
15 and I also did not place great weight on that data.

16 You have now provided me with an
17 analysis that suggests there is something meaningful in
18 that data as part of your hypothesis. I have looked at
19 that data, albeit in a preliminary fashion over the
20 weekend, and these inconsistencies as I related them at
21 HC8 come to mind but I do not know what they mean.

22 Q. I haven't looked at anything as
23 part of any hypothesis. I am suggesting that Trow is
24 not in the witness box right now and I am putting to
25 you a question as to how to relate data that we have



1 MR. HODGSON: Thank you.

2 MR. LANCASTER: Thank you, ten minutes.

3 ---Recess

4 MR. LANCASTER: Please be seated.

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6 the record and my friends that I believe this witness
7 is quite correct in saying that the interrogatories
8 clearly request pumping test data which he has not been
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20 difficult to do.

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22 was a photocopy place down the road, it might not be
23 too difficult to do, but it is not short.

24 Q. Now, Mr. Petrie, could I ask you
25 to turn up your copy of the plan view of Site F



1 Q. In your experience as a
2 hydrogeologist, have you ever come across a situation
3 where there were no inconsistencies?

4 A. I have not, and I have also not
5 dealt at great length with a complex site in which the
6 fracture geometry to my mind has not been delineated
7 and I am asked to make interpretations regarding what
8 it all means.

9 MR. LANCASTER: Mr. Hodgson, would this
10 be an opportune time?

11 MR. HODGSON: It would if I can make
12 one reference because we are leaving HC8-85.

13 Q. Could I ask you to refer to the
14 profile, the RQD profile which you will find at the
15 back of H-206?

16 MR. PETRIE: A. I see it, yes.

17 Q. And I would suggest to you that
18 the RQD profile confirms what we see in Exhibit H-673,
19 that we have down this borehole runs of very competent
20 rock.

21 A. The RQD profile is the RQD
22 profile, yes. Are you asking me to confirm ...

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24 are runs of very competent rock?

25 A. In portions of the rock, yes.



1 from HC4 must travel vertically through even more rock
2 than any leachate that escapes at HC4-85?

3 A. Well, I ...

4 Q. There is a vertical elevation and
5 another 29 metres of rock between the base of the
6 landfill at the top of Site F and the base of the
7 landfill at HC4-85, right?

8 A. Correct.

9 Q. Leachate that escapes the leachate
10 collection system at the top of the landfill and which
11 is making its way vertically through the rock just to
12 get to HC4-85 must travel vertically 29 metres?

13 A. Yes.

14 Q. Right. In order to get to HC11 at
15 79 metres it must travel vertically 91 metres?

16 A. HC11 is an elevation of 79 and
17 that looks about right.

18 Q. 91 metres?

19 A. 89.

20 Q. 89 metres?

21 A. Give or take approximately 90.

22 Q. From HC4-85 to HC11-85 it has got
23 to travel 40 and 20 or 60 metres?

24 A. Which were the two numbers you
25 just said, 4 and 11?



1 presented in B-617, page 19. I just wanted to indicate
2 for you, Mr. Petrie, and the Board, that what we have
3 been looking at today are core records and other data
4 relating to five boreholes on proposed Site F and they
5 are HC4, HC3, HC6, HC5, and HC8.

6 MR. PETRIE: A. And HC3 and 4 generally
7 run laterally midway across the site and HC5 and 6 are
8 generally midway from there to the bottom, the south
9 portion of the site, and HC8 at the south property
10 boundary.

11 Q. Do you have the regional cross-
12 section we marked up with vertical elevations the very
13 first day of your cross-examination?

14 A. We have it somewhere here.

15 Q. Please don't put those away as we
16 will need all of them.

17 A. Can I leave them here?

18 Q. Yes.

19 A. Is this the exhibit to which you
20 refer?

21 Q. Yes. HC4-85 is at an elevation of
22 139, the top of rock.

23 A. The ground surface at HC4-85.

24 Q. Looking at the plan view on your
25 page 19 any leachate that escapes Site F upgradient



1 not sure I would agree that a metre is thick.

2 Q. Would you agree a metre is a
3 metre?

4 A. Yes.

5 Q. For every borehole on this table
6 we have at least a metre of competent rock?

7 A. Competent with reference to the
8 few fractures that are real, yes.

9 Q. We have looked at the core logs
10 and they indicate that what is represented on this
11 table isn't all of the competent rock in each of the
12 cores that were developed in each of these five
13 boreholes?

14 A. I believe that to be the case.

15 Q. In other words, what you see is
16 some of what you get and there is more down below?

17 A. Yes, correct, and there is more
18 fractured rock as well.

19 Q. What we have then for these five
20 boreholes on-site are units of competent material
21 beneath proposed Site F at every one of the five
22 boreholes?

23 A. Yes.

24 Q. What we have at the bottom of HC4,
25 HC5, and HC8 are high chlorides?



1 Q. HC4 to HC11, 60 metres?

2 A. Yes.

3 Q. At HC8 down to HC11, it must
4 travel 35 metres?

5 A. Correct.

6 Q. In order to get to the discharge
7 zone, if there is a discharge zone at HC11-85, every
8 drop of leachate that gets out of this landfill system
9 has a bit of a vertical journey, wouldn't you agree?

10 A. Yes, a bit of a vertical journey.

11 Q. Now, let's look at the plan view
12 on page 19 for the five boreholes we have been
13 studying, HC4, HC3, HC5, HC6 and HC8?

14 A. I have those.

15 Q. Can we agree first of all and
16 would you first cast your eye across this table in
17 front of the Board, but we have samples from all five
18 boreholes and would you agree that for every one of
19 these five boreholes we have on this table a run of
20 very deep competent rock?

21 A. I don't know what you mean by
22 deep.

23 Q. Thick competent rock?

24 A. We are looking at some places of
25 only a metre as I recall and a metre is thick and I am



1 A. On that section.

2 Q. We have units of competent rock in
3 every one of the five boreholes and we have low tritium
4 data all the way down borehole HC8-85?

5 A. Yes.

6 Q. And we have high vertical
7 gradients, downward vertical gradients in every one of
8 these five boreholes?

9 A. We have downward vertical
10 gradients at all those locations except for the portion
11 of HC8 which you have indicated in yellow as the upward
12 gradient.

13 Q. Do you want to agree they are high
14 vertical gradients or shall we go to your Appendix A
15 and read the numbers?

16 A. They range from in excess of 0.5
17 to less than 0.1 and that is quite a range. I would
18 not use the word "high" with all of those numbers

19 Q. Let's go to your appendix and get
20 the numbers. HC3-85?

21 A. I am sorry, Appendix A?

22 Q. Appendix A in B-617.

23 A. I have it.

24 Q. From 1 to 2 we have a gradient of
25 0.5, a high gradient?



1 A. At the bottom of HC4, HC5 and HC8
2 we don't have chloride data from 3 and 6, as I recall.
3 The bottom of HC5 I am not so sure -- it is high and I
4 am noting that at the intermediate level at HC5 it is
5 1100 and at a similar elevation at HC4 it is nearly
6 9000.

7 Q. But at the bottom of each run we
8 have high chlorides?

9 A. For the three runs you mentioned,
10 yes.

11 Q. In fact, notwithstanding that you
12 see the chloride level at 108 metres approximately in
13 HC4-85 is a little lower than the others, you see at
14 HC4-85 the chlorides are 8970 at 108 metres?

15 A. Approximately 9000.

16 Q. The reality is that the bottom of
17 that borehole is still some 20 or so metres higher than
18 the discharge zone at HC11 being 79 metres?

19 A. It is higher, yes.

20 Q. We don't know how high the
21 chlorides might be below that?

22 A. Below the bottom of HC4 we do not
23 have a reading of chloride concentrations.

24 Q. We have high chlorides in the
25 three holes for which we have any chloride data at all?



1 red we have higher than 0.5 and where we see green we
2 have between 0.1 and 0.5 and I am suggesting even where
3 we see green on that scale, that most of those greens
4 are well above 0.1. Do you want to check them?

5 A. I don't need to. I can take that
6 as a given. Are you saying that 0.1 is high and 0.5 is
7 high?

8 Q. 0.1 is a high vertical gradient
9 and 0.5 is a higher vertical gradient and so there are
10 strong vertical gradients. What word would you use?

11 A. 0.1 is lower in a relative sense
12 than 0.5 and I indicated the point earlier that 0.1 is
13 a more steep gradient.

14 Q. But you agree that 0.1 is a strong
15 vertical gradient?

16 A. In a general sense.

17 Q. 0.5 is a stronger vertical
18 gradient?

19 A. In the general sense, yes.

20 Q. Stronger vertical gradients are
21 found where we have high permeability contrasts?

22 A. In a general sense, yes.

23 Q. Now we have high vertical downward
24 gradients in every borehole except you are right we
25 have an upward vertical gradient in HC8 and we have



1 A. I am using the word high because I
2 am under the impression you are using high in a
3 relative sense and 0.5 being high and smaller numbers
4 being lower so 0.1 is a high gradient.

5 Q. A high vertical gradient in that
6 borehole and that is between piezometers 1 and 2 and
7 for piezometers 1 to 3 it is 0.48 and for piezometers 1
8 to 4 it is 0.47?

9 A. We don't have an entry for
10 piezometer -- I just put a scale on that line from
11 piezometer 1 to piezometer 5.

12 Q. 1 to 5 is 0.47?

13 A. Correct.

14 Q. Between piezometer 1 and
15 piezometer 5 we have high vertical gradients in that
16 borehole?

17 A. Averaged between piezometer 1 and
18 piezometer 5 and the value is nearly 0.5 downward.

19 Q. Look at HC4-85 and don't we see
20 the same pattern of high vertical gradients in the
21 borehole?

22 A. We do, except it depends upon over
23 which vertical interval you are looking at.

24 Q. I understand that, but that is all
25 plotted on H-668 and the point being wherever we see



1 conclusion that at Site F there is very poor vertical
2 connection between the shale at the top of the rock and
3 the shale at the bottom of the rock, and I mean
4 vertical hydraulic connection?

5 A. Do you mean the top of the rock
6 being approximately the bedrock surface and the bottom
7 being the deepest piezometer?

8 Q. Yes.

9 A. Yes, there is not a good
10 connection between the top of the rock and 30 or so
11 metres of depth being the general depth of the deepest
12 piezometer.

13 Q. From this data wouldn't you agree
14 it would be extremely difficult to extrapolate there is
15 30 metres of rock with a horizontal hydraulic
16 conductivity of 2×10^{-4} ?

17 A. The value we used of 30 metres
18 came -- can I back up? The value of 15 metres was
19 better defined with respect to the pumping test
20 evaluations undertaken. We also noted that
21 Dr. Charlesworth had some difficulty in relating the
22 hydrostratigraphic conceptualization of Trow to the
23 site, and I believe his conclusion was that it was --
24 something like it was tenuous. I am of the opinion
25 that we have lateral and horizontal flow systems, and



1 high chlorides in the boreholes for which we have
2 chloride information and low tritium in HC8-85?

3 A. Yes.

4 Q. We have a lot of units of very
5 competent rock, some of which we are looking at now on
6 this table?

7 A. We do.

8 Q. Wouldn't you agree with me -- and
9 we have packer test results to suggest that we have
10 some units, where we have packer test information, we
11 have units of very low horizontal hydraulic
12 conductivity?

13 A. We have some units of low
14 horizontal hydraulic conductivity.

15 Q. Where we have those units of very
16 low horizontal hydraulic conductivity it is fair to
17 extrapolate that the vertical hydraulic conductivities
18 are even lower?

19 A. That is probably fair. We do not
20 have the measure for the vertical hydraulic
21 conductivity and we do not have an indication of the
22 incidence or openness of vertical fracturing within
23 this system.

24 Q. I suggest to you, Mr. Petrie, that
25 all of this information taken together leads us to the



1 any depth, it has to get to that depth?

2 A. Correct.

3 Q. In order to get to that depth it
4 must go through the rock above?

5 A. Or at some point upslope above.

6 Q. It must get down there somehow and
7 it must come from top to bottom?

8 A. Correct.

9 Q. It must move vertically?

10 A. Correct.

11 Q. Don't you agree that those high
12 vertical gradients suggest that moving vertically is a
13 very difficult activity for water or leachate at
14 proposed Site F?

15 A. Taking the gradients per se we
16 notice there was a contrasting gradient and there are
17 zones of horizontal flow. Yes, it is difficult to get
18 down there but on the other hand if you look at your
19 chloride data, and I am agreeing with the numbers, but
20 at HC4 you have pointed out between piezometer 3 and
21 piezometer 2 there is some low permeable rock and I
22 believe it was one of the length of rock you have
23 there, but we have low chlorides and I think we can
24 agree that a number of less than 50 is a low chloride.

25 I am indicating that a low chloride at



1 in fact we have a mixture of both within this site,
2 such that when we are looking at depth we have steeper
3 gradients and I do not know what the nature of the
4 vertical hydraulic connection is to depth.

5 We therefore postulated that if the
6 whole system could be simplified in a schematic form to
7 a horizontal flow field, what would it mean if that
8 flow field was relevant or eventuated to a depth of 30
9 metres. I took that 30 metres from Dr. Charlesworth
10 although as I recall when we first put it to him he had
11 considered a value of 25 metres.

12 It is difficult to provide a uniform
13 value for this site in any fashion. We choose to
14 schematize it in the simplest way we could to try and
15 come up with some opinions as to what the hydraulic
16 characterization of the site could be. I am not
17 particularly confident that our simple schematization
18 adequately represents the site at all. It is a
19 schematic.

20 Q. The rock, Mr. Petrie, is
21 horizontally bedded. Do you agree?

22 A. Close to horizontal, yes, and I
23 don't recall there was a number in H-40.

24 Q. Would you agree that before any
25 water or leachate can flow horizontally in the rock at



1 upslope, couldn't it?

2 A. It could.

3 Q. If you turn around and look at H-
4 645, if you have a zone in HC4-85 between 120 and 125
5 where you hypothesized there might be some horizontal
6 flow, in order to feed that horizontal flow with
7 leachate from upgradient, the leachate would have to
8 travel a fair distance vertically, wouldn't it?

9 A. It would indeed.

10 Q. It probably would have to travel
11 across that distance across a lot of competent rock?

12 A. I believe that that is a difficult
13 assumption to draw recognizing we have very low
14 chloride values below that competent rock. I think it
15 is implicit in your argument that this competent
16 rock ...

17 Q. I am not making an argument?

18 A. I believe you are. I believe it
19 is implicit in your statement that the competent rock
20 as you have defined it is laterally across the site and
21 that has not been established in my view in any way,
22 shape or form, and we could take a one metre portion of
23 rock as evidenced by some of the cores put before me
24 today and extrapolate that continuously across the
25 site.



1 this elevation, that elevation being 120 at HC4,
2 indicates that water has more recently infiltrated to
3 that depth than the depth we have at the bottom of that
4 piezometer and further, as you indicated to me with
5 reference to the borehole logs on the table, that above
6 that well screen we have a low permeable horizon of a
7 metre or something like that in thickness.

8 Recognizing there are these strong
9 contrasts in hydraulic conductivity, there are also
10 contrasts in the gradients such that we have zones
11 indicated by blue on Exhibit H-668 in which lateral
12 flow is probably more dominant than lateral flow in the
13 red zone and that water has got to that depth in some
14 fashion.

15 What I cannot tell the Board is in what
16 fashion it got to that depth and in what amount or how
17 long it took to get there. I only recognize it has got
18 below zones which are described as essentially
19 competent to use your word.

20 Q. Let me suggest to you that if
21 there is a zone of very competent rock above a zone
22 where there is horizontal flow, that that would suggest
23 the water is coming from somewhere to the north?

24 A. Upslope, yes.

25 Q. And it could be quite a piece



1 have used.

2 Q. We expect within the horizontal
3 bedding at this site some unity?

4 A. Lithologic unity, yes.

5 Q. If we look at HC3 and HC4 right
6 here on the table you will see HC3-85 and H-669 and box
7 3 from HC4-85. Can you see in each of these about a
8 metre of green rock?

9 A. Yes, I see that.

10 Q. Noting that the top of the rock in
11 each one of these boxes, HC3-85 is at 124 and the top
12 of rock here is at 125.21 -- 124.53, a difference of a
13 little under 70 centimetres in vertical elevation
14 between the top of each segment?

15 A. We are.

16 Q. Can you see therefore that the
17 green in these two boxes is roughly -- it correlates
18 roughly vertically?

19 A. It roughly does.

20 Q. That is as we would expect it, is
21 it not?

22 A. No, I would not expect it or
23 otherwise.

24 Q. If it takes 100,000 years to lay
25 down a metre of core, would you not expect in any given



1 Q. Let's put up the exhibit behind
2 you, the one with the green bars?

3 A. Exhibit H-667.

4 Q. Would you agree that if when we
5 studied the core logs and the cores we noticed that
6 there are units of core that appear to have very few in
7 situ fractures, that it is worthwhile to try and plot
8 those up on a cross-section?

9 A. And the other equally useful
10 exercise is to plot up rows on a cross-section for
11 which they are the most highly fractured intervals.

12 Q. You can't do one without the
13 other, can you? If you plot up the competent stuff, by
14 definition you have plotted up the incompetent stuff
15 because that is the stuff in between?

16 A. In a general sense yes, but I
17 think there are some portions of rock which you have
18 not coloured in for which there is no definition on the
19 legend and I am not sure that indicates a highly
20 fractured material.

21 Q. You have already agreed with me
22 that what we are looking at here is rock that probably
23 took something in the order -- did we say somewhere
24 around 100,000 years per metre to get laid down?

25 A. I believe that is the number we



1 much later times.

2 Q. Do I have it, Mr. Petrie, that at
3 Site D you are comfortable correlating between
4 boreholes for a bunch of gravel dumped off the end of a
5 glacier, but at Site F you are not comfortable
6 correlating between boreholes approximately equally
7 distant where we have between those boreholes rock that
8 took 100,000 years to get laid down by a sea, warm,
9 cold or otherwise?

10 A. With respect to the first point
11 dumped off the end of the glacier, you are talking
12 about meltwater conditions for the granular units at
13 Site D and is that what I am led to understand?

14 Q. Crudely, yes.

15 A. I have noted that for Site D there
16 are granular units which occur and the occurrence of
17 those granular units is based on the lithologic
18 description of materials. We are not looking at
19 interpreting the hydraulic characteristics from a
20 lithologic description but we are noting lithologically
21 they exist. Where we do not find it in a borehole, I
22 am indeed comfortable in suggesting it is not there and
23 recognizing that for the 84 series boreholes at Site D
24 we had a less continuous sampling frequency than in
25 1985.



1 metre of core there would be some relationship between
2 the materials laid down over the bedding plane from
3 borehole to borehole during the 100,000 years?

4 A. Your question relates to the
5 occurrence of the green colour?

6 Q. Yes.

7 A. In a general sense one may extract
8 that.

9 Q. We could expect, could we not,
10 that where we find units that are very -- hardly
11 fractured at all or not fractured for some metre or so
12 distance, there may be some geological difference --
13 there may be some difference in the material make-up of
14 those units and the units which are more highly
15 fractured?

16 A. There may be or may not have to
17 be. It does not have to be a direct relationship. The
18 occurrence of fracturing within this rock mass is a
19 secondary feature as the fractures were not necessarily
20 laid down and that is not the best way to describe it
21 with the rock in question. There have been some
22 movements in the rock mass some of which may have been
23 in sediment structure soon after deposition which would
24 give rise to some of the fracturing we see before us
25 and some of the fracturing may have been developed in



1 you have provided. Let's start at elevation 120 for
2 HC4 where we have a chloride level of 47. We note
3 there is no till overlying HC4. Going downgradient to
4 MB1, and that is not a borehole you referred to. Let's
5 refer to the chloride at HC5. At an elevation of 110
6 we have approximately 1100. At a similar elevation for
7 HC4 we have 9000. That to me does not indicate any
8 degree of lateral connection based on the chloride
9 values. The question arises, then, what is the rock
10 fractures doing but I do not know.

11 Q. It wouldn't be inconsistent with
12 this whole suggestion that water can't get down at Site
13 F with the fact that those 47 chlorides are exactly 47
14 at exactly that level in HC6. The fact you have a
15 continuous horizontal fracture across this entire site
16 through these massively bedded units of shale is not
17 inconsistent with the fact that we have massively
18 bedded units of shale and water can't travel
19 vertically.

20 I suggest that you can't look at data
21 about horizontal flow and interpret from that data
22 about vertical flow?

23 A. You have made a number of
24 statements and you lost me on the first one. I thought
25 you indicated we had a chloride of 47 in HC5 and I got



1 At Site F I am not so comfortable
2 correlating the colour changes within the rock. It is
3 my expectation those colour changes are probably a
4 function of the lime content or the carbonate content
5 in the rock, such that it might have been deposited in
6 slightly deeper water than the reddy occurrences. I am
7 not entirely sure that one can correlate them with
8 comfort and indeed I do not know. A geologist would or
9 someone else may feel more comfortable with it.

10 Q. Look again at the plan view on
11 page 19 of your own report. We have five fairly
12 equally spaced boreholes and at all five boreholes we
13 have strong downward vertical gradients. If we only
14 had strong downward gradients at one borehole or two
15 boreholes and we had very weak vertical gradients at
16 other boreholes that would suggest that where water got
17 hung up at one or two of the boreholes it could get
18 down at the others?

19 A. You could conclude that.

20 Q. But when you have five boreholes
21 and you only have five boreholes and at every one of
22 the five all the water gets hung up, how can you
23 conclude anything other than that water can't get down
24 at Site F? You can't conclude anything else?

25 A. I can. Look at the chloride data



1 exactly where the water is going at this site.

2 Q. It is not going up, is it?

3 A. I can agree with that.

4 Q. It is not going north?

5 A. No, it is not.

6 Q. It is going south?

7 A. In a general sense, in the
8 horizontal plane it is.

9 Q. If it wants to get to the
10 discharge zone at HC11, it has got a long piece to go?

11 A. It does.

12 Q. And it has a lot of vertical
13 travel to engage in?

14 A. It has.

15 Q. Everywhere we look at vertical
16 travel in the rock what we see are very strong vertical
17 gradients suggesting very slow movement of water
18 vertically, do you not agree?

19 A. Relative to the horizontal, yes.

20 Q. Therefore that would suggest that
21 if you put a landfill on Site F the leachate can't get
22 down very easily, don't you agree?

23 A. Again I refer you back to the
24 chloride data which you asked me to review and I did
25 indeed. We have low chlorides below competent rock and



1 hung up in that and missed the rest of your statement.

2 We have 47 at HC4.

3 Q. We have 47 at HC4.

4 A. Correct.

5 Q. Do you want to hang your whole
6 interpretation on one seemingly anomalous piece of
7 data?

8 A. Which was the seemingly
9 anomalous ...

10 Q. We have five boreholes and all
11 have strong vertical gradients and all of them have a
12 lot of competent rock and most of them have high
13 chlorides at the bottom and do you want to suggest
14 because we have 47 chlorides at piezometer 2 at HC485
15 that we therefore have a free flow zone at Site F?

16 A. I don't know what you mean by a
17 free flow zone.

18 Q. Your unit of 30 metres of rock
19 with a horizontal hydraulic conductivity of 2×10^{-4} ?

20 A. I indicated we had difficulty, and
21 in fact we have been unable to delineate at any one
22 point is the dominant flow horizontal or vertical
23 except for the few points where we feel based on the
24 pumping test data we have significant horizontal
25 hydraulic conductivities. I cannot indicate to you



1 section for chlorobenzene, para-dichlorobenzene and
2 that interesting cross-section we had at -- for the
3 Bayview site that came from the Geocon report. We have
4 a para-dichlorobenzene and it is satisfactory I think
5 to leave it there.

6 A. I believe this is the one you
7 referred to as interesting. We have the chlorobenzene
8 and where would you like this?

9 Q. We might have to have Mr. Crutcher
10 hold something. So let's leave that down for a few
11 minutes. Let's take this one down and put up some data
12 on vertical hydraulic gradients and the line goes from
13 Bayview down to south of the site.

14 MR. McQUAID: Has the witness seen this
15 before?

16 MR. HODGSON: No.

17 Q. You will recall, Mr. Petrie, that
18 last week we were taking an interest in the tritium
19 data and the chloride data in MB1 and there was a
20 suggestion I put to you which was ...

21 MR. PETRIE: A. The chloride data for
22 MB1?

23 Q. Right here. It is not easy being a
24 hydrogeologist.

25 A. I find taking myself through 360



1 what does that tell me about the competent rock at that
2 point, and the point I am referring to is between
3 piezometer 2 and 3 at HC4. It tells me that the
4 competent rock is perhaps discontinuous or there is
5 pronounced vertical fracturing through it. I am not
6 entirely comfortable in correlating coloured rock
7 between one borehole and another and assuming there is
8 no vertical connection across that.

9 Q. Your one anomalous data point,
10 Mr. Petrie, piezometer 2...

11 A. It is not my anomalous data point.

12 Q. Piezometer 2 at HC4-85 and I
13 suggest it could have taken thousands of years to flush
14 the chlorides out at that point?

15 A. I believe with your hypothesis
16 which you started out with last week, low chlorides is
17 much more rapid flushing.

18 Q. I asked the question and I
19 suggested to you that it could have taken thousands of
20 years to flush out the chlorides at that level, and do
21 you agree?

22 A. I don't have an answer. When we
23 are down to chlorides which are that low, I am not
24 sure.

25 Q. Could you put back up the cross-



1 that appear to have migrated through the shale and they
2 appear to have gotten as far down as the second
3 piezometer and have been unable to get lower?

4 A. Assuming they were just moving
5 vertically, essentially that is correct.

6 Q. We were correlating that with the
7 chloride data?

8 A. We did that exercise.

9 Q. And the tritium data?

10 A. We did that exercise too.

11 Q. Let's correlate it as well with
12 the vertical gradients at MB1. What do we find in the
13 way of vertical gradients below the second piezometer
14 in MB1? I have forgotten, are the MB piezometers
15 numbered from the top or bottom. They are numbered from
16 the top.

17 A. The second piezometer down from
18 the top, MB2, and there is an entry of red colouring
19 being downward greater than 0.5. Was that your
20 question?

21 Q. So we have a high vertical
22 gradient between the second piezometer and the third
23 piezometer?

24 A. Downwards we do.

25 Q. And a high vertical gradient



1 degrees is a bit difficult. I am sorry.

2 Q. What we got to last week was an
3 agreement that there appeared to be a zone of sluggish
4 flow at the toe of the Bayview landfill site in the
5 vicinity of MB15 and MB1?

6 A. I recall something to that effect.

7 Q. In fact we were trying to
8 correlate that with data we had about para-
9 dichlorobenzene in MB1 being hung up in the third
10 piezometer and not being able to get down lower?

11 A. I am sorry, you mean the second
12 piezometer?

13 Q. How many piezometers do you count?

14 A. I beg your pardon, I do see four
15 and hung up in the second and not being able to get
16 lower and you are relating that back to the chloride
17 occurrence we had over here and I do recall that.

18 Q. In fact we had the same situation
19 with para-dichlorobenzene and it was hung up in the
20 second piezometer?

21 A. Yes, where I have written shale
22 against the entry of 1.5.

23 Q. We had the peculiar situation that
24 right at the toe of the landfill, because MB1 is right
25 at the toe of the landfill, we have got contaminants



1 one down -- the second one down if there are three in
2 this nest.

3 Q. You will recall MB15 was cored
4 through the garbage at Bayview?

5 A. I recall.

6 Q. Into the shale?

7 A. Yes.

8 Q. And whatever else was above the
9 shale. If we were going to expect contaminants to move
10 into the shale and go somewhere at the Bayview landfill
11 site we would expect them to go out the bottom when
12 they are sitting on top of the shale right at this
13 borehole; right?

14 A. They may.

15 Q. What we see when we look at para-
16 dichlorobenzene is in the piezometer where we have 499
17 chlorides we don't have any chlorobenzene and we don't
18 have any para-dichlorobenzene?

19 A. We haven't sampled those
20 piezometers.

21 Q. I am sorry, Mr. Feenstra was
22 telling me that it wasn't sampled. In the bottom
23 piezometer, however, we had para-dichlorobenzene that
24 was 1/100th of a part per billion above background?

25 A. That is as you have indicated from



1 between the third piezometer and the fourth piezometer?

2 A. It is much less steep and it is
3 0.1 to 0.5.

4 Q. But you have agreed those are
5 strong vertical gradients?

6 A. In a relative sense and less
7 strong than the red ones.

8 Q. But strong vertical gradients in
9 any context?

10 A. Yes, but less strong than the red
11 ones.

12 Q. But that really goes without
13 saying because 0.1 is a weaker gradient than 0.5 but
14 0.1 is a strong gradient so 0.5 is a stronger gradient?

15 A. Yes, but you were using the same
16 adjective for both and I was choosing to distinguish.

17 Q. At MB15 we had a situation where
18 we had in the second piezometer -- I can't tell from
19 here?

20 A. I can look a bit more closely. I
21 am having trouble reading it. I imagine it is the
22 second piezometer.

23 Q. At the piezometer where we had 499
24 chlorides?

25 A. I believe that would be the third



1 MR. McQUAID: Let the witness finish.
2 It is apparent that what Mr. Petrie is encountering is
3 a new report. We are now up to whatever number of
4 schedule it is in correlation and this is not Trow data
5 -- Trow data, but it is a completely different
6 hypothesis. I think Mr. Petrie is entitled to look at
7 the 6 or 5 or 4 correlations that Mr. Hodgson asked him
8 to look at and then think about it. Mr. Hodgson won't
9 let him finish his answer again.

10 I would ask you direct he do it and also
11 be given the opportunity if he needs it to examine this
12 document or any other document. One thing I do insist
13 on if there is to be data which was requested such as
14 this pumping data that is to be cross-examined on
15 tomorrow, Mr. Petrie be given it tonight and not
16 tomorrow when he is in the witness box. This is the
17 111th day ...

18 MR. HODGSON: Taking those points in the
19 reverse order to that in which they were made, I would
20 certainly give the witness the opportunity to review
21 the pumping data and I thought I said that previously.

22 Secondly, as for the new data or the so-
23 called new data, most of this data came out of his
24 report and if it didn't come out his report it came out
25 of all the other exhibits. Now, Mr. McQuaid, you made



1 the legend of Exhibit H-661, yes.

2 Q. We had higher chlorobenzene and
3 you have put a question mark beside that higher
4 chlorobenzene reading?

5 A. I believe you asked me to.

6 Q. In the lowest piezometer we have
7 chlorides of 19,300?

8 A. We do indeed.

9 Q. Do we not see again in MB15 a
10 pattern of relating high chlorides and high vertical
11 gradients? At the bottom of a hole where we have very
12 high vertical gradients we have very high chlorides?

13 A. In a general sense, yes.

14 Q. "In a general sense?" What about
15 in a specific sense. We have two boreholes, MB1 and
16 MB15, and each has high vertical gradients and at the
17 bottom we have high chlorides. What is general about
18 saying where we have high vertical gradients at two
19 boreholes we also have high chlorides and there is
20 nothing general about that?

21 A. We also have high vertical
22 gradients to use your word at HC4 where we don't have
23 the high chlorides.

24 Q. There are high chlorides at the
25 bottom?



1 amazed that Mr. McQuaid for thinking there was anything
2 new about it, amazed.

3 Finally, and I can't remember your first
4 point other than I did interrupt the witness and for
5 that I apologize both to the Board and the witness,
6 because I do want to hear his answer.

7 MR. LANCASTER: Let him answer
8 completely.

9 MR. MCQUAID: I have not objected to the
10 presentation of these cards because it is data that has
11 been put into evidence, but it is not just the content
12 of the data that the witness must deal with but the
13 form in which it is presented.

14 Now, when I say we are getting a new
15 report in terms of forms of cards, it is being
16 presented in a different way and it was not presented
17 in the Trow report or we wouldn't have had all these
18 cards. As a matter of fact perhaps it should have been
19 presented in that particular form if that is what the
20 Region is relying on, but now that it is being
21 presented, the witness is entitled to an opportunity to
22 think through 6 or 5 or 4 cards, whatever it is, and
23 you have seen what he has had to do with Mr. Hodgson's
24 questions and then when he gets to the point of saying
25 I want you to correlate the sixth item he is not being



1 your submission and I get to make mine and you can
2 respond. This data is all in evidence and it has been
3 plotted up on cross-sections because it tells a story.
4 Mr. Petrie has gone into the witness box and what we
5 have heard from Mr. Petrie for three weeks, is Site F
6 is complex, and Site F -- what's his other word -- it
7 is uncertain, and Site F and what was the word -- is
8 heterogeneous. I am suggesting that Site F can be
9 understood and it can be understood with the data we
10 have, particularly if you set about trying to
11 understand the data we have and this is all old data
12 and we are looking at very old data and correlating
13 very old data and there is nothing new here. To the
14 extent we have any new data at all it comes from the
15 sampling CRA did in their own 1988 monitoring and no
16 one has objected to them putting that into evidence.

17 To go back to one other point
18 Mr. McQuaid made, this is not a new report and not a
19 new hypothesis. There is nothing new about the
20 suggestion that there is a unit or units of massive
21 shale here that prevent the vertical flow of leachate
22 from Site F. That is the Trow hypothesis and that is
23 what it is all about. Leachate can't get down because
24 the rock is competent and therefore something else has
25 to happen. There is nothing new about it and I am



1 cards or correlating up to the sixth item or whatever
2 number we are at, I think the witness is entitled the
3 opportunity to look at them and be given more of an
4 opportunity to answer the questions.

5 MR. LANCASTER: I would agree with that.
6 There is a great deal of information and data here and
7 it may be old data but it is mind boggling at times,
8 particularly for the witness, but he should have time
9 to consider it fully.

10 MR. HODGSON: I agree, Mr. Chairman, but
11 with this particular exhibit which I regret we have not
12 marked because I was simply going to concentrate on two
13 data sets, MB15 and MB1 and leave it there and come
14 back to the other data on it at a later date. I do
15 appreciate it is difficult, it is a difficult exercise
16 to correlate all this data, but this witness came to
17 say that the data didn't make any sense and I don't
18 think he has any choice but to stand up there and
19 correlate the data because I suggest when he correlates
20 the data it does make sense and I think it can be seen
21 by everyone in the room that it does make sense.

22 I know it is difficult and time
23 consuming an exercise, and I apologize for the time it
24 has taken, but I do think in the context of what has
25 been attempted by way of attempting to obscure any



1 allowed to answer the question and I say he should be
2 given the opportunity to do so. It is the form of the
3 data which is coming in a new, completely new form
4 every 15 or 20 minutes or every half hour.

5 I say the witness is entitled to be
6 given an opportunity to digest that. It is now up to
7 the point of check this, check this and check that and
8 we are up to the 12th, 13th or 14th new card that must
9 be checked and the witness is entitled to look at the
10 colouring, the legend, and none of this is Mr. Petrie's
11 evidence or colouring. He has to isolate where they
12 are and relate them back to the others and I say it is
13 getting to be oppressive, particularly if counsel will
14 not allow him to answer the question being put and the
15 witness is entitled to a full opportunity. To the
16 extent he says this is Trow's theory the record -- I
17 won't argue the case at this particular point, but I do
18 note that when Dr. Kingham asked him earlier to
19 correlate these various cards to the dashes which are
20 the hydrostratigraphic units which are on the Trow
21 report, Mr. Hodgson distanced himself from that and
22 asked that that exercise not be undertaken so we are
23 into some different theory, but we can argue it later.

24 In any event, what I am saying is if
25 there is to be a number of new cards or additional



1 chlorides."

2 MR. PETRIE: My response was we have
3 high vertical gradients, and we have high chlorides and
4 my response was in a general sense yes. You asked me
5 why I used the term general and I indicated that the
6 most obvious inconsistency is at HC4-85 and that is why
7 I can agree in a general sense, yes, where there are
8 high gradients there are high chlorides.

9 MR. HODGSON: Q. I don't want to
10 continue long because it is time for the Board to rise.

11 MR. PETRIE: A. We should make a note
12 for the record that H-674 was the Bayview landfill
13 vertical gradients.

14 ---EXHIBIT NO. H-674: Chart-Bayview Landfill
vertical gradients

15 MR. HODGSON: That is a cross-section
16 south from the Bayview landfill.

17 Q. Mr. Petrie, again looking at --
18 could you put up M-437-D5. You will recall I asked you
19 last week to put a blue line across above piezometer 3
20 in MB1 where we found chlorides above 15,100?

21 MR. PETRIE: A. Correct.

22 Q. Can you indicate for the Board
23 where does that blue line intersect MB11?

24 A. MB11, the blue line intersects
25 almost at ground surface, a metre or two below ground



1 meaningful interpretation of the data at Site F but I
2 have no choice but to put before this Board the fact
3 that the data can be interpreted and can make sense.

4 DR. KINGHAM: The point is that when he
5 is confronted with a new format, at that point he must
6 have the opportunity to consider it as he answers the
7 question and I think that's the only point.

8 MR. HODGSON: Yes.

9 Q. I interrupted you and it would be
10 a miracle if you knew what you were saying and would
11 you like the reporter to take you back and get the
12 question and the beginning of the answer?

13 MR. PETRIE: A. I would appreciate your
14 question again?

15 Q. I couldn't begin to tell you what
16 it was.

17 THE REPORTER: (Reading back) "Q.
18 'In a general sense?' What about in a specific sense.
19 We have two boreholes, MB1 and MB15, and each has high
20 vertical gradients and at the bottom we have high
21 chlorides. What is general about saying where we have
22 high vertical gradients at two boreholes we also have
23 high chlorides and there is nothing general about that?

24 A. We also have high vertical gradients
25 to use your words at HC4 where we don't have the high



1 Q. I am asking you to agree that it
2 is possible that what is happening at the Bayview
3 landfill site is that leachate that exits the bottom of
4 that landfill site can't move in volume vertically
5 because of the low vertical hydraulic conductivities,
6 some evidence for which I suggest we find at MB1 and
7 MB15, and as a result they move horizontally in a
8 southerly direction and because the shale is
9 horizontally bedded it exits on the NSP lands in the
10 area to the north -- in the area above the blue line?

11 A. You are asking me to agree that
12 the fracture zones are all horizontal and I can't
13 agree.

14 Q. I didn't ask you if the fracture
15 zones were all horizontal. I asked you what is
16 happening to the leachate at the Bayview landfill site
17 and I am asking you, isn't it likely, isn't it possible
18 -- let's start with possible; isn't it possible that
19 what is happening at the Bayview landfill site is the
20 leachate that manages to escape at the bottom of that
21 landfill can't travel vertically any real difference
22 because of the low hydraulic conductivity, so it moves
23 horizontally in a southerly direction and exits on the
24 NSP lands to the south?

25 A. I cannot agree specifically with



1 surface at MB11 and I believe I have drawn that line
2 horizontally.

3 Q. Could you check in MB11 in the top
4 piezometer do we find both para-dichlorobenzene and
5 chlorobenzene. You will find chlorobenzene behind the
6 exhibit?

7 A. Looking at Exhibit H-661 with
8 respect to the para-dichlorobenzene, we see an entry
9 for MB11 at the uppermost piezometer and we also have
10 an entry there with respect to chlorobenzene, Exhibit
11 H-665.

12 Q. 3.4.

13 A. That is the value, yes.

14 Q. Would you agree with me that it is
15 possible that what is happening at the Bayview landfill
16 site is that the Bayview landfill site is underlain by
17 massive shales with such a low vertical hydraulic
18 conductivity that when leachate moves out the bottom of
19 the Bayview landfill site it ends up for the most part
20 flowing horizontally and emerging on-site in that area
21 above the blue line, M-437-D5?

22 A. Are you asking me to agree that
23 that blue line has some kind of stratigraphic or
24 hydrogeological control? We drew that blue line on the
25 basis of a chloride occurrence at one well, MB1.



Nethercut & Co. Ltd.

Toronto, Ontario

28339

Crutcher, Petrie
cr ex (Hodgson)

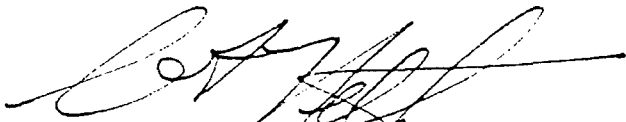
1 ---Adjournment at 4:35 p.m.

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3 Certified Correct

4

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C. F. Nethercut, C.V.R.

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7 (Page 28400 follows)

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