CONSOLIDATED HEARINGS BOARD

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

— and —

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

— and —

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

— and —

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

— and —

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

— and —

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

— and —

IN THE MATTER OF Section 22(1) of the Planning Act, 1983 in connection with a referral to this Board by the Honourable Bernard Grandmaitre, Minister of Municipal Affairs, on a request by the Regional Municipality of Halton to amend the Official Plan for the Town of Milton to redesignate a parcel of land comprising Part Lots 3 and 4, Concession 2 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 Claude F. Bennett, Minister of Housing on a request by Tremaine Britannia Citizen's Group for consideration of part of the Official Plan for the Halton Planning Area with respect to Sections 1 to 5 inclusive, 7, 9 and 10 of Part III D3 Solid Waste Management, Minister's File No. OPC-0026;

— and —

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

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

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

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

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

— and —

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

— and —

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

— and —

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

VOLUME: 123 (Pages 29650-29837)

HELD AT: Oakville, Ontario

DATE: April 13, 1988

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I N D E X

WITNESSES:

E X H I B I T S

THE CONSOLIDATED HEARINGS BOARD

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APPEARANCES (Cont'd):

C. Stevenson P. Hancock	for Framgard Holdings, Fosseri Investments Limited, Seriphos Investments Limited and Topic Investments
J.H. Olah	for the Halton Region Conservation Authority

* * * * * *

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185 Richmond St. W.
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Per: C. F. Nethercut, C.V.R.

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

MR. LANCASTER: Good morning. Thank you. Please be seated.

ANTHONY J. CRUTCHER, (resumed):

JOHN M. PETRIE, (resumed):

CROSS-EXAMINATION BY MR. ESTRIN (cont'd):

Q. Mr. Petrie, I wonder if you could up the overhead, Exhibit M-709.

MR. PETRIE: A. Excuse me, I'll just be a minute.

DR. KINGHAM: I hope the difficulties getting started aren't a reflection of triskaidekaphobia.

MR. PETRIE: What is that?

DR. KINGHAM: A fear of thirteen. Today is April 13th.

MR. ESTRIN: Q. Okay. Looking at the overhead of Exhibit M-709, and looking at the bottom of that exhibit page, we have tried to set out the hydraulic conductivities considered by various people who have expressed or considered these matters so far at the hearing. Looking at the column 1.4×10^{-8} centimetres per second, you certainly brought that number to the Board.

- and -

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

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

Dr. D.J. Kingham - Member

Netherclift & Co. Ltd.
Toronto, Ontario

Hearing conducted at The Oakville Granary Commercial Centre, 105 Robinson Street, Oakville, Ontario, on Wednesday, April 13, 1988.

VOLUME 123

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

MR. PETRIE: A. That is correct.

Q. Dr. Rowe did not consider that?

A. That is correct.

Q. Neither did Mr. Sobanski?

A. I don't think Mr. Sobanski had an opportunity to consider it before the Board.

Q. And Mr. Feenstra wouldn't have considered that?

A. He did not address hydraulic conductivities at Site D, and I believe Mr. Hodgson spoke to that yesterday.

Q. On the assumption that that is the evidence, I would be happy to ask every one to delete Mr. Feenstra's name. I don't have a clear recollection at this time of whether or not he addressed hydraulic conductivities at Site D, and if Mr. Hodgson is saying, as he said yesterday, that Mr. Feenstra did not express an opinion about that, or did not model based on any of these numbers, then it would be fair to delete his name, but if he expressed an opinion or modelled on these numbers, it seems it is fair to leave his name there.

MR. HODGSON: I don't think I should have to make a representation in that direction.

Certainly the qualification on the model, I suspect he did model using the hydraulic conductivity numbers, and perhaps it would be more appropriate for Mr. Estrin to indicate in summarizing the data what exactly he is summarizing for the record and then we would have an understanding. I don't want to stand on formalities, but there is a difference between argument and evidence and the difference is that argument is what lawyers say the evidence is and evidence is what the transcript says the evidence is.

MS. CRONK: They are always the same.

MR. HODGSON: They are always the same, I am told by Ms. Cronk. I might quote her later on that as well. I don't know, and I don't want to hamper my friend's cross-examination, but at the same time I would like him to indicate for the record what he is doing in putting this portion of the document to the witness.

MR. ESTRIN: All I am asking the witness to look at and agree to is whether it seems the various witnesses named have considered these hydraulic conductivities in assessing the impact on Site D. I am not going into any detail as to what they said, but whether or not any of these numbers seem to have been considered.

Q. Mr. Petrie, you reviewed all the information and reviewed -- you were here for almost all the hydrogeological testimony?

MR. PETRIE: A. That is correct.

Q. We have reviewed the transcripts and I am trying to get your help on what cases have been considered.

DR. KINGHAM: And I guess by whom they were considered and that is the issue here.

MR. ESTRIN: Yes.

DR. KINGHAM: Our recollection is that Mr. Sobanski was involved in the preparation of H-39 as was Mr. Beechinor and Mr. Sobanski as the hydrogeologist produced a mean of the order of 8.0×10^{-8}, but I can't recall that Mr. Feenstra produced that number or that he commented on the validity of the number, although he may have used it, I don't recall in his modelling, and maybe it would be best to credit that number to Mr. Sobanski rather than Mr. Feenstra.

MR. ESTRIN: I would be happy to do that.

MR. PETRIE: Shall I delete the name Feenstra from that exhibit?

MR. ESTRIN: Q. Yes, sure. With that

amendment and looking at 1.4×10^{-8}, CRA was the only one to consider that as an appropriate number to consider the impact on Site D.

MR. PETRIE: A. Correct but that number was generated after Mr. Sobanski had completed his testimony before the Board.

Q. Let's look at the column of 8.0×10^{-8}. That was a geometric mean produced -- well, what is your recollection?

A. It is a number produced by Trow from their own interpretation of their data regarding the unweathered upper till for Site D.

Q. Do you recall that Dr. Rowe did consider it?

A. Yes.

Q. And you did not?

A. That is not correct.

Q. You did not consider it in your report?

A. I believe we stated in-chief that we felt the 1.4×10^{-8} was the most representative and that 8.0×10^{-8} was a conservative number.

Q. In your report, you did not consider it, but in evidence you are now asking it be considered?

A. We have considered it all along.

Q. So we should change the no to a yes?

A. That is correct.

Q. The 4 x 10^{-7}, and Mr. Sobanski did not consider the impact at Site D based on that?

A. That is my understanding, yes.

Q. Dr. Rowe did use that number in his modelling?

A. He used that in his deliberations.

Q. I am not sure. Are you quarrelling with the word "modelling"?

A. He used a variety of numbers and I am not sure which he was hanging his hat on.

Q. I am asking you if he used that number?

A. He used that number in the model, yes.

Q. And your firm did not?

A. That is correct. We did not do any modelling at Site D.

Q. You did not consider that hydraulic conductivity as being a relevant one?

A. That's correct.

Q. Let's look at 8.0 x 10^{-7}, and

again Mr. Sobanski did not consider that value?

A. That is correct, as I recall.

Q. Dr. Rowe did?

A. That is also correct.

Q. And your firm did not?

A. That is correct.

Q. With those two amendments, you can agree with the data in Exhibit 709?

A. Yes.

Q. Thank you. Now, would you bring the overhead back down. Comparing -- you summarized, comparing the results of your lab tests in your Waterloo exercise to the pump test values, it produced differences of between two and three orders of magnitude, fair enough?

A. That is the numerical difference between the numbers there, yes.

Q. The results of the Hvorslev and the pump tests in Waterloo again produced differences in the range of two to three orders of magnitude, approximately?

A. Approximately.

Q. That was in a situation where the clay content was as reported by Dr. Karrow, 54 per cent for that kind of unit?

A. Yes, and there was considerable variation in the unit.

Q. Subject to local variation?

A. Yes.

Q. The Illinois work which is summarized at the top of Exhibit M-709 also demonstrated fracturing in a till considered to be basil and unweathered and there is further work using the 45 degree holes, which resulted in hydraulic conductivity values of two to three orders of magnitude over the lab tests?

A. Looking at the numerical difference in those numbers, yes.

Q. It also demonstrated one to two orders of magnitude greater hydraulic conductivity between the 45 degree holes and the Hvorslev?

A. I see the numerical difference to that effect on that table, yes.

Q. Mr. Petrie, I would like to put it to you that because of the absence of the kind of testing at Site D that you did in Waterloo, and the Illinois investigators did, both of which demonstrated significant increases in hydraulic conductivity of an unweathered till by those testing methods, your geometric mean of 3.8×10^{-8} cannot be considered

conservative?

A. I believe we felt that 8.0×10^{-8}, Trow's number, was conservative and that the geometric means provides reasonable data on the basis of the data we have.

Q. Is it your evidence that 8.0×10^{-8} is conservative?

A. It is. That is my opinion.

Q. I suggest that that is implausible and incredible, having regard to the fact that you have taken the position that you have as a result of your own Masters thesis, that only by investigations such as pump tests can you accurately or realistically determine the vertical hydraulic conductivity of an unweathered clay?

A. The work I did on my Masters project leads one to conclusions to that effect for the test area in question.

Q. So did the Illinois work?

MR. McQUAID: Let him finish.

MR. PETRIE: May I finish?

MR. ESTRIN: Q. Yes.

MR. PETRIE: A. And also for the Illinois case, as you pointed out. However, there has been no evidence provided to this Board on any of the

documents I am aware of regarding the incidence of fracturing in this material, your own consultant did not discuss it and your own consultant did not recommend angled boreholes be drilled to address this concern.

I can only suggest that to extrapolate the vast areas of North America may lead you to a conclusion, and I am not sure that is the appropriate method of investigation.

Q. Let's go if we could back to your Masters project, Exhibit M-707, and I want to direct your attention to the abstract and to page iv. Could you read the last two paragraphs on that page?

A. "Application of the Terzarghi one-dimensional consolidation equation showed that the clay till should remain unaffected by test pumping,..."

Q. That was the clay till?

A. Yes.

Q. "...but maximum measured drawdowns exceeded 2.5 m. Extensive vertical fracturing is the most plausible explanation of such behaviour."

And as I indicated yesterday, the geometry of such fracturing, I believe I said it was

curiously fortuitous and it had to be a spacing greater than the core but narrower than the borehole diameter.

Q. Keep reading.

A. The next paragraph reads:

"Such a response to pumping could not have been predicted on the basis of piezometer response tests or consolidation tests. This anomalous response is attributed to the effects of borehole smearing. The value of pumping tests in determining the hydraulic character of a confining medium is aptly demonstrated."

Q. Look at your -- can we turn the page and look over at page 1 of your Masters project paper, and I am directing your attention to the second paragraph and to the last sentence, and read that please?

A. We read it yesterday, and I can read it again:

"The formation hydraulic character as determined from piezometer response tests, could easily lead to erroneous and optimistic conclusions concerning the long term ability of these materials

to inhibit the migration of wastes."

Q. Now, Mr. Petrie, let's look at Exhibit M-696. What I have done is put beside you another, if you like, attempted copy of it without some of the data. I wonder if you could write down on the flip chart on the left your conservative number for the unweathered upper till, say on one side in one colour, the CRA value in red, which would be fine, but write it on one side of the page. Can you put CRA underneath that? I would like you to add -- Mr. Petrie, have regard to what I had you read on page 1 and I would like to suggest that it would be appropriate for Mr. Petrie to add onto that and beside that value, the words "potentially erroneous and optimistic re. ability to inhibit waste migration."

A. Those are your words you are asking me to write.

MR. McQUAID: Mr. Estrin is not the witness. The witness was asked certain questions and the result is that those words go on and they may be put on, but we don't need an exhibit from Mr. Estrin, he can put in exhibits in argument if he wants to call them aide memoires of a lawyer, but he can't argue his case now. It is the witness' evidence.

MR. ESTRIN: I am not asking him to do

it because I am saying he should do it, but I am suggesting that if we go back to Mr. Petrie's own work and his own words, he says on page 1 of this exhibit, 707, that the:

"...hydraulic character as determined from piezometer response tests,"

also in the abstract consolidation:

"... could easily lead to erroneous and optimistic conclusions ....".

Q. I say to you, Mr. Petrie, it is fair to take your words and to put them beside that value of 8.0×10^{-8} because you have written that in the absence of pumping tests, that that could easily lead to erroneous and optimistic conclusions.

MR. PETRIE: A. I made those conclusions based on my Masters project at the University of Waterloo and do you wish me to apply them everywhere in Ontario? Is that your request?

Q. I suggest you have set up in your paper which you authored a conclusion?

A. That is correct, I have.

Q. Which you did not restrict to your Waterloo case?

A. I could not predict I would be here today four years later.

Q. Mr. Petrie, in fact, if you turn to page 36, you say, if you will read the last sentence, please, on page 36?

A. "It is therefore considered prudent to evaluate the hydraulic character of Ontario clays by a number of techniques, especially that of a pumping test."

Q. You were certainly not restricting yourself to the Maryhill Till?

A. I was making a conclusion regarding prudency of investigations, yes.

Q. That is why I suggest it would be fair, and simply taking your own words as written in 1985, and not very long ago?

A. It was 1984. The date is 1985, but I was some what slow in signing on the dotted line.

Q. I understand, but it is still not very long ago, but to take your words and to apply them to the value you say is the best one which has not been the result of pumping tests. All I am asking you to do is apply your own words to that and I think that would be fair.

MR. McQUAID: That's a suggestion and the question is does Mr.Petrie agree that that should

be done?

MR. LANCASTER: Is that your opinion?

MR. PETRIE: It is not my opinion, I am basing my opinion on the available data before me and pumping tests have been conducted at the site.

MR. LANCASTER: Would you say that that's optimistic?

MR. PETRIE: The value of 8.0×10^{-8}, I believe to be a conservative number for the hydraulic conductivity from the available data.

MR. ESTRIN: Q. Mr. Petrie, that is not what we are discussing and that is not what you talked about in your thesis. You said here is the result we get from consolidation lab tests, and here are the results from piezometer tests and they are two to three orders of magnitude lower than what you got from the pumping tests and therefore you say:

"It is therefore considered prudent to evaluate the hydraulic character of Ontario Clays by a number of techniques, especially that of a pumping test."

You say it more clearly on page 1, where you say in the absence of these pumping tests, in effect, the values obtained from piezometers or consolidation tests as you say in your abstract, could easily lead to erroneous

and optimistic conclusions concerning the long-term ability of these materials to inhibit wastes, and that is all I am asking you to agree to, that your words, written in 1984 about the very situation the Board has to adjudicate on here, Mr. Petrie, should be applicable here today. Can you tell me why there is any cogent reason why the prudency which you so clearly articulated in your written document, why that prudency should not be applied to Site D and to the value you brought to this Board based on other kinds of testing. Can you tell me why it should not?

MR. PETRIE: A. I can. There have been pumping tests conducted at Site D and as I understand the data, I do not see responses through the till strata.

Q. That is your response?

A. That is my response to the question you just posed.

Q. Mr. Petrie, you told me yesterday, and we would have to get the transcript if you disagree, that the pumping tests that were conducted at Site D were not set or attempted to obtain the response in the unweathered till to a pumping test of the aquifer?

A. That is what I told you yesterday

and I have reviewed some other data which has now been provided to me for Site D and I find some entries in the data columns which leads me to suspect that maybe they were monitored.

Q. "Maybe they were monitored"?

A. I am trying to read a not particularly legible document.

Q. There has been raw pumping data before this Board since Mr. Beechinor brought it forward in Exhibit 172A several months ago.

A. That is correct and I imagine I was here on the day in question and for some reason it escaped me.

Q. Maybe it is 174, but somewhere in there.

A. I have that, because I was reviewing it last evening. On page 13 of that exhibit, we have some entries there which I find not particularly easy to read, but perhaps it is worth clarifying.

Q. You are looking at which exhibit?

A. I am looking at H-174, which in our document we have described as "Raw Pumping Test Data (Site D)" dated, by I believe Mr. Crutcher's handwriting, September 21, 1987. For some reason it

escaped my recall. I have numbered the pages in the document I have, being page 1, the title page, Raw Pumping Test Data, and page 2 being the page with the words Pumping Test No. 1 written on it....

Q. Just a moment, please. Raw pumping test data, Site D is No. 1 and pumping test No. 1 is 2?

A. Correct, and I have numbered them sequentially and the page I wish to address is page 13.

DR. KINGHAM: Our copy of that exhibit, interestingly enough, has after page 2, pumping test No. 1, there is a blank page. I just want to know whether I should number that or not?

MR. PETRIE: I do not have a blank page.

DR. KINGHAM: Your third page is one that has drawdown record for pumped well across the top?

MR. PETRIE: It has PW-1 written in the upper corner at an angle.

DR. KINGHAM: That is your page 3?

MR. PETRIE: Yes, and it has a telephone number on it. The copies I have are not particularly easy to read and I do not believe they are intended for persons other than the field people who were to prepare the data for evaluation within Trow.

DR. KINGHAM: Can you tell us a bit about what is on the pages you want to refer to so I can be sure we have the right page number?

MR. PETRIE: I am looking at page 13 and it's a table and across the top there are some headings but no entries on the adjacent blank lines. We have in addition to the table an OW-1 in rather bold print at the top with a little arrow underneath it.

DR. KINGHAM: We have the same number.

MR. PETRIE: What I am noting is column headed No. 3 standpipe, and if I turn to the preceding page, page 12 at the same position on the same table, I see something that looks like No. 3 standpipe and underneath it something that looks like FL2-85, and I believe that to be HC2-85, although it does not appear as an HC2-85. I come to that conclusion with reference to Appendix 10 of H-39A and that is the pumping test results, and one of those graphs for PW-2, being the upper granular unit well, it indicates an OW-1 and it's bracketed with HC2-85. I am assuming that might be HC2-85, but I do not know that for a fact.

DR. KINGHAM: Exhibit H-84 in Appendix C shows OW-1 as HC2-85 clearly with reference to a master plan. Is that of any help?

MR. PETRIE: Which page?

DR. KINGHAM: Appendix C or Addendum C of H-84, and it's the second page.

MR. PETRIE: The second page of information and HC2 is OW-1 and yes, I understand that to be the case. That is as it appeared to me last night, but the question I have in my mind is what is the data entry. Starting at page 12 and working from the far left column, the far left entry, we have elapsed time and then depth from MP, and I understand MP to be the measuring point, and so on page 12 for the two columns of data, I understand that one is time since pumping started and the column that reads depth from measuring point, the values are increasing and I understand that to mean that the water level is dropping down and so we are looking at drawdown data here.

I notice at the far left of the table outside the body of the table, we have some pumping rates, 10 gallons per minute, 10 gallons per minute, and I understand that page 12 represents drawdown data from HC2-85. At HC2-85, there are three piezometers and piezometer 1 is completed at depth in the system, and I will just draw your attention to it.

Now, I can get an overhead to that

effect which would be easier to explain. I have put an overhead before the Board and taken from our Site D report, being B-618, and I am drawing your attention to installation HC2-85, which is in approximately the middle of the cross-section. We have three piezometers and I am indicating the bottom one right at the base of the bedrock in a material described as silt, gravel, boulder, and I understand that to be HC2-85, piezometer 1. I will use a different cross-section, one I have with the interpreted granular units detailed, and it would be more illustrative. I have put up Figure C2.4a from B-618 before the Board, and I would draw your attention to installation HC2-85. As I just indicated, with HC2-85 piezometer 1, it is at depth in the system at the bedrock contact and HC2-85, piezometer 2 is screened partly within what we have interpreted as the upper granular unit and then we have a third installation, HC2-85-3, which I also believe is described as a standpipe variably by Trow, a standpipe typically being a longer screen that straddles the water table. At this point we should note that I believe this is the installation, HC2-85, piezometer 2, which is described as OW-1 with respect to pumping test PW-2 and that is the one for which much data was generated and curves plotted and from that curve

interpretations were made regarding the hydraulic character of this unit, this unit being the upper granular unit during the pumping test of that unit. I am drawing your attention to the data provided as I read the document, Exhibit H-174, for the deepest piezometer No. 1, and the standpipe, piezometer No. 3.

With reference to page 12 of Exhibit H-174, there are only two entries under the columns for No. 3 standpipe for just piezometer No. 1 and they do not provide a lot of information, except I note that they are on the same page for which the far left entry column records drawdown. I believe this is water level change during the pumping event.

If we turn to page 13, the first point to note is looking at the far left two columns where we note that the elapsed time starts at 485 and, turning back to page 12, that is 65 minutes after the last entry on the previous page and the water level on the previous page was 4.79 and on the page in question, being page 13, it is 4.93 and note that as time increases, i.e. the value for the elapsed time increases, the depth from the measuring point also increases. I believe the far two lefthand columns record drawdown data for HC1-85 and I checked that against the plot of the drawdown data -- I think I said

HC1-85, and I meant OW-1 or HC2-85. The data at the far left on page 13 appeared coincident with the data plotted in Appendix 10.

I make those comments with respect to the fact that I believe we are looking at drawdown data for HC2-85, and the far left entry is for piezometer 2, completed in the upper granular unit. The question that is not clear in my mind is what does the data mean under the column entries No. 3 standpipe and No. 1, which I believe to be HC2-85, piezometer 1.

Starting with the entry under column 1, which I believe to be HC2-85 piezometer 1, I note the water levels are declining there. It appears to be 1.925, the first entry on that page, 1.93, 1.93 and then 1.94 and then values in excess of 2 and I cannot read some of the data there.

Moving to the bottom of the column, we see a total drawdown of 2.335. I understand that to be metres below the measuring point and I do not know what the original water level was prior to pumping for that installation, but I note that at least during the period of elapsed time as recorded in the far left column, an elapsed time starting at 485 minutes and going to 2900 minutes, approximately 2500 minutes, that the water level changes from 1.9 metres from below the

measuring point to 1.335 or approximately 0.4 of a metre of drawdown.

When I review the pumping graphs provided by Trow in Appendix 10 of their report, I cannot find any data that matches that drawdown.

The next entry there, or the one I first referenced, being standpipe No. 3, we notice at the top it is 1.82, the first entry there, adjacent to an elapsed time of 485, and looking down that column, we note the water levels appear to generally rise and there is some oscillation towards the end, and I see 1.82 and 1.78 and I can't read the next number, 1.7, 1.6, 1.5, and then 1.3s and 1.2s and then down towards the bottom it goes to 1.3, 1.37. I would interpret that, recognizing that this is not particularly conclusive from this figure, the figure being page 13 of H-174, but during the pumping event at PW-2, from an elapsed time of 485 minutes to the termination of pumping, that in the standpipe piezometer, the water levels appear to have risen, whereas in the deep piezometer, being OW-1, they appear to have declined.

Turning to the next pages, 14 and 15, they are for installation OW-2, and so they do not provide any clarification, as I understand it, to the data we have on page 13. So, pages 12 and 13, as I

read it, is the only recorded data from installation OW-1, which I am interpreting to be HC2-85 for the pumping event on the upper granular unit. Recognizing there are a number -- there is some uncertainty in how I have read the data, and it is not in my mind perfectly clear, but I think that my conclusions are reasonably logical, although if there is clarification that could be provided I would appreciate it, but during the pumping of the upper granular unit, piezometer 2 responded and that is the bulk of the data provided on pages 12 and 13. Piezometer 1 also responded by drawing down and that is a deep piezometer in the till and the standpipe piezometer does not appear to have responded to pumping and to the contrary, it appears to have risen. That would suggest that based on that review, that there is a degree of hydraulic isolation between the pumping event in the upper granular unit and the standpipe piezometer being in the upper till and we also note there appears to be a degree of hydraulic connection between the upper granular unit and deeper down in the lower till, as evidenced by the water level change at OW-1 for the deep piezometer.

I do not recall any discussion by Trow addressing this point in their description of the

pumping tests and I only noticed this last evening in my review, so I have not had a chance to discuss it with Trow to make sure that the information I am providing to the Board is consistent with their recollection of these data sets.

MR. ESTRIN: Q. Now, then let's try and understand what you are telling us first of all. Mr. Petrie, let's back up about ten minutes.

MR. PETRIE: A. I can.

Q. And then we can let the time run again.

Your value expressed to the Board or your conservative value for the unweathered upper till was 8.0×10^{-8} and that was without any pumping test data you knew of at the time?

A. Correct.

Q. What I am saying to you is that it would be appropriate, based on your own research, to put beside that value "optimistic, potentially erroneous...." and you might want to add, "in the absence of pumping tests"?

A. And I indicated I did not think it would be appropriate.

Q. I asked you what single reason you could give me for that and you said because there is a

pumping test?

A. That is what I gave you.

Q. You reasoning, I suggest, is very circular. Let's go back.

MR. McQUAID: You can suggest, but you are not supposed to argue, but ask questions.

MR. ESTRIN: I am asking a question. I am saying isn't his reasoning totally circular.

Q. Let's go back....

MR. McQUAID: Let him answer that question.

MR. ESTRIN: Let me finish my question.

Q. My question is isn't your question circular, because you have expressed to the Board an opinion that the value to be taken is 8.0×10^{-8} and your own work says that that kind of value is potentially erroneous and optimistic with regard to the reliability of inhibiting waste migration in the absence of a pumping test, and there was no pumping test you were aware of at that time?

MR. PETRIE: A. Correct.

Q. That is why I say it is fair and consistent with your own writings and research to put that, that kind of wording beside that value, and if you want to qualify it by saying in the absence of a

pumping test that would be appropriate. I am suggesting it is consistent with your writings to put "potentially erroneous and optimistic re. inhibiting waste migration in the absence of pumping tests," and wouldn't that be fair, and then we can look at the pumping test to see if we want to change it or not?

A. I have indicated to you that I had some concerns with some of the data generated in my Masters project and it may not be appropriate to draw direct conclusions from that.

Q. Are you finished?

A. Let me think for a moment about that answer. The other thing that has come to light in my reading of these sorts of questions since is that because of this sort of bending effect of the aquitard as a response to pumping I am not entirely sure that the pumping data gives the most reasonable representation of the vertical character or vertical hydraulic character of a till. It gives you reasonable under the stress condition, realizing that pumping is an imposed stress, but the reverse water level fluctuation effects, I am not entirely sure in my mind that pumping tests give the most conclusive picture for vertical flow across a layered system.

Q. That is directly opposite to the

conclusions you reached as a result of your Masters project?

A. Correct, and my Masters project was done in 1984, and I have since done some reading and deliberations to that effect, in the four years in the interim, but you are asking me to ignore my thinking in the last four years and focus on something I wrote at university, and I am indicating that I don't think it is necessarily appropriate.

Q. What readings have you done since 1985 and, more importantly, what research have you done since 1985?

A. I have not done research into this since 1985 or '84, which is the appropriate date. I have done readings of those papers, the ones I have referenced in my thesis, and I have done additional thinking, but I have not done research into it. You are asking for my opinion and I am providing my opinion.

Q. You are saying the opinion you reached in your Masters project as a result of your field work is wrong?

A. I am not suggesting that at all. At the time that was my opinion and I am indicating I have done additional deliberations and believe that the

stress condition induced by pumping also leads to a hydraulic modification of the properties of a till strata, such that I do not believe the pumping data gives you the most realistic picture.

Q. Aren't the results you produced completely consistent with the results in the Illinois study obtained through a different method?

A. The results of the Illinois study indicate the contrast between the different test methods, yes, and I don't recall if they did pumping tests. I am at a loss.

Q. They didn't, they did slug tests and angled boreholes and they found the same change in hydraulic conductivity between that method and the lab method?

A. I can only speak to the results you have provided as to that test.

Q. Are you not taking those readings into consideration?

A. You didn't ask me to take them into consideration, you asked me to take words from my thesis and apply it to the site, and I told you I didn't believe that that is appropriate.

Q. So, if we were to look at your thesis or your project paper today, we would delete all

those references on which you base conclusions?

A. You might.

Q. Would you?

A. No, it stands as my conclusions at the time.

Q. I am asking today, how relevant is that paper?

A. How relevant is any historic paper? At the time it was relevant to me and I authored it, and I am indicating to you that I may have done it differently today if I was doing it today, but I am not doing it today.

Q. You did conclude regardless of the exact values from the pumping test, that the previously unrecognized unfractured massive till was fractured?

A. That was my conclusion, and I noted the rather curious fracture location or geometry.

Q. There is nothing you have read subsequently or can produce to this Board that would say that that conclusion was wrong?

A. No, I cannot; I am merely indicating to you my deliberations on this subject matter since have led me to slightly different considerations.

Q. How about if we put then besides

8.0 x 10^{-8} centimetres per second, "potentially erroneous and optimistic (Petrie, 1985)" and would that not be fair?

A. I do not see the connection. If you ask me to do it, and on your insistence I can, but if you are asking me to agree to it, I have indicated I do not think it is appropriate.

Q. It was your opinion when you wrote the paper in 1985?

A. 1984, but yes.

Q. If we were in 1984, you would agree that those words would be fairly added to that value in the absence of a pumping test?

A. In 1984 I would have recommended the pumping test be redone and piezometers installed in the upper till to investigate this possibility.

Q. Further investigation was done of that very same till by the person you named yesterday in a subsequent Master's project, wasn't it?

A. Correct.

Q. He reached essentially the same conclusion as you, did he not?

A. No, he did not reach essentially the same conclusion. He noted differences between the response from pumping and from field tests and noted

there was quite a range, depending upon the field test method, and he also concluded, I believe, that the stress induced within the system as a response to pumping, as evidenced by reverse water level fluctuations, led him to suggest that stress changes within the system are significant.

Q. Have you read this work, as you had it overnight and you lent it to me yesterday so I could make a copy, but the Masters project by Usher?

A. I have looked at it but I have not evaluated it in great depth.

Q. Do you have a copy?

A. I do.

Q. Would you agree that this was a subsequent investigation referencing your investigation and was in the same specific area?

A. I do.

MR. McQUAID: I'm sorry, I didn't get down exactly what Mr. Petrie said, and whether he has had a chance to examine it or not examine it, but if there is going to be an examination in detail, I would certainly ask Mr. Estrin to at least give the latter part of today or defer this until tomorrow morning to give us a chance to examine it, especially if we are going into detail, the numbers and certain pages from

the document.

MR. ESTRIN: I think Mr. McQuaid should be aware that the witness waved this document around yesterday in response to my cross-examination and suggested he obtained it yesterday or the day before, the evening before, and there was applicable information in here on which he was basing his responses to me. Now, I think on that basis that he has already used it in response to my cross-examination and he should be prepared to answer questions, but if he feels in fairness that he would like further time to review it, I can leave it until tomorrow and I would be happy.

Q. What is your choice?

MR. PETRIE: A. I think you can pose the questions and if I do not feel comfortable answering, I can say so at the time.

Q. I would rather you take the time to review it tonight and I can pose my questions when you are ready?

A. I can.

Q. Mr. Petrie, you gave me information and responses yesterday based on this paper?

A. I did.

Q. Had you read it?

A. I have.

Q. Can't we go through it now?

A. As I indicated, I am not intimately familiar with it. I reviewed it and we can go through it, if that is your wish, and, as indicated to you, if you are in an area that requires additional thinking on my part, I will indicate so to you.

Q. I think I would rather you took the time so you can be fully comfortable answering questions on this.

A. I can do that.

Q. Mr. Petrie, I want to come back to 8.0×10^{-8} and I want to come back to the flip chart and I want to suggest to you that if we were to say or put beside that number "potentially erroneous and optimistic re. ability to inhibit waste migration in the absence of a pumping test (Petrie 1985)," that that would be accurate, and that's all I am asking?

A. In 1985 that was my opinion.

Q. Can you put that down and we can put Petrie, 1985?

A. You are asking me to write it as your opinion.

Q. I am asking you to write that down

because you said it would be accurate?

A. My thesis was done in '84, so can I write the date?

Q. Sure.

A. Could you repeat the words you are asking me to write?

Q. The words out of your project.

MR. McQUAID: Mr. Chairman, we must deal with the evidence as it stands now before the Board. The concern I have with writing it down is when we come to argue the case later in the summer or the fall, that particular notation won't be very helpful to the Board. I don't know, but the question has been asked I think three times, maybe four, and Mr. Petrie says he doesn't think it's appropriate today and I submit the Board has to deal with the evidence today and not an opinion that might have been held three or four years ago.

MR. ESTRIN: We are dealing with it in two steps. First of all, he has agreed it would be appropriate to put that as of 1984-85 and then we will go through the reasons why after he has re-read the Usher thesis, why I say, and I am going to suggest to him it is still ought to be his opinion in 1988 and he has no basis for changing his opinion, and it's a two step process, so let's get down what his position was

then.

MR. LANCASTER: Subject to that qualification, if he is qualified to answer.

MR. PETRIE: Could you read me the words you wish to see on this exhibit?

MR. ESTRIN: Q. I am referring to page 1 of your thesis, and I would simply ask you to adapt them in a short form and I would ask you to put beside that, "potentially erroneous and optimistic re ability to inhibit....".

A. "Potentially erroneous and optimistic re ability ...."

Q. ".... to inhibit waste migration without pumping tests."

A. All right.

Q. You can reference it 1985 or 1984, whichever you feel is more accurate.

A. I will go with the date on the document and I indicated to you it was prepared in 1984. At Mr. Estrin's request, I have written "potentially erroneous and optimistic re ability to inhibit waste migration without pumping tests (Petrie 1985)."

Q. If we turn to page 36 of your project paper and look at the words on page 36, at the

end of the second last sentence or look at the middle sentence:

> "Indeed, predictions of the ability of the Maryhill Till to restrict the migration of contaminants based solely on piezometer response and consolidation test results would be overly optimistic."

And so it would be fair for you to put in "overly optimistic"?

A. If that is your request.

Q. Wouldn't you agree....

A. I haven't.

Q. If we were going back to your conclusions in 1985 or '84, then that would be appropriate.

A. As a university student, those were the conclusions I made.

Q. Would you put that down?

A. Where would you like the word?

Q. " Potentially erroneous...." and insert "overly" before the word "optimistic". Could we mark this as M-696R.

A. This is M-696.

MR. LANCASTER: M-696R.

--- EXHIBIT NO. M-696R: Revised version of M-696

MR. ESTRIN: Q. All right, Mr. Petrie, we will come back to discuss the pump test aspect of Site D to the extent you feel it is relevant and I want to discuss that with you at the same time I discuss the Usher paper with you tomorrow.

MR. PETRIE: A. As you wish.

Q. I have heard what you said, but I think that both of these things go together and so I will come back and give you a chance to answer my questions on what you said about the pumping tests at that time.

A. Very well.

Q. I would like to turn to another aspect of the calculations of impact at Site D, and that is the bit on infiltration. We won't spend a lot of time on this. First of all, I want to deal with the unweathered upper till. In your report, B-618, page 40, you say CRA considers that in effect an infiltration rate of 9.6 millimetres per year may reasonably represent the infiltration rate through the unweathered upper till?

A. Could you refer me to the page number.

Q. I believe it's page 48. Do you see

that?

A. Yes, I see it.

Q. That is a value that you say may reasonable represent the infiltration rate through the unweathered upper till?

A. That's what it says.

Q. Do you say that today?

A. Mr. Hodgson put some exhibits to me in a consideration of the Darcy equation, that my estimates are probably inappropriate, and I agreed that the numbers he put to me were more appropriate than the numbers we have in B-618.

Q. What is your evidence since Mr. Hodgson has put some numbers to you. Please refresh our memories. What is your opinion?

A. I am trying to find the exhibit. H-647 indicates the Darcy infiltrations and I considered the numbers provided in H-647 as more appropriate.

Q. Let's just look at that. Can you tell me please what is your number?

A. Considering the Darcy equation and the hydraulic conductivities, the calculated number for deep infiltration of 0.88 millimetres per annum is an appropriate number for the unweathered upper till.

However, that is in consideration of our most representative number for the hydraulic conductivity of the upper till.

Q. Being what?

A. It is indicated above, 1.4×10^{-8} or 10^{-10} metres per second.

Q. You are saying that is now your most representative? I thought the most representative number was 8.0×10^{-8}?

A. I believe that was a conservative number, 8.0×10^{-8}; and using a conservative number you would get a factor of six or so higher than the 0.88.

Q. First of all, let's go back. Between writing the report and Mr. Hodgson's discussions with you, you have changed the infiltration rate at Site D by an order of magnitude through the unweathered upper till. You have changed your mind by an order of magnitude; isn't that right?

A. The statement is that we considered the value and now we have a calculated value which I consider to be more appropriate.

Q. Did you not bother to try and check the value you considered to be appropriate before you wrote it in your report?

A. I did not.

Q. You did not?

A. I did not, Mr. Estrin.

Q. Don't you think it would be appropriate in presenting values to this Board in a written document to which you have signed your name, that you ought to have at least given the Board the benefit of checking the calculation and what its implications are?

A. Yes, I do believe that and I was remiss in not doing that calculation.

Q. I think I would like to discuss with you, because you wrote it in the document, what the implication of 9.6 millimetres per year is because you took it -- it is very simple. Can you just take a flip chart for me. The gradient you have said is the appropriate gradient here, which is on page 47 of your report, and that is 0.2, and if you look at item 1 on page 47:

> "Strong downward gradients ranging from 0.014 to 0.421 occur between the unweathered Upper Till and the underlying strata. These values average approximately 0.2."

A. Yes.

Q. Let's calculate the hydraulic

conductivity values your calculations give us?

A. You said calculate a hydraulic conductivity....

Q. Based on your gradient and your infiltration of 9.6 millimetres per year in your report. You can do it very quickly.

A. You can, but I note it was a consideration and that infiltration may be appropriate, so you are asking me to take a consideration and recalculate the input data.

Q. Take the infiltration number you presented to the Board and the gradient number you presented to the Board in your written report and simply tell us -- multiply or divide whichever the right way of doing it is, and give us the hydraulic conductivity that would result. That is Darcy's Law.

A. Calculate a hydraulic conductivity from an estimate of infiltration?

Q. From your evidence about what was in the report as 9.6 millimetres per year, which may reasonable represent the infiltration rate through the unweathered upper till and I want to see where that takes us?

A. Realizing I have since qualified those numbers.

Q. I understand.

A. Certainly.

Q. We can do that, I understand, first of all getting the Va, the Darcy velocity and converting your 9.6 millimeters to metres per annum and that would be 0.0096 metres per annum?

A. Do you want me to check or take it as given? You have asked me to calculate and then given me the answer. It's your cross-examination.

Q. Would you write them on the board.

A. I can.

Q. Va = 0.0096 metres per annum.

A. Yes.

Q. That comes directly from converting 9.6 millimetres per year?

A. It does.

Q. Then the K or the hydraulic conductivity is equality to Va over i, is that right?

A. Yes.

Q. That would equal 0.0096 divided by 0.2?

A. Yes.

Q. That equals 0.048 metres per annum?

A. 0.048.

Q. Metres per annum, and I think Mr. Crutcher is checking all of this. I suggest that is equivalent to 2 x 10^{-7} centimetres per second, and Mr. Crutcher is going through that.

A. I get 1.5 x 10^{-7}.

Q. We can take 1.5 x 10^{-7}. Perhaps someone rounded it off. You would agree that using a gradient of 0.2 and an infiltration rate of 9.6 millimetres per year would give you, using Darcy's Law, a hydraulic conductivity of 1.5 x 10^{-7} centimetres per second for the unweathered upper till?

A. Using a considered value for infiltration and doing the calculations you have described with those numbers, yes.

Q. Could you label that please and we can mark it as an exhibit and we will label it as CRA's infiltration and gradient values from B-618.

A. Could you repeat the title.

Q. There may not be enough room and you can put it at the bottom, but hydraulic conductivity calculated from CRA infiltration and gradient values for unweathered upper till - B-618, pages 47-48. Perhaps we could mark that as an exhibit.

MR. LANCASTER: M-712.

--- EXHIBIT NO. M-712: Chart, hydraulic conductivity calculated from CRA infiltration and gradient values for unweathered upper till - B-618, pages 47-48.

MR. ESTRIN: Q. Now, Mr. Petrie, I take it that 1.5×10^{-7} is the number you would have given the Board had you used your values in the report for the hydraulic conductivity of the unweathered upper till?

MR. PETRIE: A. Had I used a considered calculation to back-calculate a hydraulic conductivity, I would have come up with that mathematical number, yes.

Q. But you had some discussions with Mr. Hodgson and have changed your mind?

A. That is correct and the numbers I considered were inappropriate.

Q. Did you have any discussions with Mr. Hodgson or Mr. Feenstra....

MR. HODGSON: I am uncomfortable with "discussion", because it was my cross-examination, but this implies it all happened somewhere else and it happened here.

MR. PETRIE: Cross-examination is the word I meant to use.

MR. ESTRIN: Q. That is what I had in

mind, but I was going to ask if you had any discussions with Mr. Hodgson or Mr. Feenstra or Mr. Sobanski on this point before Mr. Hodgson cross-examined you on it?

MR. PETRIE: A. No, I did not.

Q. What about you, Mr. Crutcher?

MR. CRUTCHER: A. No, I did not.

Q. So, just so I understand it, the relevant number you say today is 0.88 metres per annum?

MR. PETRIE: A. Based on the Darcy velocity for the most representative vertical hydraulic conductivity, yes.

MR. ESTRIN: Excuse me, Mr. Chairman. I just need a moment.

Q. Mr. Petrie, let me see if I understand this. Your 0.8 millimetres per annum is essentially related to a hydraulic conductivity of 1.4×10^{-8}?

MR. PETRIE: A. Correct.

Q. If the Board concluded that a more representative hydraulic conductivity for the unweathered upper till was in the vicinity of 1.0×10^{-7}, then I take it that your infiltration would go back up to what you had originally stated?

A. It would be recalculated to the appropriate number, yes.

Q. Okay. Now, I would like to turn to infiltration in the weathered till.

MR. LANCASTER: This may be a good time.

MR. ESTRIN: Thank you.

MR. LANCASTER: If you are starting something new.

MR. ESTRIN: I am.

MR. LANCASTER: Fifteen minutes.

--- Recess

MR. LANCASTER: Please be seated.

DR. KINGHAM: Before we get started, I would like to be clear on what you said before we broke. On page 48 of your exhibit, your Exhibit B-618, you had a value for infiltration which you report as 9.6 or a consideration of 9.6 millimetres per year, based on Trow's work?

MR. PETRIE: Correct.

DR. KINGHAM: You made that qualification and you made the statement just below and just before the break, are we to understand you said the value might be 0.8 millimetres per year based on the vertical hydraulic conductivity of 1.4×10^{-8} centimetres per second?

MR. PETRIE: Correct and it's 0.88 and that number is described as deep infiltration in

Exhibit H-647.

DR. KINGHAM: Thank you very much.

MR. ESTRIN: Q. Mr. Petrie, I would like to turn, as I said before the break, to infiltration in the weathered till and discuss that for a moment. The exhibit you referred me to and which you discussed in cross-examination with Mr. Hodgson, H-647 -- we will come to that. You have said in your report, B-618, originally that at least 50 millimetres per annum will go down -- let me start again.

You said in your report that 9.6 millimetres per annum out of at least 50 millimetres per annum would go down through the unweathered upper till and you told Mr. Tidball that the balance was going out laterally in the weathered till and that the upper weathered till was active and it provided re-supply to surface drainage and discharge to adjacent surface waters; do you recall that?

MR. PETRIE: A. Something to that effect, yes.

Q. In your report you said that Trow's value for hydraulic conductivity for the weathered upper till of 10^{-5} -- Trow's value of 10^{-5} was conservative?

A. Yes.

Q. And you said that your conservative value, based on one lab result was 10^{-6}, page 87?

A. Page 87?

Q. Page 87 of your report. Do you see that at the top of page 87?

A. Yes, and I am not sure if it was based entirely on one lab result, because Trow had done additional work using tritium, as I recall, and this sort of sums the data available, but I see a value of 1.0×10^{-6}.

Q. I am saying that that's your value?

A. Yes, I am saying I see a value there of 1.0×10^{-6}.

Q. That is your value?

A. It is.

Q. I wanted to ask you to go through the calculations based on either what you say is the conservative value of 10^{-6} or Trow's value of 10^{-5}, having regard to the opinion about infiltration you brought to this Board of 9.6 millimetres per annum. I gave you before the break a piece of paper.

A. Indeed.

Q. Have you had a chance to look at

that and maybe we can go through it?

A. I have glanced at it, yes.

Q. Let's look at this, Mr. Petrie. You told Mr. Tidball and that expected infiltration at Site D would be in excess of 50 millimetres per annum?

A. I recall something like that.

Q. Have you changed your mind about that number since you have now come up with 0.88, going through the unweathered upper till?

A. We discussed that and in cross-examination it was addressed with Mr. Hodgson.

Q. You have also changed the amount of infiltration generally?

A. Yes.

Q. What is it?

A. As I indicated, we are not entirely sure what the infiltration into a fractured clay might be, given you might have some rapid transport through the fractures, discharge to the adjacent surface waters.

Q. Would it go up or down?

A. I don't know what the precise number is for infiltration into the fractured clay at Site D. I also indicated with respect to landfill considerations, that that horizon, being the weathered

and fractured clay, is relatively easily addressed in the engineering phase, and the precise definition of its hydraulic character, in my opinion, is not as necessary.

Q. Mr. Petrie, the hydraulic trap's purpose is to prevent leachate from going laterally as well as down?

A. Most definitely.

Q. Therefore the only way it could have a relatively high hydraulic conductivity in the weathered till -- you must be concerned about the lateral migration of leachate, are you not, if the trap does not work?

A. For high hydraulic conductivities, yes.

Q. Let's talk about 10^{-5} and that's relatively high?

A. It's a modest hydraulic conductivity.

Q. What I want to talk about is let's say your value. The point is that the weathered upper till layer is of importance in determining the potential impact by way of lateral migration?

A. It potentially has importance, yes.

Q. I know your evidence is we can engineer that and put in a cutoff wall or whatever?

A. That is the evidence.

Q. But Mr. Petrie, in part of your report you are saying that before you ever get to engineering measures and monitoring, you are saying what could be the potential impact of putting waste in those cells and relating that to the ability of the soils themselves to deal with it. That is a first step?

A. Yes and no. I beg your pardon, yes, and the 'and no' relates to during the excavation phase of the landfill where one has a chance to examine the whole face of the cell, the sidewalls, and if one had suspicions that maybe the fracturing is more significant than one had initially suspected or there is more seepage from those points, then one can do some works at that point in time. I also noted that experience in Ontario indicates that the upper weathered fracture zone around landfills does not appear to provide for major off-site movement, and I think that is consistent with looking at roadside salting and things like that, where we don't seem to get it spreading a long way across farmers' fields adjacent to roads.

perhaps he could lend you his.

A. He has offered to do that, yes.

Q. This is the paper by Johnson et al and I wanted to direct your attention on the point we have just been discussing, or relative to the point we have been discussing to the first page of that, the righthand column. Could you read the paragraph beginning on the first page, "Earlier that year" on the righthand side?

A. "Earlier that year, in February, 1982, the IEPA..."

The Illinois Environmental Protection Agency:

> ".... discovered that routine monitoring of wells at the site had shown migration of organic pollutants as far as 50 feet from the trenches in a three-year period. This discovery was a separate issue from the court proceedings and exhumation order. The migration rates were 100 to 1,000 times faster than predicted. Two obvious questions were posed: (1) Why were these organic compounds migrating faster than predicted, and (2) What are the implications to a land disposal of

similar wastes at other sites? This research project was designed to provide answers to these and many other questions regarding the impact of land disposal of hazardous wastes, particularly organic liquids."

Q. Now, Mr. Petrie, we know it is not proposed to specifically put hazardous organic wastes into the Halton regional landfill site?

A. That is my understanding.

Q. You will also agree that we develop as part of the leachate organic components....

A. Organic compounds are generated within the leachate typically from municipal landfills.

Q. We have talked a lot about those.

A. Typically the concentrations are very much lower than one encounters at hazardous waste sites, the difference being at hazardous wastes sites one commonly encounters pure organic fluids in some form or another and in municipal landfills we are looking at dissolved solutions and very dilute concentrations by comparison.

Q. You will recall from our discussion of this paper and the paper by Herzog, the follow-up on the actual investigations that are

Q. Have you ever done a specific investigation of lateral migration through an unweathered clay from a landfill in Ontario?

A. I have not looked at lateral migration through an unweathered clay.

Q. Sorry, through a weathered clay?

A. Many of the landfills with which I am associated are founded on weathered clays.

Q. I am asking you if you have made what could be termed as scientific investigation and tried to calculate the rate of migration of leachate through weathered upper till clays in Ontario related to a landfill?

A. The one instance I can think of off the top of my head where we have seen a bit of migration was clearly evident from field inspection, that overland flow from sidewall break-outs contributed and water had gone down adjacent to a shallow piezometer.

Q. Can you answer my question?

A. Could you repeat your question.

Q. Have you ever made an investigation and written any kind of report attempting to assess the migration of leachate in weathered clay till around an existing Ontario landfill?

A. In conjunction with investigations of such landfills, yes, but specifically, no. I have not published a paper.

Q. Have you published or written reports where you have delineated the migration rates and arrived at the effective hydraulic conductivity values?

A. I have not.

Q. So you are speculating?

A. In the absence of contamination at the sites I am thinking of, yes. Typically one looks at migration rates from noting an impact at a point and noting the time at which landfilling occurred and the separation of the monitoring point from the landfill perimeter and arriving at some estimates for lateral migration. I have not seen evidence of such, as I am indicating.

Q. Perhaps we could go back to Exhibit 711.

A. Could you indicate what that is?

Q. It is the Johnson paper. If I had another copy, I would lend you one.

A. I know I have it here. Make that the past tense, I had one.

Q. I see Mr. Crutcher has a copy so

contemplated in the Johnson paper, when we put up -- you told me yesterday and agreed that the site that is being discussed and was going to be investigated and then was investigated in the Illinois case had till with similar hydraulic characteristics to that at Site D, and by that I mean similar clay size, sand and till?

A. I indicated that was the difference in the tills with respect to the mineralogy, depositional history, length of exposure of the tills, development of soils following ice retreat.

Q. My question is simple and that is, they had migration of contaminants of 50 feet in three years and they did a subsequent investigation and they found that fracturing of that supposedly unfractured till as a result of that investigation, right?

A. You are referencing the document from yesterday?

Q. Yes.

A. Yes, I recall they indicated fracturing.

Q. They concluded by the test methods they subsequently used that the hydraulic conductivities in the unweathered till itself was greater. Anyway, my point is simple. They had 50 feet of contaminant migration in three years and that raises

a concern, fair enough?

A. Yes.

Q. I guess what I am asking is do you not have a concern and should this Board not have a concern for the residents around Site D about the potential for lateral migration in the weathered upper till?

A. It is in my opinion, no.

Q. They shouldn't have a concern. Should it not be a subject of thorough investigation before we rely on your opinion?

A. With respect to the hydraulics of fractured clays, I believe there is a large amount of uncertainty to that and what is an effective transport porosity, what are the effects of infiltration into it, i.e. the transient gradient effect. We note from the large number of monitoring events in Ontario in the weathered clay profile adjacent to landfill sites, that contamination within those units is not commonly encountered and it is not the general experience. Mr. Feenstra addressed some concerns on that and suggested that trench monitors may be an appropriate method for investigating occurrences of contamination adjacent to landfills. It is the experience in Ontario that weathered upper clay does not provide a major conduit

for contaminant migration.

Q. That is not your experience and you have had no such experience and you told us that a minute ago?

A. No. The question you posed was have I calculated travel rates or something to that effect, and I said we have not encountered contamination adjacent to landfills and I indicated one encounters -- derives estimates of travel rates from contaminant occurrences and noting the time of landfilling and the separation of that occurrence from the landfill.

Q. You told me a minute ago that you had done no calculations of travel rates of contaminants in weathered tills around Ontario landfills; is that right?

A. I have not encountered any.

Q. Have you done investigations?

A. The sites I am thinking of were existing sites prior to my exposure to them and I am referencing ongoing monitoring.

Q. The answer is no?

A. The answer is I have not investigated a new site with respect to the capacity of the upper and fractured till to provide a conduit for

lateral migration.

Q. Now, let's go back to your infiltration number in the weathered till. You told Mr. Tidball 50 millimetres -- you said in your report at least 50 millimetres would go down through the unweathered till and you have now told us you don't know whether it is 50 and you don't know if it's less and you don't know if it's more?

A. I don't recall saying 50 millimetres.

Q. 50 millimetres of infiltration on the site?

A. That I recall saying.

Q. But now you are saying you don't know if it's that and you don't know if it's more and you don't know if it's less?

A. I really don't know what the infiltration is into a fractured clay medium.

Q. If you don't know what it is, how is it that you can say or agree with Mr. Hodgson that it is 0.88 millimetres a year going through the unweathered portion?

A. That is based solely on the Darcy calculation for the hydraulic conductivities and gradients posed and represents to my mind a reasonable

number. In the fractured material there is a large amount of uncertainty as to what goes on in the fractured material respecting infiltration, transport velocities, et cetera, and I cannot be definitive on that.

Q. Let's just look at this calculation. Let's go through this. Take what you told Mr. Tidball and let's start with that. Infiltration to be in excess of 50 millimetres per year, and that is what you told him, right?

A. I don't recall the word "excess."

Q. In that vicinity?

A. 50 millimetres; in that vicinity is what we discussed.

Q. You put in your report that Trow's estimate of 9.6 millimetres passing down through the unweathered upper till is reasonable and that is what you put in your report?

A. That is correct.

Q. You considered that the remaining 40 millimetres per annum moved laterally in the weathered upper till?

A. Or discharged to surface at some point, yes.

Q. You agreed with Trow that the

thickness of the weathered upper till is about 4 metres?

A. Correct, I did.

Q. You considered the effective porosity of the weathered till is 0.02 and that's in your report on page 87?

A. And recognizing that number was developed from an investigation at Sarnia.

Q. That is the number you reference in your report at page 87?

A. Correct, I do.

Q. Let's consider the water balance over the proposed landfill and let's look at how this is calculated. You take the area times infiltration, which is 1000 metres times 500 metres times your 50 millimetres per annum put into metres per annum, and you come up with a figure of 25,000 cubic metres per annum; is that fair?

A. That appears correct.

Q. Then you calculate the total flow to the unweathered upper till, again the area times 9.6 millimetres converted equals 4800 cubic metres per annum?

A. It does.

Q. More or less. Then we can deal --

we get the total lateral flow by subtracting one from the other, 4800 subtracted from 25,000, gives us 20,200 cubic metres per annum going laterally?

A. Correct. That is the calculation.

Q. We can therefore get the Darcy flow in a lateral direction by taking or doing the calculation set out there and we have two sides 1000 metres long and a 4 metre thickness and we add two times 500 metre sides, 4 metres thick, which gives us 12,000 times the Darcy velocity?

A. That appears to be correct, yes.

Q. Therefore the Darcy flow laterally would be the lateral flow of 20,200 divided by -- it should read 12,000 and that is equal to 1.68 metres per annum?

A. Yes.

Q. We take the lateral gradient you provide for us in your report at page 87, 0.005, and we can put it into the formula expressed there and we get a Darcy velocity of 1.68?

A. Yes.

Q. Then we can calculate hydraulic conductivity of the weathered till by dividing the lateral gradient into the Darcy velocity, which equals 336 metres per annum?

A. That is correct.

Q. Which if converted to hydraulic conductivity values would give you 1.0×10^{-3} centimetres per second?

A. That is mathematically correct, yes.

Q. If we wanted to calculate the lateral groundwater velocity, we could take the porosity and divide it into the Darcy velocity as set out there and it tells us we would have lateral groundwater velocity of 84 metres per annum?

A. Can I just check that one. Mr. Crutcher tells me he checked it and yes, I can take that.

Q. Therefore, the time required for groundwater to move laterally off-site is the distance divided by the groundwater velocity, say 100 metres of buffer divided by 84 metres per annum equals 1.19 years?

A. That is what it says, yes.

Q. Mr. Petrie, that would be the result of the infiltration numbers that you presented to this Board in your written report?

A. That is correct.

Q. You did not do that calculation, I

take it, when you wrote your report?

A. No, I indicated I did not. The concern with doing that is what do those flow rates mean, because we have streams and uptake from plants and discharge from the fractures to surface in some fashion and I do not know what the infiltration into the weathered clay is.

I indicated that based on the information provided in H-647, that I thought our numbers were not appropriate, but you have taken an inappropriate number and back-calculated a hydraulic conductivity.

Q. I have taken the number that you wrote and presented to the Board originally and which you continued to stand by when you were cross-examined by Mr. Tidball, right?

A. That is correct, and I indicated I was remiss in not doing the supporting calculations.

Q. Mr. Petrie, 10^{-3} centimetres per second is consistent with almost an aquifer situation?

A. A value of 10^{-3} for hydraulic conductivity is what one generally considers an aquifer.

Q. That would provide lots of recharge to adjoining ponds and streams?

A. It would if that indeed was a realistic value.

Q. Mr. Petrie, in the back of Dr. Charlesworth's report there is a map of the area, Exhibit M-438?

A. Yes, I do have it somewhere.

Q. M-438. While we are doing that, I wonder if we could mark this calculation as the next exhibit?

MR. LANCASTER: M-713.

--- EXHIBIT NO. M-713: Calculation of hydraulic conductivity of weathered upper till, based on CRA's evidence, Site D.

MR. ESTRIN: Q. Can you put that up?

MR. PETRIE: A. I don't know which one.

Q. The general site plan.

A. Does it have a figure number?

Q. Figure 1.

A. I have it.

Q. I want you to look at Figure 1 from that and look at the margin and can you confirm that there is a symbol that would indicate ponds?

A. There is a symbol which indicates ponds, yes.

Q. I wonder if you could take a highlighter and highlight some of the ponds on and

around, particularly south of Site D. Take whatever colour you like, as long as it can be seen?

A. Yellow?

Q. Sure. I draw your attention first of all to what appear to be some symbols for ponds around HC8-84?

A. There are two symbols for ponds, and you would like me to highlight those?

Q. Yes, please.

A. There is a symbol for a pond underneath HC4-85 or just south of, and there is a symbol for a pond just to the left of HC6-85 and moving further south....

Q. South along Highway 25?

A. We have one there, a well, I believe a well indicated as 33HC and further south --

Q. I think we can go over to the west of the site?

A. There is a small symbol for a pond near 5663 to the west of the site and one further south near 2459, which is just adjacent to the end of the cross-section marked RB and one crossing the road and moving a little farther south and there is one adjacent to something called 8HC, and I believe it probably refers to this pond.

Q. There may be more, but those are sufficient for my purposes. Thank you.

A. I have coloured in yellow on the legend.

Q. I am not sure if you were here for the evidence of any of the homeowners, the residents around Site D?

A. I was not.

Q. I want to show you an exhibit, Mr. Petrie, that was put in when these people who live and work around Site D were testifying before the Board, Exhibit MR-562, and I will ask you to assume that these are pictures of the Winter's farm.

A. Mr. Winter's farm.

Q. Yes. I will ask you to assume that Mr. Winter's property is located at the point I am indicating in Figure 1 of the Geocon report, which is around 33HC?

A. I can assume that.

Q. I am also directing your attention to a picture in the bottom righthand corner of Exhibit MR-562, which shows water in the foreground and what appears to be a drainage channel going into the picture into a woodlot about mid-point in the picture?

A. I see that.

Q. I will ask you to assume that the water you see in the foreground is the pond that you have coloured yellow beside 33HC on Figure 1 from the Geocon report?

A. I can assume that for your purpose.

Q. I will also ask you to assume that what has been described as the drainage channel going back to the woodlot is -- well from the Geocon report, would you agree that there appears to be a drainage channel going in a northwesterly direction back into Site D?

A. There appears to be that.

Q. Now, this picture, Mr. Petrie, is entitled Water Impoundment Fed by Site D - Drainage Channel.

A. That is how it is entitled.

Q. I will ask you to assume that Mr. Winter testified that he waters cattle out of that?

A. I can assume that.

Q. Mr. Petrie, are you able to tell the Board that the water in that pond we see in Exhibit MR-562, are you able to tell the Board the source of the water?

A. Following the assumptions you

have asked me to assume, it appears to be from the surface water at Site D.

Q. Could it also be, the water in the pond, quite likely be a function of groundwater recharge happening through the weathered upper till?

A. There is undoubtedly some groundwater getting into it, and I think surface water is the dominant component into such an impoundment.

Q. Wouldn't it be reasonable and conservative to assume that some of the water in Mr. Winter's pond is being recharged through the weathered upper till? You have told us that that is an active zone?

A. Water moves in that zone. It could. I expect it is minuscule at most.

Q. But you don't know?

A. I can't give you a number.

Q. Mr. Petrie, I suggest the calculation we have done in M-713, based on the numbers you originally brought to this hearing, are quite consistent with water flowing through the weathered upper till, or at least travelling through the weathered upper till and providing a source, some source of the water in Mr. Winter's pond, and that calculation I am suggesting is consistent with that?

A. Yes, and I considered. I don't agree with that.

Q. But you have no basis of investigation at or around Site D to come to that conclusion; is that fair?

A. I cannot agree with the hydraulic conductivity of 10^{-3} for the weathered upper till.

Q. That is because you have changed your mind about infiltration?

A. In part. I cannot agree with that number for the upper weathered till independent of an infiltration calculation.

Q. You can't tell us what the infiltration is?

A. I can't tell you what the infiltration is, but I have indicated I don't believe it is an appropriate hydraulic conductivity for the weathered upper till.

Q. But the water in Mr. Winter's pond is coming from somewhere?

A. The water in Mr. Winter's pond is most probably surface water from runoff from his fields and adjacent fields, yes.

Q. Mr. Petrie, you would agree that Site D is a local headwaters area. It is a drainage

divide?

A. Yes, there is drainage flow.

Q. Waters originate, and surface flow as well as I suggest, in the shallow weathered till from Site D and run in various directions?

A. That is fair.

Q. All right. I would now like to turn to another topic. I would now like to discuss with you -- can we turn to your Exhibit B-618, page 11.

Could you read the second and third paragraph on page 11. I guess I should back up and ask you -- this is in Section A of your report, and the general context of Section A, as I understand it, is to give CRA's definition of hydrogeological suitability for landfilling?

A. That is correct.

Q. And as part of your definition of determining hydrogeologic suitability, I take it you have concluded that an impact assessment ought to be done?

A. Correct.

Q. I am directing your attention to page 11, and I would like you to read the paragraph beginning, "It is the intention."

A. "It is the intention of an impact

assessment to demonstrate that, based on the observed hydrogeologic system and the proposed engineered landfill system, that operation of the landfill will meet accepted criteria regarding groundwater quality at the site boundary."

Q. Stopping right there, you will in part base your impact assessment on observed hydrogeologic systems and the proposed engineered landfill system?

A. The hydrogeologic system is singular there.

Q. But in part that is what it would be based on?

A. Yes.

Q. Would you read the next paragraph?

A. "It should be pointed out, however, that the effects of a failure of the engineered system must also be assessed. This is assessed by assuming that there is an uncontrolled build-up of leachate in the site which has the effect of increasing the rates of groundwater flow and reducing the time of arrival of contaminants at the site

boundary."

Q. Now, that is another significant component of an impact assessment in your opinion?

A. It is.

Q. In part C of this report you attempted an impact assessment of Site D, or at least what you call a suitability analysis, I take it?

A. Could you direct me to a page?

Q. I am looking at page 76 and the heading there....

A. I see the heading, yes.

Q. Is that what you were trying to do in part C, in effect do an impact assessment or at least a suitability analysis?

A. In general. We had noted at this point in our report that Trow were conservative in our opinion with respect to their assessment of the site and I believe we note that their assessment of the site indicates that the site is suitable and we are also of the opinion that the site is suitable for landfilling.

Q. I am just trying to understand, but what you were trying to do was make up your own mind, based on an impact assessment and interpreting all the data, whether or not in your view the site was suitable?

A. In general, yes.

Q. That would include, or should include, according to your principles on page 11, assessing the impact of the failure of engineered systems?

A. That is what Trow have done and we are of the opinion that their assessment was appropriate.

Q. I understand what you are saying, but however you got there, it was appropriate for an impact assessment to be done which assumed there was an uncontrolled build-up of leachate?

A. Yes.

Q. In doing your impact assessment or in determining that Trow's impact assessment was appropriate, what I am really addressing my mind to is your opinion, CRA's opinion here, but it's quite clear from what you have said before in evidence that CRA did not consider a hydraulic conductivity for waste of 10^{-5} centimetres per second?

A. We considered it was inappropriate.

Q. You did not consider a scenario which had a waste hydraulic conductivity of 10^{-5}?

A. No, we did not.

Q. Indeed, Mr. Petrie, on numerous occasions during your evidence, you said a hydraulic conductivity for waste of 10^{-5} considered by Dr. Rowe in his cases 2 to 5, and 2 to 5 where with the leachate collection system operating as designed....

A. I recall that.

Q. You said the hydraulic conductivity of 10^{-5} was "unreasonable and implausible"?

A. That is our opinion, yes.

Q. Those are very strong words, correct?

A. Yes.

Q. They imply to me that you consider it virtually impossible that the waste could have a hydraulic conductivity of 10^{-5}?

A. The waste within the landfill being municipal waste over the area of the landfill, yes.

Q. That is what you are telling the Board?

A. That is what Mr. Crutcher and I are telling the Board.

Q. Mr. Crutcher, I would like to confirm my understanding of your evidence on this. I

am giving you an excerpt from the transcript, Volume 110 and beginning at page 26538. This was the examination-in-chief by Mr. McQuaid of you, and I wonder if I could get the Board's copy?

DR. KINGHAM: Our copies seemed to stop at 107. I know we have up to 112 upstairs.

MR. ESTRIN: Mr. Hodgson has kindly suggested you could borrow his.

Q. I am at page 26538. You see you are being questioned by Mr. McQuaid about line 8 where he says:

"Q. I guess I would ask you, Mr. Crutcher, first of all as I understand it you are going to address column 2, the hydraulic conductivity of the waste?

A. That is correct."

And he goes on to ask you a question at line 16 and you respond:

"A. Dr. Rowe in the preparation of the table provided essentially the input data to his model and a number of the parameters and specifically the hydraulic conductivity of waste which I am addressing we believe are not based on realistic assumptions. The item I

am initially addressing is where he utilized a permeability of the waste of 1 x 10^{-5} cm/sec.

Q. What cases should we be looking at for that?

A. That refers to cases 2 to 5."

And then going over the page, you say:

"In this particular area, cases 2 to 5, he utilized the waste permeability of 10^{-5} or 1 x 10^{-5} cm/sec. We have not, in our experience, found such a permeability of the waste. That permeability is -- I would call it excessively low. The design permeability which is typically used by the industry as a whole is 10^{-4} cm/sec."

Did the transcript get all those comments right?

MR. CRUTCHER: A. Yes, flexible I believe I said.

Q. You go on to say, around line 13: "Any testing that I have been involved in in dealing with the permeability of the waste has never encountered a permeability up to that range."

A. Yes.

Q. Is that correct?

A. Yes.

Q. You go on to say at the bottom of the page, line 25:

"Our submission to the Board is that a permeability of 10^{-5} is unrealistic."

A. Yes.

Q. That is your evidence?

A. It is.

Q. Mr. Crutcher, could you turn up a page for a flip chat?

A. Shall we mark this one?

Q. We should before we leave that. Can we mark Figure 1 from the Geocon report, which has been coloured in yellow by Mr. Petrie with the ponds in the vicinity of Site D, as Exhibit M-438-1 if there isn't already such a number. I don't know.

MR. LANCASTER: Yes.

MR. ESTRIN: Or F1, to make it clear.

--- EXHIBIT NO. M-714: Figure 1 from Exhibit M-438 with ponds marked.

MR. HODGSON: I'm sure that's in evidence and I know I have put a portion of that in evidence and I am sure the original was in evidence.

First of all I wonder, as a precaution,

if it would be possible -- we are getting into the problem of taking the same documents and putting on a piece of information on it and marking it as a new exhibit and I think it would be more appropriate to go to the document room and pull out the original and put it up and add what we need to add where appropriate, understanding there are circumstances where you want to start with a new one, but I think this should carry M-714 because I think it will be confused with the original.

MR. ESTRIN: I have no problems; whatever is most helpful.

MR. LANCASTER: Perhaps it should be M-714. I know it is included on one exhibit, but when it is used separately...

MR. ESTRIN: It would be?

MR. LANCASTER: M-714 and it will be Figure 1 from Exhibit M-438.

MR. ESTRIN: Q. My question to you, Mr. Crutcher, is can you list for me on that chart the landfill sites where you have personally performed tests to determine the hydraulic conductivity of wastes. Could you list them please?

MR. CRUTCHER: A. Normally that is an outcome of what we observe at the site and I am saying

that a test has been done and I think I referenced within the transcripts the Keele Valley, and that was not specifically a test but more the outcome of the results.

Q. My question is fairly specific. List the sites where you have made a specific investigation of in situ waste to determine hydraulic conductivity?

A. I have not undertaken a particular test for that, but what I have done is seen the results and I am referring to that.

Q. You haven't done any such investigation yourself?

A. Not personally, no, but I am saying you can back-calculate from other work that has been done.

Q. People have back-calculated and perhaps you have back-calculated and I am asking whether you personally determined the in situ values?

A. I have not undertook to go to a site for the sole purpose of determining the permeability of the waste and undertaken a test designed solely for that purpose.

Q. And has your firm?

A. I can only speak from my knowledge

of the projects I am aware of that the firm has undertaken, so no, I am not dealing with that specifically. I am also indicating that you can see the outcome of a 10^{-5} centimetre per second waste, and we have not seen the outcome of that.

Q. Mr. Crutcher, we have that evidence already in the transcript; I am asking you a more specific question.

MR. McQUAID: You don't have to keep asking the same question again and again. He said he didn't do the test but he has seen the results, and you don't have to ask him five times.

MR. ESTRIN: That is not what he said and let's get it clear.

Q. If I was to ask you to put down on the flip chart, landfill sites where I have investigated in situ hydraulic conductivity of waste, the answer is zero, correct?

MR. CRUTCHER: A. Specifically for that issue, yes.

Q. The same answer would be true, as far as you know, for your firm?

A. I am not aware of any that we have done.

Q. Mr. Petrie, I take it you are in

the same position?

MR. PETRIE: A. That is correct.

Q. You have both read Dr. Charlesworth's report, the Geocon report on Site D?

MR. CRUTCHER: A. Yes, I have, and I know Mr. Petrie has.

Q. And you recall that Dr. Charlesworth in that report expresses an opinion that it is reasonable to consider a hydraulic conductivity of 10^{-5} centimetres per second for waste in determining the potential impact of system failure?

A. Could you refer me to what page?

Q. Sure, turn to page 5-13 of M-438. Could you read, please, the first paragraph on page 5-13 under the heading of 5.3.5, Refuse?

A. "Trow (Ref .1) have assumed a value of 10 x 10^{-4} cm/sec for the hydraulic conductivity of the waste. Reported values in the literature range from 10^{-2} to 10^{-5} cm/sec (Ref. 7, 8 for hydraulic conductivity of refuse)."

Q. Just read the next paragraph.

A. "In view of the fact that Dr. Rowe's modelling indicates that the hydraulic trap is sensitive to the

hydraulic conductivity of the waste, and that with a hydraulic conductivity of 10^{-5} cm/sec, the trap will fail, it is important to assume a conservative value. Given that the two references cited above both quote values as low as 10^{-5} cm/sec in the refuse, it is realistic to model the proposed landfill assuming a refuse hydraulic of 10^{-5} cm/sec as one of the possible scenarios."

Q. All right. You gentlemen in your -- in the cross-examination by Mr. McQuaid and subsequently in your evidence in-chief, you gentlemen took the Board to one of those references; do you recall that?

A. We referred to the Board to what information we had on the Fresh Kills landfill.

Q. What about reference 7, the Hughes article?

A. I believe that is an Illinois article, eastern Illinois, 1972 or something in that order.

Q. Did you review that reference?

A. I was quite aware of that

reference and that document, it has been referenced many, many times, it is a very early document dealing with landfills.

Q. Let's look at it. This is just one page, and the witness said he reviewed it and is familiar with it.

DR. KINGHAM: Could we have another copy?

MR. ESTRIN: I am sorry.

Q. This is, you will agree, what the reference is in Dr. Charlesworth's report to Hughes?

MR. CRUTCHER: A. From the title, yes.

Q. This article, or this booklet, and it was really a booklet which this is, and it is really one of the earlier standard texts on solid waste disposal and hydrogeological investigations that was very much used or referred to in the seventies?

A. Yes, and that is where I was familiar with it.

Q. You know George Hughes?

A. Yes.

Q. Who is he?

A. He has a doctorate and he works with the Ministry of the Environment, I think, in policy, and I think Miss Hewetson actually works for

him.

Q. He has a doctorate and is he not a renowned hydrogeologist?

A. Yes.

Q. Do you respect his opinion?

A. At some length.

Q. I take it you know R.N. Farvolden?

A. Yes, I do.

Q. Mr. Petrie, I take it you know R.N Farvolden?

A. Yes, I do.

Q. He was your Masters project supervisor?

A. He was indeed.

Q. The same gentleman who is now at the University of Waterloo in what department?

A. Earth Science, and in that capacity he acted as my supervisor.

MR. CRUTCHER: A. If it means anything, I know Mr. Landon was well.

Q. I don't know him. Who is he? I don't really care, but if you think it is relevant...

A. It is not relevant, but since you were going through the names....

Q. Mr. Crutcher, can we look please

at Table 15 from Hughes et al, and you see on page 108 there are well numbers on the left and the second column says Material set in and then if you look down that column you will see the heading of Refuse?

A. Yes, I do.

Q. You will see there are three wells listed under that heading of refuse and when we go to the third column on the left, the hydraulic conductivity is set out and for the first well listed, MM30, the reported value is greater than 8.5×10^{-3}?

A. I see that.

Q. For the second well, LW 1C, there is nothing reported, and the comment is -- first of all there may be a comment with regard to the first one and I think you have to draw a line to get it clear. 8.5×10^{-3} and if you put a rule under that whole line, MM30, 8.5×10^{-3} and extend it over to the righthand side, I think you would see the comment is, "Too fast for accurate measurement."

A. I see that.

Q. The second one is LW 1C no value reported and the comment is "Too slow - screen probably clogged."

A. I see it.

Q. Then LW10B and a value of 2.2 x

10^{-5} and no comment beside that?

A. Yes.

Q. That was a value reported in a study by both Drs. Hughes and Farvolden, gentlemen whose reputation in this area you respect and have you any reason for quarrelling with that reported value?

A. I assume that that is what they measured from their slug tests they undertook and I don't believe it's a representative number of a landfill site, but I can concur they have reported that number, yes.

Q. You told us you are familiar with the study and would you not agree that this value was obtained from a study of a landfill site?

A. It's a study of a slug test, and I don't recall how they did it, but I assume they had a well within the refuse and they undertook a slug test on that, but I don't believe that that's an appropriate way to determine the permeability of the waste. You are looking at a permeability of a waste as a whole and there will be individual parts within the site that have lower and higher permeabilities and what you are looking at is what is the overall permeability of the waste. What I have indicated is I have never seen the overall waste mass have something like 10^{-5}, and that's

-- and if you calculate, as Dr. Rowe indicated, you would have very high mounds within landfill sites, and, as matter of fact, I think it was shown in cross-examination with Dr. Rowe that you would have leachate coming out of all the side slopes and you would have an incredibly high leachate head, and I am just saying I have never seen that type of leachate mound in a landfill site and I just have not seen any evidence of that type of permeability for the waste.

Q. Can you answer my question which is have you ever conducted a pumping test to determine the hydraulic conductivity of waste?

A. I have not.

Q. Do you know of your firm has undertaken?

A. I am not aware of one specifically. We may have done a pumping test for another purpose, but I am not aware of it.

Q. Now, I would like to show you something else. Do you have the Phase II Morrison Beatty report on Site F, and I believe you referred to it at one point or another. I don't believe the whole report is an exhibit and we don't need to get into the report. I am, however, showing you a couple of pages from it. Could we mark that excerpt from the Hughes

article as the next exhibit?

MR. LANCASTER: M-715.

--- EXHIBIT NO. M-715: Hydrogeology of Solid Waste Disposal Sites in Northeastern Illinois.

MR. ESTRIN: Q. What I want to do is look at the log for well OW-15. Could you confirm by reference to the Morrison Beatty report or your own report which indeed references some values from this log, that this borehole relates to a hole in the Bayview landfill site?

MR. CRUTCHER: A. I was just conferring with Mr. Petrie. Yes.

Q. If is possible, Mr. Petrie, could you put up a map to show us where this hole, OW-15 is?

MR. PETRIE: A. I believe you have it on the cross-section on one of these exhibits.

DR. KINGHAM: It is also on page 19 of B-617.

MR. PETRIE: It is shown on M-437-D5 and it has been added on in my handwriting, MB15 and this is not the appropriate exhibit as it does not intersect the waste.

MR. ESTRIN: Q. I think we had better look at another one.

MR. CRUTCHER: A. The log indicates

a very low number and you would have very high leachate levels in landfill sites all over the place, and we don't have that type of leachate levels in landfill sites.

Q. I know what your expectation is, but I am asking you to confirm simply that this value of 10^{-5} or 2.2×10^{-5} was indeed reported from a test in refuse in a waste disposal site in Illinois. Have you any basis for disagreeing with that?

A. No, and I can see you could get that, but you could have the well screen sitting in an interim cover and an interim cover could have that permeability. You have to look at more like doing pumping tests on sites and looking at how the heads build-up in the site and leachate collection systems and then you will get a better appreciation of the permeability of the waste.

Q. Have you ever done that?

A. All the sites we are involved in have that.

Q. I am asking you if you did all those steps?

MR. McQUAID: Come on. The witness indicated he has seen results from many sites, and he said he hasn't done a specific test and to put it on

this narrow basis is just not helpful to the Board. The witness was answering the questions because he said he has seen results, and the Board is entitled to have the answer and have the results that have been seen and I submit he should be entitled to finish his answer.

MR. ESTRIN: I will let him finish his answer.

Q. Are you finished?

A. I don't recall.

Q. You told me there were three steps you would do in order to get the true hydraulic conductivity of waste, and would you remind repeating those for me? One included a pump test.

A. If you wanted the permeability of the waste in a particular area, I believe the appropriate way would be by doing a pumping test. I would say that you could get an appreciation of the site as a whole, which is essentially what we are looking for, looking at the permeability of the waste of the site as a whole, you can look at how the site is performing with a leachate collection system and what sort of head build-up there is in the site which has developed. There is the head build-up and that is the whole gist of what the permeability of the waste is, and I am saying, taking a look at sites having a 10^{-5}

there is refuse at that well if it's of help.

MR. PETRIE: A. Dr. Kingham referenced page 19 of B-617.

Q. If it's quickly available, we can go to page 19 of your Site F report. We can look at page 19 and, Mr Crutcher, can you confirm for me that OW-15 is located in the garbage in the Bayview sanitary landfill site and in the area where waste has been disposed of?

MR. CRUTCHER: A. Yes, and that was my understanding, that it was on the southern slopes or southern toe of the landfill site at Bayview.

Q. Now, if we turn to the second page of this handout which has four pages, you will see there are some construction details for borehole OW-15, and I am directing your attention specifically to piezometer 9?

A. I see that.

Q. You would agree with me that it is stated to be screened between 8.23 and 9.14 metres?

A. Yes.

Q. If we turn back to the first page of this document, we can see the symbolized location of the piezometer, can we not?

A. Yes, I see that.

Q. It is just above the line that would be 9.1 metres down?

A. Yes.

Q. That is consistent with the construction details, more or less?

A. It appears to be.

Q. Then, the opening at which this piezometer is taking water is where? Can you draw it on your copy?

A. It is essentially from -- we have the screen interval from 8.23 to 9.14 and the seal placed -- the lower part of the seal is 7.62, so I would assume it is taking water essentially from 7.62 to 9.14, assuming it was constructed properly, and I assume the highlighted mark on the graph is a seal. Yes, it appears that the highlighted mark is the approximate location of the seal.

Q. You have an original copy and you can see the faint markings on the original and these were highlighted to make sure they would show up on the photocopy, but you can compare it to the original you have. The interval drawing water is approximately 7.62 to what?

A. 9.14 I believe the actual number was.

Q. And you agree that the description that is in the lefthand column for that horizon of between 7.62 and 9.1 is "REFUSE, wood, cloth, plastic with grey silt fill..."?

A. And "odorous," yes.

Q. That's what it reads?

A. Correct.

Q. Could you turn please to the fourth page of this document. This is out of your report on Site F, and I would direct your attention to OW-15, piezometer 9, the third entry from the bottom of the page?

A. I see that.

Q. Would you please read the hydraulic conductivity value which you have put down in your report?

A. 2.5×10^{-5} and I assume that is actually referenced out of one of the documents in Morrison Beatty where we obtained that.

Q. 2.5×10^{-5} centimetres per second?

A. Yes.

Q. There is a reported value for the hydraulic conductivity of refuse at the Bayview landfill site in the Region of Halton, right?

A. That that location, yes.

I also note there is not much of the leachate head built up at that particular point and there is about, I would guess, looking at it, just a little over two metres of leachate head and in fact if the refuse was 10^{-5} as a whole, you would expect pinning the exact location from the toe, the distance from the toe considerably more head if the refuse was all 10^{-5}. As I indicated, I don't know exactly how these tests were taken, but I assume that is a slug or recovery test and my evidence is that I have not observed a refuse mass having an average value of 10^{-5}. There would be locations within the refuse that may have that but, as a whole, I have not observed that.

Q. I would like to ask you a question. Did you know about that value for refuse in the Bayview Park landfill site that I have brought to your attention at this point in time prior to giving your evidence in-chief? Had it been brought to your attention?

A. I don't recall. I am aware of the Bayview landfill site because we have installed the leachate collection system and I am also aware of the head within the landfill site and where there are seepages at the site.

Q. You weren't aware of that

particular reported value for refuse?

A. I don't recall it. I may be aware of it, but I have not reviewed these documents, but I reviewed an incredible number of numbers.

Q. Do you not think that it is a number that you should have brought to the attention of the Board in the context of giving the Board an opinion that such a number was improbable or unrealistic?

A. No. My evidence is based on looking at the site as a whole and not looking at an individual reading within the site. As I indicated, a landfill site is a very heterogeneous mixture of garbage and you have cover soils mixed in with it and you cannot take a small point within the landfill site and say this is representative of the whole site, you must look at the site as a whole.

Q. If there are values of 10^{-5} as found in Halton garbage, City of Burlington garbage to be more specific, and there is a value of 10^{-5} reported by Dr. Hughes and Dr. Farvolden in Illinois, wouldn't it be prudent, conservative and reasonable to take into account a value of 10^{-5} in assessing the potential impact of a site?

A. You would have to look at the site as a whole. I do not believe it is prudent or

reasonable to use 10^{-5} for the site as a whole and I think that is totally unreasonable.

Q. That is something different because you see what I have gathered from your initial evidence-in-chief and in references to the transcript was that there couldn't be a single value of 10^{-5}?

A. If I have misrepresented that, there was no intention, because I was referring to the site as a whole. I think that way. However I said it, if I misrepresented it in some fashion, I apologize, but what I am saying is that I have never seen a site as a whole having a value of 10^{-5}. You would have leachate spewing out everywhere if that's the case and we don't see that at sites.

Q. Your evidence is clear, and you are saying there certainly can be areas in a landfill of municipal garbage in Ontario, and specifically in Halton Region where we can expect to measure hydraulic conductivities as low as 10^{-5}?

A. Within a pocket within the waste or a small area within the waste, sure, I can accept there would be areas, and there could be areas of 10^{-0} and there could be ranges and you have to look at the site as a whole. I think that 10^{-4} is a conservative value and I think it is a fair design value, and that

is why I refer to it as a design value, and I also think of it as being conservative.

MR. ESTRIN: Mr. Chairman, I am about to move onto another aspect of this, and I think this would be a convenient point.

MR. LANCASTER: Yes, it would be.

MR. CRUTCHER: Should we mark this?

MR. LANCASTER: M-716.

MR. ESTRIN: The excerpts from the Morrison Beatty Phase II report.

--- EXHIBIT NO. M-716: Excerpts from Phase II - Morrison Beatty Limited Hydrogeologic Investigation for National Sewer Pipe Limited - Landfill Site Burlington.

MR. LANCASTER: I am going to require a little extra time for lunch today, so we will adjourn until 2:00 o'clock.

-- Luncheon Adjourn (12:22 p.m.)

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

MR. LANCASTER: Please be seated.

MR. ESTRIN: Q. Mr. Crutcher, before lunch we were discussing the hydraulic conductivity values for waste and you confirmed for me that in the Bayview site we have one recorded value of 10^{-5} in the refuse and we talked about that same value for refuse in the Hughes study. I believe we ended before lunch with you replying to all of that to the effect, if I have got it right, that 10^{-4} is an appropriate design parameter in your view for the conductivity of waste and if I have got the note right, you said you considered that to be a conservative number?

MR. CRUTCHER: A. Yes, the lower end of the scale. The lower end of the scale, yes.

Q. Do I understand correctly you are telling the Board, therefore, that you need not design to any lower conductivity than 10^{-4}?

A. That is correct.

Q. Are you also saying it is your view that you need not use a number lower than 10^{-4} in doing an impact assessment for a landfill when you are considering mounding?

A. When you are considering mounding, 10^{-4} is a conservative and appropriate value to use for

an impact assessment for the landfill as a whole, yes.

Q. Well, tell me this, Mr. Crutcher, is it not a fact that your firm, CRA, has in fact recommended to the Regional Municipal of Waterloo that the two expansion areas being considered by the Region at the present landfill site be designed for a hydraulic conductivity of waste of 10^{-5}?

A. Not that I am aware of.

Q. Not that you are aware of. Let me show you a report from your firm, a draft report sent to the Region with a transmittal letter signed by someone in your firm, and I want to show you the covering letter. Do you want to read it?

A. Yes.

Q. Would you read it for us?

A. It's a letter from Jamie Puskas from our office to Mr. Michael Quinn, the Region of Waterloo and it says:

"We enclose a draft copy of the report entitled Technical Memorandum, Leachate Collection System Design, Waterloo Landfill Site for your review. This reports presents the rationale for the recommended leachate collection system designed for the northern and the

southern expansion areas."

Q. What was the date of that letter?

A. September 21, 1987.

Q. Mr. Crutcher, you are in charge of the Waterloo landfill site expansion program?

A. I am the overall project manager for it.

Q. Can we look at -- could we mark this as the next exhibit?

MR. LANCASTER: The draft report will be M-717.

--- EXHIBIT No. M-717: Draft Waterloo Landfill Site Technical Memorandum, Leachate Collection System Design.

MR. ESTRIN: Q. Could I first of all ask you to turn to page 14.

MR. CRUTCHER: A. Yes.

Q. And can you read the first full paragraph on that page for us?

A. "Due to the relatively large uncertainty and variability in the refuse hydraulic conductivity, it is recommended that the leachate collection system at the Waterloo Site be a two stage design. The primary stage will consist of collector pipes constructed

in french drains and be designed based on a refuse hydraulic conductivity of 1.0×10^{-4} cm/s. The second stage will be a system of french drains without collector pipes with spacing designed for a refuse hydraulic conductivity of 1.0×10^{-5} cm/s."

Q. Going back to the first sentence, Mr. Crutcher, what is said here by your firm I suggest is essentially the same thing Dr. Rowe was saying and considering in his modelling; that is there is relatively large uncertainty and variability in refuse hydraulic conductivity, isn't that correct?

A. There is variability, yes. I indicated that as well.

Q. Is that not what Dr. Rowe was considering in his modelling?

A. He considered a value of 10^{-5} for the complete mass of waste and I do not agree with that.

Q. And he considered 10^{-4} as well in other scenarios?

A. Yes.

Q. I am saying he considered the same range of hydraulic conductivity for refuse as is

addressed in that paragraph?

A. Which paragraph?

Q. The one you just read from 10^{-4} to 10^{-5}?

A. He did, but I do not think it is appropriate.

Q. Can we turn to table 5 following page 12?

A. Table 5.2?

Q. Table 5.2. You will see there there is set out in effect calculations or modelling, if you like, of the drain spacing that would be required for the proposed expansion areas based on various hydraulic conductivities of waste; correct?

A. Yes.

Q. Can you confirm that this indicates your firm considered it appropriate to model cases or calculate cases where the hydraulic conductivity of the waste was, among others, 10^{-5}?

A. I can confirm that the individual who wrote the report did that. I should note I have not reviewed this report.

Q. But a report has been sent to the Regional Municipality of Waterloo for their consideration?

A. In draft form.

Q. Yes.

A. If I may explain the rationale, I personally have been involved in this hearing for so long that I have a number of projects where I have not been able to be actively involved. What I have done is I have told my clients that I have not had an opportunity to review the documents for consistency and to make sure that I am in agreement with the documents, but we would forward them in draft and we would continue on and I would be involved in the general gist of what is proceeding, but we would not finalize anything until I have had the opportunity. I have a client, who happens to be the Regional Municipal of Waterloo, who has accepted that, mainly because I do not have the availability of time and they are eagerly awaiting for me to get off the stand and get working on this project, and likewise I have the same position.

Q. Mr. Crutcher, when you speak of consistency, one could think uncharitably of the notion that the kind of consistency you would like is that none of your reports even contemplate a hydraulic conductivity of waste of 10^{-5} to make it consistent with your evidence here. Is that what you mean by consistency?

A. No, I mean that what we put in our reports we can support.

Q. Mr. Crutcher, why don't you turn please to page 7 of this document and looking under the heading of 4.3 Hydraulic Conductivity of Refuse and would you read the first two sentences?

A. "The hydraulic conductivity of refuse is an important parameter in determining the spacing of leachate collectors. The hydraulic conductivity of refuse has been reported to range from as low as 1.0×10^{-5} cm/s to as high as 1.0×10^{-3} cm/s depending on the compaction of the waste."

Q. Yes. That is what this report is modelling, that range, and if you look back on Table 4.2 following page 12, that is the range which in fact your firm modelled?

A. That is the range that was used on these calculations, yes.

Q. Can we turn to page 14?

A. Recognize I am only reading the pages you have referred me to and I have not read this report.

Q. I am sure you will have that

opportunity. If you turn to page 14 and look about half-way down, or the second full paragraph begins, "A design" and can you read that for us?

A. "A design for both expansion areas has been developed and is presented on Plan 1, attached. This design uses a grid pattern with the main collectors running in the direction of the base slope. These main collectors consist of perforated pipe installed in french drains. The layout of the main collectors is based on minimizing the length of pipe and the depth and number of manholes required. The main collectors are spaced at a maximum distance of 90 m. These collectors, by themselves would control the leachate head to a level less than 4.5 m with an assumed refuse hydraulic conductivity of 1.0×10^{-4} cm/s."

Q. Read the next paragraph.

A. "The secondary system consists of a network of french drains. The french drains run perpendicular to the main collectors and are spaced a maximum

distance of 20 m apart near the edge of the landfill and 30 m over the rest of the Site. This system is expected to control the leachate head to less than 3.2 m along the edge of the landfill and 4.7 m over the rest of the Site based on a refuse hydraulic conductivity of 1.0×10^{-5} cm/s."

Q. Mr. Crutcher, at the back of the exhibit is a copy of the plan, Plan 1. I wonder if you could put that up for us. Do you have a scale for 1 to 3000? First of all, I wonder if you could....

A. I don't have a scale of 1 to 3000. Oh, I have found one here.

Q. If you would have regard to Plan 1, and on the righthand side of it to begin with....

A. I assume this is Plan 1, but it is not on my copy.

Q. That was the only plan attached to the document?

A. I will write on this Plan 1 then.

Q. Please do. Would you confirm for me that the spacing between the drains that are running horizontally, if you like, these, is 20 metres?

A. It appears to be variable.

Q. We will have to do it another way.

A. Towards the centre of the site....

Q. 30 metres.

A. 30 metres, and along the edge it's 20 metres.

Q. Could you perhaps take a green pen, and I will give you a highlighter, but delineate the area that has 20 metre spacing from 30 metre spacing. Just highlight it.

A. I have marked in green highlighter the area where there appears to be a 20 metre spacing to the french drains.

Q. Now, Mr. Crutcher, the report indicates that the french drains are designed -- when they are designed for a 10^{-5} centimetres per second hydraulic conductivity, they are spaced 20 and 30 metres and would you look back at the top of page 15, and it really begins on the bottom of page 14:

> "The secondary system consists of a system of french drains. The french drains run perpendicular to the main collectors and are spaced a maximum distance of 20 m apart near the edge of the landfill and 30 m over the rest of the Site."

A. Yes.

Q. "This system is expected to control the leachate head to less than 3.2 m....".

Could you please take pink pen here....

A. I have a pink highlighter.

Q. Highlight please all of the 30 metre lines?

A. I just noticed a few more 20 metre ones.

Q. Would you....

A. Pink is everything in between.

Q. I would like a pink line on each of those french drains that are either 20 or 30 metres spacings. I want you to use the pink to outline the french drains that are spaced 20....

A. The area or each drain?

Q. Each drain, please. You have highlighted those french drains which are 30 metres apart and I am interested in having you indicate with the same colour all the drains that are designed for refuse with a hydraulic conductivity of 10^{-5} and that would also include the 20 metre ones as well, if you go back to the top of the page, page 15.

A. That's not what you said.

Q. I am suggesting there is a different spacing, but they are all designed for 10^{-5} hydraulic conductivity?

A. I read that as well.

Q. The green ones would also cover that?

A. Yes. My understanding was that the main collectors were designed on the basis of 10^{-4} and the french drains were designed on the basis of 10^{-5} and I do not understand that rationale.

Q. Mr. Crutcher, looking at this diagram, is it correct that all of the horizontal -- all the drains that run left to right?

A. In a north-south direction.

Q. On this plan if we consider the top of the diagram....

A. You will throw me off if you do that.

Q. I don't know the Waterloo site.

A. I'll put on a north arrow.

Q. Can we agree that all of the drains that run north-south whether coloured pink or green on the righthand side of this plan according to the text on page 15, are based on a refuse hydraulic conductivity of 1.0×10^{-5}?

A. It appears that way, yes.

Q. Can we turn look at the lefthand side of Plan 1. Can you take a green pen and highlight those that are, I guess to be consistent, 30 metres apart?

A. Green was 20 metres.

Q. I am sorry, you are right.

MR. ESTRIN: Does the Board need a pen that is an equivalent colour?

DR. KINGHAM: We can rely on the exhibit.

MR. CRUTCHER: Shall I cross-hatch the area like I did on the other or do you want the lines marked?

MR. ESTRIN: Q. Sure.

MR. CRUTCHER: A. I assume you would like the pink ones done as well?

Q. Please. Can you put a legend down at the bottom with a pink line and a green line and indicate something to the effect that it indicates french drains based on a refuse K of 1.0×10^{-5}?

MR. HODGSON: I wonder, Mr. Chairman, if the witness could count the lines he has done in green and pink on the lefthand side, because I am having difficulty coordinating what I have in front of me with

what I see up there. There is a number running diagonally across that cell and there is a line and a 376 number and do you see the number?

MR. CRUTCHER: Yes.

MR. HODGSON: Where does the pink come in relation to the 376?

MR. CRUTCHER: It stops right at 376.

MR. HODGSON: The line below 376 is pink and the line above 376 is green.

MR. CRUTCHER: Correct.

MR. HODGSON: The distance between the 376 number above and below that line is 20 metres?

MR. CRUTCHER: 30 metres.

MR. HODGSON: The line above 376 to where there is 377, is that 20 metres?

MR. CRUTCHER: Yes, the spacing appears to be that.

MR. HODGSON: Thank you very much.

MR. CRUTCHER: Let me look at the scale. I was going visually, but I may be off.

MR. LANCASTER: It looks like 20 metres to the north and 30 to the south.

MR. CRUTCHER: I think it's a bit on a skew, and I don't know if it makes any difference.

MR. ESTRIN: I don't know if we are

concerned about the exact location of those lines.

Q. Now, Mr. Crutcher, to be fair, you might wish to go back to page 14 and re-read to yourself the last paragraph which talks about the main collectors where it says they are spaced at a maximum distance of 90 metres:

> "These collectors, by themselves would control the leachate head to a level less than 4.5 m with an assumed refuse hydraulic conductivity of 1.0×10^{-4} cm/s."

So you might wish to highlight those in a different colour.

MR. CRUTCHER: A. If you wish.

Q. It's up to you. For my purposes, I am only interested in 10^{-5}, as you know.

A. As I indicated, I put no credence on this document and I have not reviewed it and it's not finalized.

Q. I will leave that decision to you, sir. So, we understand -- perhaps this plan should be given a number that corresponds to the exhibit it comes from as a separate number.

MR. LANCASTER: That will be M-717-1.

--- EXHIBIT NO. M-717-P1: Plan 1 from Exhibit M-717.

MR. CRUTCHER: Could I suggest P1?

MR. LANCASTER: Plan 1, as I have it marked as Plan 1.

MR. ESTRIN: Q. Just so we are all clear, Mr. Crutcher, you have used cross-hatching in green to indicate the area of the 20 metre spacing, but so that we are all clear, is each one of these lines running north-south, it's a french drain that is designed to accommodate 10^{-5} centimetres per second K waste, is that correct?

MR. CRUTCHER: A. Yes.

Q. To be consistent with the way you have put pink lines on the 30 metre spaced drains, could you put a solid green line along each one of the 20 metre spaced drains?

A. It will look rather confusing now, I believe.

Q. Thank you.

MR. LANCASTER: Can you read me what you have written down on the conductivity of the pink?

MR. CRUTCHER: KW = 10^{-5} centimetres per second, the K of the waste.

MR. ESTRIN: Q. They are written in pink or green, correct?

MR. CRUTCHER: A. Correct.

Q. When we look at this plan, M-717-P1, we see pink or green lines running north-south or, in the case of the second on the left, east-west, across all of both expansion areas; is that fair?

A. Yes.

Q. In other words, all of the two proposed expansion areas under this plan are designed to accommodate refuse of a hydraulic conductivity of 10^{-5} centimetres per second?

A. It appears that way, yes.

Q. This design I suggest has been put forward so as to ensure -- the design of a leachate collection system and this design in particular, I suggest, is put forward to ensure there will not be excessive mounding of waste -- mounding of leachate in the refuse; is that fair?

A. It has been put forward to indicate to Mr. Quinn the rationale that the person doing this work had for the design, and it was a preliminary, a conceptual design of the leachate collection system.

Q. The purpose of the leachate collection system and the purpose of designing as it has been is to, I suggest, prevent excessive mounding in the event that the hydraulic conductivity of the

waste is as low as 10^{-5}? That would be the natural purposes?

A. It appears that the author has used 10^{-5} and I am not in agreement with that number. I should note that this design is all to be incorporated in a design and operations report. Mr. Quinn had requested some preliminary information of what the leachate collection system would look like and we had no budget to prepare this and what we ended up doing was providing him an idea. I did not have an opportunity to review it, and, as I indicated, everything was sent out in draft and we will complete all this information when we do our design and operations report, which I have indicated to the Region I will be forthright on as soon as I finish this hearing, an hour I am patiently awaiting.

Q. He is a professional engineer, is he, registered to practise in the province of Ontario?

A. He is.

Q. How long has he worked for your firm?

A. A couple of years maybe, or in that order.

Q. Mr. Crutcher, both you and Mr. Petrie have made a very conscious effort to indicate to

this Board that Dr. Rowe's scenarios where a hydraulic conductivity of the waste of 10^{-5} is assumed are unreasonable and implausible. What we see your firm has recommended as a conceptual design for the Region of Waterloo is a design that assumes the waste could certainly be in that range, fair enough?

A. An individual of our firm has. I have indicated I am not in agreement with that.

Q. I can understand the reasons.

A. You can understand the reasons because I don't believe it is correct.

Q. Mr. Crutcher, for the people of Waterloo, your firm or a professional engineer with your firm has said or it is implicit in this recommendation that it is reasonable to design for 10^{-5} for the people of Waterloo, but what I find difficult is that when it doesn't suit another client's case, you consider it unreasonable to consider 10^{-5}. I would like to suggest to you that it is perhaps you that is being unreasonable and implausible.

A. You can suggest what you like. First of all, I would indicate that when this design is finalized it will be based off 10^{-4} and I have now had an opportunity to review the report and I can discuss this with my cohorts, the information in here. The

design will be finalized on 10^{-4} and the reason for that is that there is no justification for 10^{-5}. So, the residents of the Region of Waterloo will not be blessed with 10^{-5} waste.

Q. Someone else in your firm thinks that 10^{-5} is an appropriate number and has so stated on page 7 that:

"The hydraulic conductivity of refuse is an important parameter in determining the spacing of leachate collectors."

and has apparently considered the reported literature and information and says that it can be as low as 10^{-5}. On what basis do you disagree, because you said yourself you have done no tests?

A. He does not have the experience to make that statement.

Q. Mr. Crutcher, I have to suggest to you that based on this document, your position here before this Board on what is a plausible, reasonable, conservative value to design a landfill leachate collection system on, ignoring 10^{-5} for waste, I have to suggest to you that that position seems to be, and I would like your reaction, it is first of all inconsistent with the available data for hydraulic conductivity of waste and, secondly, it is inconsistent

with your firm's approach in Waterloo?

A. I disagree on both matters. I will agree it is inconsistent with what you have presented on M-717, and I indicated I have not had an involvement in that portion and I will be having an involvement.

Q. I am sure before the end of this hearing we will see your final document which eliminates 10^{-5}?

A. No you won't, because I won't have time to have it prepared, I don't suspect.

Q. It may become a priority.

A. It always has been.

Q. In any event, let's approach this in another way. Your evidence is you have never seen the leachate coming out and therefore it can't be 10^{-5} essentially?

A. I have never seen leachate mounds that would evidence the 10^{-5} in municipal refuse.

Q. Can you indicate which of these landfills you have in mind had a 4 to 1 or lower waste to cover ratio and used a cover material with a compacted hydraulic conductivity of less than 1.0×10^{-8}?

A. Many landfill sites have that.

Q. Can you name one?

A. Sarnia.

Q. Is that one you designed?

A. I have been involved and the site evolved itself.

Q. Do you know, and can you affirm to this Board that the waste to cover ratio is 4 to 1?

A. The waste to cover ratio of every site, if it operated on a 4 to 1 basis, I would be overjoyed because our slow balances would work and they have a high range and 4 to 1 is a generalized number, and I would tend to think of Sarnia in the earlier days, that they had less soil used and currently I think they are using too much soil and that is a fairly common problem at landfill sites, and we deal with it, and so I can't say it's 4 to 1, but I can say at Waterloo they are running about 1.3, I believe, which is actually quite good for them.

Q. 1.3?

A. 1 to 3. We would like to get them to 1 to 4.

Q. What is the K value for the cover that has been put in place over the last number of years where you have finished this site, do you know?

A. Which site?

Q. Waterloo.

A. Waterloo? We are using a value, an assigned value of 10^{-6}.

Q. So that site does not fall within the range of the questions I asked. I said which of the landfills you are suggesting, because there is no leachate spurting out, had a 4 to 1 or lower waste to cover ratio and used a cover material with a K of less than 10^{-8}?

A. First of all you don't get a cover material that less than 10^{-8}. We may start with a soil that is 10^{-8} and we can't place it as I have learned, because I originally felt that you could, but I have learned from experience that you cannot, it's not practical. You can't place the cover material as the same in situ permeability. It just doesn't happen and you can't get the compaction and you get differential settlement within the site and you are getting some fracturing within the waste, within the cover, and I did not originally have that opinion, but I have subsequently through just observing what is happening at landfill sites, I have come to that conclusion.

Q. I think you are telling me we might have some difficulty in fairly comparing any existing sites to what the intent here in Halton is,

where we have heard from Mr. Hiraishi he wants 4 to 1 waste to cover ratio?

A. Mr. Hiraishi wants 4 to 1 and I want 4 to 1, but you never get 4 to 1, you get the best the operator can achieve. 4 to 1 is a design number to be able to give you the quantity of soil you need for daily cover and that is all you use that number for.

Q. I guess what I am coming to, Mr. Petrie, is that there is very little data on which to base a definitive opinion regarding the hydraulic conductivity of the waste in the sense that you are just not concerned about the waste per se, you must take into account the hydraulic conductivity of the soil in which it is placed and how thick and compacted that layer is above and below, fair enough?

A. No, I don't believe that. The placement of daily cover on the refuse I do not believe contributes in any significant amount to the overall permeability of the waste. It is relatively thin and sometimes it is too thin and, in fact, maybe it gets incorporated into the waste matrix on the next lift and so I do not believe that it controls to any significant degree the overall waste permeability. The placement of interim cover does have some effect and what that effect is it tends to cause a perching of water within

the landfill sites and the design of landfill sites now is to remove, or at least ensure a hydraulic connection through any interim cover, interim cover being a thicker cover placed, because the landfill is not being used for a period of time. I do not believe that they contribute to the overall permeability of the waste itself.

Q. Well, Mr. Crutcher, can you show me any studies your firm has done? You have told me you haven't done any pump tests on the hydraulic conductivity of waste and I take it now what you are saying is that each landfill is an entity unto itself and the design engineer may have certain numbers in mind but what happens out there may be another thing in terms of what exactly he can get in terms of a waste to cover ratio, for example; is that fair enough?

A. Yes. Landfills are where you are placing waste and you don't have uniform grade material being placed on a site and we have to recognize that.

Q. It is difficult to come to a definitive opinion regarding what could be called the bulk materials which you would want to determine in terms of looking at hydraulic conductivity of the waste. You don't have the studies which actually go in there and do that?

A. You can do it the other way around and look at the effect of what a 10^{-5} waste would have on leachate mounding in sites, and you get very, very high leachate mounds in sites. I am saying from my experience of sites I am involved in, quite a number of sites, I have not observed that kind of mounding within the sites, and some of them are with imperfect leachate collection systems and even with that, I don't see it.

If you look at the Bayview landfill site, we do not have that major a leachate mound within the Bayview landfill site. If we had 10^{-5}, I would suspect we would have leachate emanating at the top of the landfill site and pouring out all over the place but we have it at the toe of the landfill site.

Q. We are going to come to that, but as I understand what you are saying, if we find within a landfill site a mound of several metres -- how high, 5 metres or 10 metres?

A. I am going off the top of my head, but I think Dr. Rowe had something like 15 metres being developed up in Site D, or even higher than that, and that -- translating that back to feet, that is something like a 50 foot mound with the leachate collection system on the side, and I am saying that I have not seen that, seen that occurrence.

Q. What if we find a mound of say 5 metres, Mr. Crutcher, and what would you say about that?

A. It depends upon what the situation is and whereabouts on the site you are.

Q. What if it was a uniform height of leachate across the site of say 5 metres, and what would you say about that in terms of hydraulic conductivity of waste? What would that tell you?

A. It depends upon where the leachate collection system is. If you look at most sites, they are excavated down in the order of 3 to 4 metres as a typical excavation and you are talking of a mound that is 2 to 3 metres above the ground surface.

Q. What would you say if we had a significant mound within a site of say 13 metres?

A. I would say that you have quite a significant mound, and it is an atypical site.

Q. What would you have to say about the hydraulic conductivity of the waste in that situation or the daily cover?

A. I would have to look at the situation as I would consider it an atypical site and we should understand what is going on. There may be something unique about the particular site.

Q. It could also be quite consistent that either the hydraulic conductivity of the waste is 10^{-5} or your daily cover is less permeable than you have assumed; wouldn't that be fair?

A. As I indicated, I don't think daily cover plays a very major impact and the permeability of the waste, I think that would be something unique about the waste and it would not be a typical municipal waste.

Q. Let's come back to that point, but I want to ask you about one of the documents you introduced, the Fresh Kills report, Exhibit B-503, and there were a couple of aspects about that. This is one of the documents....

A. Are we finished with this?

Q. I am.

A. Would you like the map placed in the back of this report, as it's an exhibit. Oh, I'm sorry.

MR. ESTRIN: If I may have just a moment.

Q. I wanted to direct your attention to page 13 and we had to number these pages by hand as I recall.

MR. CRUTCHER: A. There are page

numbers, but my copy is not numbered.

Q. It is after Table 5.

MR. LANCASTER: It has 4-34 at the bottom.

MR. ESTRIN: Q. Yes, 4-34 at the bottom.

MR. CRUTCHER: A. I have it.

Q. The sentence begins at the top of the page, and this was put to Drs. Rowe and Charlesworth in their cross-examination:

"As seen from the data presented in Table 4, the calculated waste permeabilities are similar and range from 1.93×10^{-3} to 6.6×10^{-2} cm/sec. While these values may appear higher than that typically reported in the literature, i.e. 1.0×10^{-3} cm/sec as an average, they do appear reasonable for the Fresh Kills site."

That is as far as it was read, as my notes indicate, but can you read the next sentence?

A. "More particularly waste deposition during the early operation of the site took place without compaction with a waste space advancing into marsh

areas to provide firm support. This type of operation would yield loose, relatively permeable waste."

Q. That would be therefore -- it would not be surprising therefore to find and to attribute a range, a high range of 10^{-2} to 10^{-3} in that situation?

A. That is correct.

Q. Can we look at page 24, which is a table entitled Geometric Mean of In Situ Permeability Results, Fresh Kills Landfill.

DR. KINGHAM: It should be the last page in the exhibit.

MR. ESTRIN: Yes.

MR. CRUTCHER: Yes.

MR. ESTRIN: Q. Would you agree that the lowest permeability stated for in situ results was 10^{-6} and that -- including clay?

MR. CRUTCHER: A. All the values reported are in the 10^{-6} range and the lowest one I observed is a glacial sand at 1.9×10^{-6}.

Q. You wouldn't expect ordinarily to have glacial sand with such a low conductivity, would you?

A. I don't know what glacial sand

stands for. I presume it is predominantly sand, but it depends on the silt and clay content and the actual mixture.

Q. How about recent sand?

A. If it was sand or if you said sand, then I would not expect that permeability.

Q. Wouldn't it be fair to conclude that once you start placing more permeable materials or what would be expected to be more permeable materials like sand into a landfill site, then you are going to start changing the hydraulic conductivity values that you might ordinarily expect and get lower values?

A. As I indicated, I don't believe the cover soils play a very important role on the overall permeability of the waste.

Q. All right.

A. They do play an important role regarding the perching conditions within the site, but that is not referring to the permeability of the waste.

Q. Did you hear Mr. Hiraishi's evidence here or did you read it that he recommends stripping of the daily cover or tilling of it or something so we don't in fact get perching?

A. Yes, and I don't recall exactly, but something to that effect and that is very common.

Q. That would be important, particularly near the base?

A. It is important throughout the site.

Q. Isn't it true that the cover material which is being proposed to be used at Site D and material which when compacted as your firm did, has a hydraulic conductivity of less than 10^{-8} at least based on the older Golder results?

A. If you can compact it, yes, but as I indicated on waste as I have learned, you do not compact and waste has a spongy nature to it and you don't have the ability to actually get the compaction of that waste, nor is it normally done. It is done on final cover.

Q. That is what I am talking about, cover material.

A. Final cover?

Q. Yes.

A. If you are referring to final cover, there is an attempt to compact it.

Q. And intermediate cover?

A. Not usually.

Q. Don't you take equipment and get good kneading compaction by doing so?

A. They don't use compactors on a normal basis for interim cover. I am not aware of anybody doing that.

Q. Were you present when Mr. Hiraishi indicated to the Board he considered it possible the hydraulic conductivity of the waste could in places be 10^{-5}?

A. I don't recall that, but I can concur that in places it would be 10^{-5}.

Q. Then there was also some discussion, and this was by the way at page -- Volume 49, page 11204, and then....

A. Shall I get that?

Q. You don't need to. I am sure you can recall correctly or accept his evidence.

Then there was another aspect of this matter he was asked about and that was Exhibit H-41-D6 and that's behind you, and I wonder if you would put that up. He has illustrated on there in brown on cell 2 a hatched area?

A. Yes.

Q. That indicates intermediate cover?

A. I recall something to that effect. I don't see a legend on here, but that would make sense.

Q. I am reading from page 11198 of the transcript and it's just a couple of references, and I don't think you need to pull it out:

"Q. I want to look at H-41D6. Now, you have illustrated on there a hatched area on cell 2 where you have indicated intermediate cover would be used. You, I think, described it in evidence as being a minimum of one foot but probably closer to a metre.

A. I would think that is the way it would be, yes.

Q. That intermediate cover of up to a metre or closer to a metre, would that stay there?

A. I would think that operationally it would be more prudent to leave it alone than trying to scrape it off. I believe if it is closer to a metre, and that knowledge was in fact true that you may be able to scrap off a foot or two of that but clearly we are not in a position of wanting to dig out that material and so that we don't want to get into a situation where the recovery

of that material would mean that wastes are exposed. My recommendation would be that they not touch that area.

Q. That same intermediate cover concept would apply, as I understood your evidence between each cell?

A. Generally that would be the case, yes, with the except of cell 5 of course which is the last cell to be filled."

Do you accept that that is what the transcript says and what Mr. Hiraishi said, and you have no reason to question it?

A. You read it, and I am assuming you read it correctly, so I accept that.

Q. That means in effect that if Mr. Hiraishi's design recommendations are followed, there will be an intermediate cover between each of the cells, except cells 5 and 6, which could be up to -- I am sorry, there are only five cells, except with regard to cell 5 -- perhaps up to a metre thick, yes?

A. That's what it says, yes.

Q. You are talking about cover material from this site which your range for the in situ value of that clay material is somewhere between 10^{-7} and 10^{-8}. Is that your value?

A. We have indicated in situ it is 10^{-8}.

Q. What I am suggesting to you, Mr Crutcher, is that there is going to be significant areas of the site if this recommendation for design is carried forward, that will have a metre of 10^{-8} intermediate cover material and 10^{-8} -- a metre thick is what you are suggesting would be a nice liner at Site F?

A. First of all, as I have indicated, you wouldn't be able to get that placed at 10^{-8} and I would say the best you could probably get would be about 10^{-6}. That statement would have an effect on the perching conditions within the site, or as a potential, depending upon what angle. I would recommend if they were going to leave it in place, that they make hydraulic connection, which means you would take a backhoe and excavate out portions of it so there are holes within that to ensure hydraulic connection across the unit. These again are a common item to deal with.

If that was not done, it doesn't really control the overall site as each cell is essentially designed on an individual basis, and it would not really control the bulk permeability of the waste.

Q. But what that could mean, and I

discussed this as well with Mr. Hiraishi, I believe, is that if you have a relatively impermeable layer between cells, you then produce an ideal situation for hydraulic connection between cells of waste above that impermeable layer. Do you follow what I am saying?

A. No.

Q. Perhaps you could sketch -- take a flip chart and sketch a couple of cells in cross-section and say looking from the west side of the site?

A. I think they would look the same from the east.

Q. All right, it doesn't matter. Now, let's put in some waste?

A. Do you want it mounded?

Q. Sure.

A. When the waste is below the level of the original ground, there is not a lot of opportunity for hydraulic connection between those two cells, fair enough?

A. Correct.

Q. But once the waste starts to mound physically higher than that original ground surface, the opportunity for hydraulic connection between two cells is good, and in fact you would expect it?

A. Yes.

Q. Wasn't it the failure of the leachate collection system within two cells that Dr. Rowe was considering for total failure?

A. I recall something to that effect. Is that your question?

Q. Yes, thank you.

Can we turn to the Waterloo landfill report, and this is another CRA document. This is the interim report, excerpts from your interim report. I just wanted to turn to page 72, and this is another report called interim report of May, 1986 on the investigation of the proposed expansion area, the same geographic area we were considering in the last exhibit, the Waterloo expansion.

A. The report deals with the existing Waterloo landfill site and the expansion areas and you must be careful because Waterloo is a rather confusing site from a logistical explanation point of view. We have an existing landfill site in the centre and we are dealing with expansion to both the north and south and then you can get into a discussion of what is approved at the site and what is not approved, so you have to be very careful in going through the documents.

Q. If you start at page 71 under the heading Predicted vs Measured Leachate Volumes, you are

talking about the results of monitoring of leachate levels in the leachate wells during the period of March 1985 to April 1986. I understand here in this portion of the site, Mr. Crutcher, there is no leachate collection system; is that right?

A. Yes, this is in the existing site or the central part.

Q. No leachate collection system?

A. No.

Q. We are talking about a situation where if we wanted to think in terms of Site D, we could compare it to Site D with the leachate collection system not working?

A. Assuming you had an even base grade, yes, but note that there is not on an even base grade.

Q. Where?

A. Here.

Q. That may produce -- it is not even so it is sort of undulating?

A. I think in the old days they didn't really pay attention to excavating to base grades and they landfilled where there were hollows.

Q. But it is undulating and it's not one defined slope?

A. I think there are some significant undulations in the base grade, but we do not know as there has been no field verification of that.

Q. It says:

"Leachate has accumulated to a level of approximately 3.7 to 5.5 m.... above a base grade of about 378 m..... However, at LW11-80, the level was substantially greater, but the well has been destroyed. LW10-80 which is terminated in native materials 6 m above the base was found to be dry."

and can you read the next two paragraphs?

A. "Examination of this data indicates general agreement between the observed leachate levels in LW18-85, LW19-85, and the bottom screen elevation at LW10-80. However, the measured level at LW11-80 may preclude the possibility of a uniform level across the site, and indicate that substantial mounding of leachate has occurred. On the other hand, it may simply represent a perched condition, and is not hydraulically connected to the other wells."

Q. Read the next paragraph.

A. "It is very difficult to ascertain whether the measured levels in the leachate wells reflect a more or less uniform height of leachate accumulation across the site of about 3.7 to 5.5 m (12 to 18 feet) above base grade, or a significant leachate mound within the site of about 3.7 to 13.4 m (12 to 44 feet) above base grade. However, in order to verify the predicted leachate volumes in 1986 the existing leachate volumes were estimated by assuming a refuse porosity value of 0.4 and an existing landfill area of 26 ha (65 acres)."

Q. So what this report is saying is that it was very difficult to ascertain whether measured levels in leachate wells were reflecting a less uniform height of leachate, 3.7 to 5.5 metres above base grade, or a significant leachate mound within the site of 3.7 to 13.4 metres?

A. Yes, dealing with a historical site.

Q. In other words, your report or

your firm's report was indicating there may be what you term as a significant leachate mound of 13.4 metres maximum?

A. I am going from memory here, but if I recall, the wells we were dealing with, one well found the elevation of the base grades at an elevation of 1260 and the base grades were supposed to have been at 1240 and so we had a 20 metre undulation under the base grades. In fact, that is why I was indicating that we may have quite a pocketing effect within the site itself.

Q. Mr. Crutcher, as I understood what you were saying a few minutes ago, you were saying that one of Dr. Rowe's models took the leachate up to I believe it was 15 metres?

A. As I recall it was something like that.

Q. That sounded to you like it was implausible or incredible and yet your own report is saying that you may indeed have such a mound at Waterloo?

A. At one location, which to my mind is quite explainable.

Q. In fact your own report was suggesting it could possibly have occurred, whatever

the explanation?

A. We were giving the options and my personal opinion is that it's caught within the centre of the site in a pocket and that is somewhat verified by the base grade elevation we determined. The Region of Waterloo was supposed to have cut the landfill site down to an elevation of 1240 and we were told they cut it down to 1240, but when we installed a leachate well, we found one of the base grades was at 1260 and it happened to coincide with where there was an elevation of land and it appears what they did in the mid-70s, they landfilled in the valleys and didn't level it out ahead of time. That to my mind perfectly explains the leachate levels.

Q. Let me give you....

A. The site was not designed at that time and we are dealing with an existing historical site.

Q. I understand that, we were dealing with a site that has the equivalent of a leachate collection system that doesn't work.

A. The equivalent -- it doesn't have a leachate collection system because we have just recently installed on the west side of the site a leachate collection system, on the periphery.

Q. It's the same situation as if there was a leachate collection system and in part of the site it wasn't working; and wasn't it a 13.4 metre mound?

A. I am also indicating that it is within a hollow in the site and bounded, I believe, on all sides. It's within a valley within the site itself, so it's a bathtub within the site.

Q. Would you agree with me that one reasonable explanation for variation in leachate levels across this site could not only be undulations, but significant variation in the hydraulic conductivity of the waste. Wouldn't that be a reasonable explanation as well?

A. I am also thinking of Waterloo -- not so much Waterloo, but at one of the other regional sites, the Kitchener regional landfill site, I learned through working on the site that they used a very large amount of cover soil relative to waste. It was about one to one, which really doesn't do well in landfilling and if that was transferred to Waterloo, then that would affect the permeability of the waste.

Q. Sure.

A. That was the occasion where I could say yes, it would be significant, a one to one

ratio. As you will note, the sites are not designed on a one to one basis, nor is there enough soil to deal with it on a one to one basis. That means for every yard of refuse you put a yard of soil in the site and if you consider the cost of establishing a landfill site, you don't want to waste it with placing that much soil. That may be a possibility, but I could not concur that I in any way believe that the refuse itself will have a bulk permeability of 10^{-5}.

Q. I am suggesting, Mr. Crutcher, we really don't know all that much about the hydraulic conductivity of waste and we are not sure about the permeability of the daily cover and how much daily cover is actually put on. Is that fair?

A. Historically there may be a little bit and in current sites I don't concur at all. Where you have got a fully engineered site, no.

MR. HODGSON: Could Mr. Estrin give us an opportunity to review the entire report from which this is an extract?

MR. ESTRIN: I have it here and I certainly would.

MR. CRUTCHER: I believe that is the report you held up before the Board.

MR. LANCASTER: The Board should see it

as well.

MR. ESTRIN: What I want to suggest is that even if a site were redesigned to 10^{-5} waste to cover -- designed to deal with waste that was 10^{-5}, taking into account daily cover, et cetera, the hydraulic trap of even that kind of site may fail, fair enough?

MR. CRUTCHER: I think Dr. Rowe indicated -- I think he thought you could design around that and I wouldn't do that because I think it's a waste of taxpayers' money, but I believe you can design around that. If in fact that was a design parameter, I believe you can design around that fact.

MR. ESTRIN: Q. You have the question reversed. Assuming you wanted to be as conservative as your design document for Waterloo is and design for 10^{-5}, even if you have done that, the hydraulic trap may fail for other reasons. The hydraulic trap could fail because of clogging or other reasons and that's all I'm asking.

A. Then your question has nothing to do with 10^{-5}, but whether the hydraulic trap can fail and my answer is yes, the hydraulic trap can fail in areas.

Q. Even you designed at 10^{-5}, that

doesn't mean you have necessarily stopped the site from having an adverse impact, fair enough? That is if you get events you don't want to have happen such as clogging of the leachate collection system?

A. If you have designed to 10^{-5}, and the reason I believe 10^{-4} is a conservative value then you have over-designed your leachate collection system and over-designing the leachate collection system will then help minimize the occurrence of a failure because you will have quite a level of redundancy within the system itself. So, if in fact you do design to that, that to me says that your level of problems at the site are even less because of that redundancy level. It's a cost item which you have to weigh, and I would not recommend it to this Board.

Q. You seem to have shown a lot of concern about the people in Aldershot who don't use the groundwater and who have an alternative water supply. How about your concern about the people at Site D who have used the groundwater and have no other source? I don't seem to get the same sense of concern about them.

A. Most certainly I have that concern, but I indicated that I felt any major landfill site should be designed with the best practical technology and I believe that that is being applied at

both sites...

Q. I would suggest the most practical and most conservative values are those espoused by your firm in their recommendations to the Region of Waterloo and that's 10^{-5}?

A. I can assure you that is not what is being espoused by the firm.

Q. Does that mean Mr. Puskas no longer works for your firm?

A. No, it means I am going to have a discussion with Mr. Puskas, because it means he obviously must bone up on the literature and what is reality.

MR. ESTRIN: Mr.Chairman, could we please take a break?

MR. LANCASTER: Yes, ten minutes.

--- Recess

MR. LANCASTER: Thank you, please be seated. Mr. Estrin, you left with us what I have marked as M-718, the Waterloo Interim Report.

--- EXHIBIT No. M-718: Extracts from Hydrogeologic Investigation, Interim Report, Existing Waterloo Landfill and Expansion Area.

MR. LANCASTER: Will you produce the entire report, or other parts of it?

MR. ESTRIN: I have no need to refer to

other parts, and I can produce the whole report for my friends to examine, but the whole report is over one hundred pages.

MR. LANCASTER: I realize that. For your purposes, this would suffice?

MR. ESTRIN: It would be sufficient, but I am happy to let my friends look at the whole report and if they want to do something further with it, they can.

MR. LANCASTER: We can do that later, but we can mark this M-718, the excerpts presented so far.

MR. ESTRIN: Thank you.

Q. I will give this to you while you are waiting for your colleague, you might recognize it. We'll have your whole life history here.

MR. CRUTCHER: A. I can see that.

MR. PETRIE: Excuse me. I apologize.

MR. ESTRIN: Q. These questions, except for a couple, are for Mr. Petrie.

MR. CRUTCHER: A. I would like to make one point. I had an opportunity at the break to read this report you provided me and there is one other important comment I should make about the report.

Q. Which report?

A. M-717, the Waterloo landfill technical memorandum, the leachate collection system design. I note just after the paragraph you had me read on page 7, it says right under hydraulic conductivity of waste, mid-way in that paragraph:

> "The expansion areas of the Waterloo Landfill are expected to be operated as a shred landfill. The shredded waste will provide a more homogenous material then (sic) a conventional landfill, however, the compacted waste will have a greater density. No data is available on the hydraulic conductivity of the shredded waste."

That is a rather important statement and in fact it may reflect why Mr. Puskas used the 10^{-5} on the basis that it has a higher density. I should also note that there is no longer going to be shredded fill and that is no longer being proceeded with, but I think that is a rather important distinction and I felt perhaps I was a bit hard on Mr. Puskas, because in fact that would be a consideration worthy of following up on, the fact the Region was proceeding with a shred fill.

I would also note on page 12, we were

doing a section on leachate head versus drain spacing and were using a model and the model was referred to as the HELP model, a model called -- HELP stands for hydraulic evaluation of landfill performance, and if you look at the end of page 12, the last sentence, it says:

"It is noted that the default hydraulic conductivity value for refuse used in the HELP model is 1.0×10^{-4} cm/s."

And I think that demonstrates that is an industry-wise value.

Q. Mr. Crutcher, as the report indicates, there does not appear to be data available on the hydraulic conductivity of shredded waste, right?

A. That is correct.

Q. Assuming shredding is put into this site. Mr. Crutcher, Waterloo was considering going to shredding for some of its waste?

A. For the bulk of its waste, but it turned out to be prohibitively expensive.

Q. However, that certainly may be the situation given Halton -- what has been indicated here about Halton's dilemma of dealing with waste. The point is dealing with waste is expensive relatively speaking no matter how you cut it, it seems?

A. Excuse the pun.

MR. HODGSON: Metaphorically speaking.

MR. ESTRIN: Q. Is there any reason to be categorical and say the Region of Waterloo may not want to shred waste for disposal at Site D or Site F in the next twenty years? You can't say that wouldn't be prudent?

MR. CRUTCHER: A. The site -- you have to look into the feasibility of that and what I learned in Waterloo is the costs of the shredding are astronomical and I think it ended up to mean something like a capital cost of $120 million and that was a pretty high cost and the Region took it out of their master plan.

Q. That may be an incredible cost, but there are incredible costs associated with the handling of the Region of Halton's garbage over the next two or three years, between now and the actual operation of a new landfill site, whether at Site D or Site F, and if you read the Globe & Mail yesterday it says about $48 million in terms of trucking it somewhere else?

A. The quote I gave you was for just shredding the waste, not all the other associated costs, and the incremental benefit is quite small on

the shredding itself.

Q. That is because you really don't get much greater density compaction, do you?

A. The estimates were going from 1400 to 1700 pounds per cubic yard, and typically we are getting 1000 to 1200 pounds.

Q. So between 5 and 10 per cent?

A. I would say more like 20 per cent or something in that order, but there is a handling problem and a portion of the waste cannot be shredded as well. You have to take that into account. I was not involved in the actual numbers, but just involved -- I was just around during project meetings.

Q. I have a report by MacLarens to the Regional Municipality of Waterloo on the feasibility of shredding municipal waste?

A. What is the date of that report?

Q. May, 1986. It says, it appears, if you will read with me from page 1:

"In addition, it appears that the in situ density of the waste might increase by at least 5 to 10 per cent over that of conventional landfilling."

A. That may be overall, but I indicated portions of the waste -- portions of the

waste cannot be shredded and overall that may be the case.

Q. In effect, you may not be having any significant effect on either the density overall or the hydraulic conductivity overall?

A. You may not.

Q. Yes.

A. All I indicated was that when I noted that, I suggested it was something we should take a look into and maybe Mr. Puskas was taking a step ahead and I was a little hard on him.

Q. It would be nice to allow the Region of Halton flexibility over the next twenty years to do something like shredding, if that was their choice too, wouldn't it?

A. I learned that the feasibility of shredding is out to lunch and so I doubt that would ever happen, and if it was part of the application, then you would have to look into that matter.

Q. It may not have to be part of the application.

Now, Mr. Petrie, you have indicated to the Board that you consider Dr. Rowe's case 1, which corresponded to Trow's failure case, as reasonable?

MR. PETRIE: A. I believe I have, yes.

Q. That's in your witness statement. Would you please indicate to the Board just exactly what this failure represents in terms of numbers of cells? Would you agree that it is basically two cells he was considering, or what is your understanding?

A. I think Trow was considering, and I don't recall the number of cells they considered, but I noted they have a leachate head in the system and one can relate that to any number of cells.

Q. It could be one cell for example, or two?

A. It could be one or two.

Q. Dr. Rowe's failure scenario considered two cells?

A. Could I check on that? I thought it was a total failure and a partial failure. My recollections are two cells.

Q. All right. If you learn differently overnight, perhaps you could tell me tomorrow?

A. I will.

MR. McQUAID: If it is important to have it, let him look at the document now and let's get it on the record right now, rather than spending every night looking up data and checking things over.

MR. PETRIE: A. I am looking at page 27 of M-442, Dr. Rowe's report, page 27, which addresses the cases considered and I don't see a reference to two cells.

MR. ESTRIN: Q. It's based on a length of 575 metres and we may have to go to the exhibit, M-442 to have that more fully described?

MR.PETRIE: A. I see a length of 575 metres, but I cannot relate that to cell geometry.

MR. McQUAID: I might say it seems to me that Mr. Estrin should not be cross-examining the witness on what his own witness has said, or cross-examining Mr. Petrie on what his own witness said, and if it's important that it is one or two cells, then Mr. Estrin should check that before he puts the question. I know there were two possible cells Dr. Rowe said he considered might fail in a certain area, but whether it was at the same time or separate, I don't recall.

MR. ESTRIN: It's not important for the purposes of these questions that we answer the question right now, and if Mr. McQuaid wants it answered, let's do it.

MR. McQUAID: You were the one who asked him to check.

MR. ESTRIN: I thought he would know the

answer and I didn't consider it important, but go ahead.

DR. KINGHAM: The Board is a bit confused, I must confess, on this point, because case 1 says no leachate collection and the L value, as we understand it, applies to cases 2 to 12 and not case 1 and I am not sure....

MR. ESTRIN: Case 1 is Trow's case.

DR. KINGHAM: Isn't that the case to which you are referring, case 1?

MR. ESTRIN: Initially. I was asking Mr. Petrie what he understood by that failure scenario.

Q. You were saying what, you understood it to apply to the whole of the site?

MR. PETRIE: A. I did not understand it was specific to any portion of the site, but I understood Trow assumed no leachate collection system and imposed a head within the landfill as a driving force and then undertook an impact assessment based on a hydraulic head, i.e. a driving force. I believe the arguments would apply to each or any cell.

Q. "Each or any"?

A. That is my belief, but I do not recall that Trow specified that, because my understanding was a surmising of Trow's discussion to

that effect.

Q. I thought you said you supported Trow's failure analysis, impact assessment?

A. Their failure assessment was based on the leachate head, and I believed the leachate head and gradient they used were appropriate for a failed system.

Q. But you are not sure over what area it was applicable?

A. I don't recall that Trow addressed that.

Q. Are you sure about what mound of leachate Trow's failure scenario represented?

A. Right now, no. I recall the discussion was provided during cross-examination or in-chief, and I believe Trow used a gradient as a driving force and they were asked to provide what that head was for the gradient they used, and I do not recall the specifics of the discussion.

Q. I think you will find the evidence is that it represented a mount of leachate six metres above the base of the landfill. Let's assume that.

A. I can assume that. Can I make a note to that effect?

Q. Sure. That would be an average

height.

A. You are assuming that?

Q. I am asking you to assume that and if you wish to check it, fine.

A. I can assume that that is Trow's case 1 or Dr. Rowe's case 1, which is Trow's case, that it assumes a 6 metre mound as an average mound.

MR. McQUAID: May I just make the point that if there is an assumption to be given based on evidence we have already heard, it's the responsibility of the lawyer, whether it is Mr. Estrin or me or anyone else, to be sure to put that assumption correctly. The witness doesn't have to go back and check if Mr. Estrin is right or not. If that's what the evidence was, then the lawyer is to say, I want you to assume that and that is what the evidence was and the other lawyers can check it, but I don't think the witness has to.

MS. CRONK: He did say that.

MR. McQUAID: He said if Mr. Petrie wants to check it, he can do it.

MS. CRONK: I'm sorry, it's late in the day and it's been a long day, but as I heard Mr. Estrin, that's precisely what he said, he said, "I can't remember," and Mr. Petrie said he couldn't remember and you said, "Fine, you can check if you

wish." It's standard practice in reviewing evidence particularly in a lengthy hearing of this kind that you don't have immediate recall of the page reference at your fingertips, but you believe in good faith you are stating the evidence correctly, to say as we have heard over the last few weeks, assume that that is the evidence as I have suggested it to you and if you wish to satisfy yourself, you are free to do so and that is all Mr. Estrin did.

MR. McQUAID: I agree, but my point is that the responsibility is on Mr. Estrin.

MR. ESTRIN: With the greatest of respect, this witness has come to the Board said he thinks Trow's failure scenario modelling is peachy keen but he is not able to remember what it's all about and he doesn't know how big a site it involved or what head of waste it involved and I thought he might have some idea.

Q. In any event, can we assume a 6 metre mound?

MR. PETRIE: A. We can.

Q. Now, Mr. Crutcher, please, I showed you an article you wrote with others at the break and you are a co-author of a paper with McBean et al and would you confirm that this paper deals with a

technique for calculating the height of mounding above the base of a landfill for a landfill which has a base slope?

MR. CRUTCHER: It does.

Q. Would you also confirm....

MR. McQUAID: Could we have copies?

MR. ESTRIN: I am not tendering it.

Q. Would you confirm the slope of the proposed landfill for Site F is approximately 4 per cent?

MR. CRUTCHER: A. I thought it averaged something like 2 per cent and it had a slope and I thought the average was 2 per cent, but I would have to check that.

Q. Could you check that overnight?

A. I can.

Q. Whatever the slope, whether 2 or 4, and I would like to have your evidence on that in the morning, based on the equations given in the paper you were a co-author of, would you agree the average depth of leachate mound between two collection tiles will decrease as one increases the slope?

A. Yes. In fact, I have just recently completed calculations on the head, or I will when I have completed, because they are not completely

finalized, but the head calculations on the liner which has a slope consideration and it does have an effect. The numbers that Mr. Hodgson provided was assuming without a slope and I was doing the more sophisticated calculations with the slope and it does have an effect.

Q. Am I correct in understanding that all other things being equal, the equations in that paper show that the steeper the slope, the lower the average height of mound?

A. Yes.

Q. Could you take a flip chart and illustrate what we have just been discussing?

A. That is very simplified, but if we have a flat base for instance, you develop a mound between two leachate collectors, and at the centre I have labelled it as X_1 and if you have a sloped landfill you will have a mound developed between the two collector pipes which is not centred within the pipes and I believe, if I recall, it's a little bit more on the downslope side, as X_2, and X_1 will be greater than X_2 and it depends upon the situation. You can engineer around various scenarios to get the head by placing drainage -- you have a number of options available for adjusting the head and the closeness of the leachate collectors by the placing of the drainage

blanket or sloping the base, and there are quite a number of options available to control the head within the site.

Q. Would I be right in saying that you can fill a bathtub that is flat higher than one that's on a slope?

A. The analogy doesn't quite apply, but essentially that is true.

Q. When you have a slope, it runs down the low side essentially?

A. To some extent, yes.

Q. Now, could we turn to Exhibit 617, and I guess we should come back -- you can stay with us, Mr. Crutcher. Exhibit 617 is the Site F report, page 157, page 157 of B-617?

A. I didn't know it went that high.

Q. This may be a typographical error. No, there is a page 157.

A. We were certainly verbose.

Q. Can you please read the paragraph that begins "Mounding"?

A. "Mounding of leachate within the landfill will effectively increase the horizontal... gradient in the underlying shale."

Q. The horizontal hydraulic gradient?

A. Yes, in the underlying shale.

Shall I read the whole paragraph?

Q. Please read that whole paragraph.

A. "For an assumed leachate mound of approximately 6 m and assuming the hydraulic head in the shale at a point 300 m downgradient does not change, the horizontal hydraulic gradient increases to approximately 0.05. The groundwater flux in the underlying shale increases to 47.3 to 94.6 m^3/yr respectively for the thickness considered above. Again, assuming that all the exfiltration from the landfill exits the system laterally, a potential exfiltration rate of 37.8 to 75.7 mm/yr respectively is calculated...."

Q. Read the last sentence.

A. "This scenario does not provide an exact measure of exfiltration, but does demonstrate that a conservative exfiltration estimate from the base of the landfill in the range of 50 to 100 mm/yr is reasonable."

Q. To summarize to this point, I take it you consider a 6 metre mound at Site F and you calculate the corresponding exfiltration into the shale to be between 37.8 and 75.7 millimetres per annum and then, to be conservative, at the bottom of the page you round these numbers to a range of up to between 50 and 100 millimetres per year?

A. That is correct.

Q. My question is, if you have a 6 metre mound at Site F where the base slope we will assume is at this point 4 per cent; for the same failure conditions, would you not have even a greater mound at Site D where the base slope is only 0.25 per cent?

A. Could you say that again?

Q. Sure. If you have a 6 metre mound at Site F and let's assume a base slope of 4 per cent, a sloped base?

A. Yes.

Q. For the same failure conditions, would you not have an even greater mound at Site D, where the base slope is only 0.25 per cent?

A. Yes, you would.

Q. Mr. Petrie, let's assume the failure scenario that Trow considered involved a 6

metre mound at Site F, all right?

MR. PETRIE: A. I am not sure Trow considered a failure scenario at Site F with respect to mounding.

Q. Let's consider that in their failure scenario, there was a 6 metre mound?

A. Do you mean Site F or Site D?

Q. Was there no failure scenario by Trow for Site F?

A. I don't think they detailed it with respect to mound.

Q. My recollection is that Mr. Sobanski said you could assume the same scenario for the purposes of calculation at Site F and have you any recollection?

A. No, I do not.

Q. I guess we'll both have to check. If a failure scenario at Site F involves a 6 metre mound, I suggest it would be reasonable to expect a greater mound at Site D under the same conditions and that is what Mr. Crutcher has essentially told us?

A. I believe Mr. Crutcher was referring to the mound height developed on the slope between specific drain spacings. I recall when Trow described their failure scenario, they just said no

collection system working, but I don't believe they used the Rothe equation to define what that head meant, they just took a head, or they took a gradient to define their failure condition.

Q. Let's go back to page 157 of your Site F report, B-617, and let's go over the paragraph I just had Mr. Crutcher read out and that is, "Mounding of leachate within the landfill..." talking about Site F.

A. We are on page 157.

Q. You say:

"For an assumed leachate mound of approximately 6 m, and assuming the hydraulic head in the shale at a point 300 m downgradient does not change.... there will be an increased hydraulic gradient and increased groundwater flux."

A. Correct.

Q. And an increased exfiltration rate?

A. Correct.

Q. You have assumed in considering Site F in terms of assessing its impact, a scenario where there is a 6 metre mound?

A. Correct.

Q. What I am saying to you is that based on what Mr. Crutcher has just told us, if you can assume a 6 metre mound at Site F, I am suggesting it would be reasonable and consistent with Mr. Crutcher's work and his testimony to expect the same mound would be higher -- the same conditions would produce a mound that is higher at Site D?

A. It may be reasonable, I believe, to evaluate the reasonableness of that and one would have to examine the cell geometry. I also believe both Trow and Dr. Rowe assumed the peripheral drains, and I am not sure that's the correct engineering term for it, but the peripheral drains were working. I do not have the relative geometry of those in my head, and so there are some other facts which impinge upon that number.

Q. Have either of you gentlemen previous to this moment calculated, if you have assumed as you have at page 157 of your report, a 6 metre mound at Site F, what the failure conditions that produced that 6 metre mound would produce at Site D, given Mr. Crutcher's writings and testimony on this topic?

A. I have not.

Q. Have you, Mr. Crutcher?

MR. CRUTCHER: A. The sites are

different, so you can't take a direct relationship between the two because of different design, but no, we have not, or I have not calculated nor has Mr. Petrie done any direct calculations. The 6 metres came from a value I gave Mr. Petrie, and it was essentially off the top of my head and was -- Dr. Rowe, I believe, used a value of 18 metres....

Q. That was one of his twelve cases?

A. That was one of the values used and I thought that was ridiculous and off the top of my head I indicated to Mr. Petrie use something like 6 metres and that as much thought that went into that particular number.

MR. PETRIE: A. Could I make a comment?

I think what Mr. Crutcher meant was a reference to 18 metres and that was for Site F and the 12 cases I believe relate to Site D.

Q. All right. I am suggesting, and I wonder if you can agree, but it would not be consistent if you are considering a 6 metre mound at Site F to suggest that you can't get more than a 6 metre mound at Site D. It would not be consistent with Mr. Crutcher's work and testimony?

A. Mr. Crutcher indicated the mound height is also a function of landfill geometry and I

can't speak to the landfill geometry.

Q. Neither of you have done that calculation, so neither of you are in a position to suggest that based on the calculations reported by Mr. Crutcher in his paper, a 6 metre mound -- a mound greater than 6 metres would not be unreasonable?

A. I am sorry, which site are we on?

Q. Site D. I want to end up at Site D. You have assumed a 6 metre mound at Site F, a sloping site, and Mr. Crutcher says if you compare a sloping site and a flat site you will get a higher mound on the flat site and you have assumed a 6 metre mound on a sloping site, Site F, and I suggest the same conditions that produced that 6 metre mound at Site F would produce a higher mound at Site D?

A. Again I can only repeat that the landfill geometry impacts on that calculation and I haven't done that calculation.

Q. That landfill geometry is one thing in the formula, Mr. Crutcher?

MR. CRUTCHER: A. It is. The calculation would have to be done to properly answer that question.

Q. Mr. Petrie, the exfiltration of 50 to 100 millimetres per year that you have indicated is

reasonable at Site F, right?

MR. PETRIE: There has been additional discussion on that, yes.

Q. You said it was reasonable at page 157?

A. I believe we indicated that 50 was the most reasonable number of the range and 100 millimetres per year was not unreasonable in discussion.

Q. That is based on an average mound over the entire site of 6 metres?

A. It stems from it in part and it's not a direct relationship.

Q. But it included that assumption?

A. The assumption of 6 metre mounding gave exfiltration numbers as you see them before you and we took a conservative value from that to estimate that exfiltration could range from 50 to 100 millimetres per year.

Q. The second sentence in the paragraph in the middle of page 157 says:

"For an assumed leachate mound of approximately 6 m...."?

A. That is what that sentence says.

Q. What I am suggesting to you is

that a 6 metre mound which you have assumed over Site F, the entire Site F, either represents a large scale failure or a hydraulic conductivity of the waste of about 10^{-5}?

A. In the absence of doing calculations, I couldn't answer. We noted that Dr. Rowe, when he did similar -- or it's my opinion, because he may have a different opinion, but he had used a head build-up at Site F of 18 metres, and we felt that was rather an excessive head build up and were a head build-up of 18 metres to have occurred, then I believe the site operators would be aware of it and be instigating some sort of remedial activity to prevent additional build up. We felt 6 metres was a more reasonable number.

I also note at Site D, I believe, Dr. Rowe only considered a maximum failure height of 15 metres.

Q. My question is very simple.

A. Perhaps then I am misunderstanding.

Q. You have a 6 metre mound that you have assumed at Site F and you have produced some exfiltration numbers and that mounding is one of the parameters in the exfiltration?

A. That is correct.

Q. I am suggesting the only way you are going to get a 6 metre mound at Site F is on the basis of a large scale failure of your leachate collection system or by having a hydraulic conductivity of the waste of about 10^{-5}?

A. I responded that I believe that until I do the calculations, I cannot answer.

Q. Let me suggest you get a 6 metre mound from 50 metre spacing?

A. I am sorry, I just want to make a note if you want to go a bit slower.

Q. Perhaps you can check this. You would get a 6 metre mound if your leachate collection system pipes were 50 metres apart and the hydraulic conductivity of the waste was 10^{-5}?

A. A 6 metre mound for a spacing of 50 metres.

Q. And a hydraulic conductivity of the waste of 10^{-5}?

A. What is the infiltration you have used for that calculation?

Q. Perhaps you can let us know.

A. Perhaps I can. You are giving me two variables, and I can examine a third variable, yes.

Q. Mr. Petrie, if you have a 6 metre mound over the entire area of Site F where there is a 4 per cent slope, isn't it -- I am sorry, you're writing?

A. I'm sorry, I was reading.

Q. If one could have a 6 metre mound over the entire area of Site F where there is a 4 per cent slope, isn't it equally possible that you could have a failure of only two cells at Site D?

A. I don't see the two are related. You could have a failure at Site D of two cells independent of Site F.

Q. Of course. I am suggesting to you that the scenario which envisions and which tries to assess the impact of a failure of only two cells at Site D is more realistic in a way than trying to assume a 6 metre mound over the entire Site F unless you want to take a K of the waste of 10^{-5}?

A. I believe we have indicated we don't consider that appropriate.

Q. Right. I think you have driven back -- if you don't want to take that assumption -- to the fact you are assuming a 6 metre mound at Site F because of a large scale failure over the bulk of the site of your leachate collection system, and I am suggesting Dr. Rowe has been much more reasonable than

that and only wants to consider a failure scenario involving two cells in Site D?

A. At Site F I believe he used a value of an 18 metre mound.

Q. That is not being responsive to my question.

A. I am sorry, then I am misunderstanding you.

Q. I'll try again. Your 6 metre mound from page 157 of your report...

A. Site F report.

Q. Site F report.

A. An assumed mound.

Q. You are talking about an assumed mound of 6 metres, and you have calculated exfiltration and other values. The exfiltration values I suggest that you have reported there on 157, 50 to 100 millimetres, were based, I suggest, if you go back and look at your calculation, on an average mound over the entire site, Site F, and that's all I'm suggesting right there and is that fair and can you agree?

A. I have indicated we haven't done the calculations, and perhaps that is why I am getting confused with your question.

Q. Can you check that overnight?

A. Can I do some calculations to that effect? I can.

Q. Specifically, did you not have to assume an average mound over the entire Site F in order to come up with your 6 metre mound to get the exfiltration you have reported on page 157?

A. We assumed the mound and it is across the entire site, in order that a stronger driving force would be generated, and if that's the case; that stronger driving force is the gradient which enters into the calculation.

Q. So you can answer, you did assume a 6 metre mound over the entire Site F for the purposes of that calculation?

A. Correct.

Q. I suggest the only way you can get that 6 metre mound at Site F is based on a large scale failure over the bulk of the site, your leachate collection system, or a hydraulic conductivity of the waste of 10^{-5} and you reject that proposition and I am suggesting to you that the calculations you present in your report have to be based on an assumed large scale failure of the leachate collection system at Site F?

A. That appears reasonable on the face of it, but, as I indicated, we have not done the

calculations and this was an assumption.

Q. I am also suggesting to you that you were prepared to accept for the purposes of presenting data to this Board, a 6 metre mound over the entire area where there is a 4 per cent slope; right?

A. Correct.

Q. I'm asking you, isn't it....

A. I'm sorry, I don't mean to interrupt, but I'm not sure of the 4 per cent slope.

Q. You are going to check that, there is a more significant slope than at Site D?

A. Yes.

Q. Isn't it at least equally possible, and this is my question, that you could have a failure of only two cells at Site D, and you say -- I don't know if you follow the question?

A. I'm sorry, it's late in the day.

Q. Well, I'll try. Your failure scenario on page 157 assumes a 6 metre mound over the entire Site F?

A. It does.

Q. That has to be based, unless you go to a K of 10^{-5} of the waste, on a wide scale failure of the leachate collection system?

A. That is presumably the result of

your calculations.

Q. It seems reasonable and it is inherent in your calculation?

A. I am sorry.

Q. Which you haven't done, but it would be if you considered it. I am suggesting, Mr. Petrie, that you were prepared to assume this 6 metre mound over the bulk of the site and Dr. Rowe has been much more conservative in a way, or perhaps you might call it realistic, I don't know what you want to call it, by only wishing to discuss a failure scenario at Site D that involved two cells?

A. The use of a gradient as it is input into either the calculation for exfiltration or an impact assessment regarding contaminant travel times is just a gradient, and I don't know that it has to be related back to the area of the site. I am sorry.

Q. I am sure you will want to think about that overnight?

A. Yes.

Q. You told me a minute ago the 6 metre mound was assumed for the entire site to produce your exfiltration?

A. For Site F?

Q. Yes.

calculations and this was an assumption.

Q. I am also suggesting to you that you were prepared to accept for the purposes of presenting data to this Board, a 6 metre mound over the entire area where there is a 4 per cent slope; right?

A. Correct.

Q. I'm asking you, isn't it....

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A. That is presumably the result of

your calculations.

Q. It seems reasonable and it is inherent in your calculation?

A. I am sorry.

Q. Which you haven't done, but it would be if you considered it. I am suggesting, Mr. Petrie, that you were prepared to assume this 6 metre mound over the bulk of the site and Dr. Rowe has been much more conservative in a way, or perhaps you might call it realistic, I don't know what you want to call it, by only wishing to discuss a failure scenario at Site D that involved two cells?

A. The use of a gradient as it is input into either the calculation for exfiltration or an impact assessment regarding contaminant travel times is just a gradient, and I don't know that it has to be related back to the area of the site. I am sorry.

Q. I am sure you will want to think about that overnight?

A. Yes.

Q. You told me a minute ago the 6 metre mound was assumed for the entire site to produce your exfiltration?

A. For Site F?

Q. Yes.

calculations and this was an assumption.

Q. I am also suggesting to you that you were prepared to accept for the purposes of presenting data to this Board, a 6 metre mound over the entire area where there is a 4 per cent slope; right?

A. Correct.

Q. I'm asking you, isn't it....

A. I'm sorry, I don't mean to interrupt, but I'm not sure of the 4 per cent slope.

Q. You are going to check that, there is a more significant slope than at Site D?

A. Yes.

Q. Isn't it at least equally possible, and this is my question, that you could have a failure of only two cells at Site D, and you say -- I don't know if you follow the question?

A. I'm sorry, it's late in the day.

Q. Well, I'll try. Your failure scenario on page 157 assumes a 6 metre mound over the entire Site F?

A. It does.

Q. That has to be based, unless you go to a K of 10^{-5} of the waste, on a wide scale failure of the leachate collection system?

A. That is presumably the result of

your calculations.

Q. It seems reasonable and it is inherent in your calculation?

A. I am sorry.

Q. Which you haven't done, but it would be if you considered it. I am suggesting, Mr. Petrie, that you were prepared to assume this 6 metre mound over the bulk of the site and Dr. Rowe has been much more conservative in a way, or perhaps you might call it realistic, I don't know what you want to call it, by only wishing to discuss a failure scenario at Site D that involved two cells?

A. The use of a gradient as it is input into either the calculation for exfiltration or an impact assessment regarding contaminant travel times is just a gradient, and I don't know that it has to be related back to the area of the site. I am sorry.

Q. I am sure you will want to think about that overnight?

A. Yes.

Q. You told me a minute ago the 6 metre mound was assumed for the entire site to produce your exfiltration?

A. For Site F?

Q. Yes.

A. Yes.

Q. Let's try another way of coming at it. I think you told the Board on numerous occasions you considered Dr. Rowe's failure cases at Site D, 6 to 10, to be unreasonable, page 27?

A. Yes.

Q. Those cases involved the total failure of the collection tiles and I suggest if you check that that involved two cells?

A. You suggested that I check tonight, yes.

Q. Can you explain to me how it is that you assume a mound at Site F of 6 metres is reasonable and Dr. Rowe's mound of 4.8 metres at Site D, say in case 6, is unreasonable? I am looking at page 27 of Exhibit M-442, and you will agree with me that Mr. Hodgson or someone, and I don't know if it's in your copy, had us write the height of the mound in each scenario beside the second column?

A. I have a clean copy and I don't have mine marked up.

Q. Do you have that, Mr. Hodgson, the height of mound?

Well, I think we can go back over this and perhaps that's something that you can confirm for

me tonight, Mr. Petrie, the height of mound, and Mr. Crutcher perhaps can take note of this, but the height of mound that is produced in Dr. Rowe's total failure scenario, case 6, is only 4.8 metres. Could you please check that overnight?

A. Yes. That was case 6?

Q. Yes.

A. It looks correct, yes.

Q. What I am saying to you, and I am asking you to assume that that is the mound that Dr. Rowe would calculate for that failure scenario and can you explain to me how it is that your mound at Site F of 6 metres is reasonable and a 4.8 metre mound at Site D is unreasonable?

A. I note for the case you have referenced for Site D, there is the waste permeability of 10^{-3}.

Q. Which is the number you would accept?

A. As within the range of reason, yes, but for calculating failure modes, I believe we would use 1.0×10^{-4} for assessing any mound within a landfill.

Q. The question is simply, you have assumed a 6 metre mound at Site F for the purposes of

producing figures to this Board and you said Dr. Rowe has been unreasonable in his scenarios, and yet his scenario involving case 6 is only producing and using a 4.8 metre mound, and I am suggesting that you in fact are the one who is being unreasonable?

A. I cannot agree I am being unreasonable. You are pointing out differences between the two sites, and I have indicated I have not done the calculation, and I also said that the geometry of the system impacts upon that calculation. As I recall, Dr. Rowe in his discussion of the cases, he had assumed for all his cases that the periphery drains were working and I believe there was a drain across the middle of the site which he describes as a peripheral drain and I believe if you are going to have that drain working, you can't have more than two cells failing.

Q. Mr. Petrie, perhaps I can try it another way. According to the report from Waterloo I discussed with Mr. Crutcher a few moments ago, at Waterloo there was a mound from 3.7 to 5.5 metres and possibly as much as 13.4 metres?

A. I recall those numbers.

Q. If you could have a mound of that magnitude at Waterloo, and if you consider it appropriate to consider a 6 metre mound on a steeply

sloping landfill at Site F, relatively speaking, then if one was really trying to be fair, wouldn't you agree that it might in fact be reasonable to consider a failure with a 9 to 10 metre mound at Site D or at Site F?

A. I have indicated again that it's a function of the geometry and I have not done those calculations to indicate just what that would be. I cannot answer your question as of now.

Q. I think you will find the answer about the 4.8 metre mound for case 6 in M-442, page 27.

A. I have that before me.

Q. Would you agree that case 10 of Dr. Rowe's corresponds to an average leachate head of 9.8 metres?

A. Case 10 looks like 9.8 metres. I also note for case 6 that you referenced earlier that he has a hydraulic conductivity of the upper till ten times in excess of the value....

Q. We are not discussing that, but the height of the mound, and I am asking you if one was trying to be fair, wouldn't you agree it would be reasonable to examine a mound at Site D of 9 to 10 metres, based on the Waterloo experience and the fact that you assumed a 6 metre mound at Site F on a slope

and according to Mr. Crutcher's calculations, there must be a higher mound on a flat surface at Site D? I am just asking you, don't you want to be fair?

A. I do want to be fair.

Q. Thank you.

A. Yes.

MR. ESTRIN: Mr. Chairman, perhaps we could, as this would be the appropriate time?

DR. KINGHAM: Before we do, can we at least agree where we are on the base contours of Site F and to save anybody from using different numbers in going over this ground tomorrow. The numbers which I recall as being most current, and please correct me if I am wrong, would be from page 3 of H-42B, which reads:

> "The base elevation at the north end is 177 metres above sea level and slopes to the south at about 4 per cent for a distance of about 210 metres and a step is affected at this point dropping from 169 metres above sea level to 162 metres above sea level, and the base then varies in slope to the south at about 2.4 to 4 per cent."

Is that where we are in terms of the site design, the last evidence I assume? That is what

we will go from....

MR. CRUTCHER: I wanted to check the revised design of the base.

DR. KINGHAM: I understood H-42B, and we had a long discussion as to whether it was to be or not to be, and it was decided it was.

MR. LANCASTER: 9:30.

--- Adjournment (4:26 p.m.)

CERTIFIED CORRECT:

C. F. Nethercut, C.V.R.

(Page 29900 follows)