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: 170 (Pages 42300-42333)

HELD AT: Oakville, Ontario

DATE: August 30, 1988

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Toronto, Ontario

I N D E X

STANLEY FEENSTRA (Resumed)

Examination in chief by Mr. Hodgson (Cont'd) 42304

THE CONSOLIDATED HEARINGS BOARD

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

Dr. D.J. Kingham - Member

Nethercut & Co. Ltd.
Toronto, Ontario

Hearing conducted at The Oakville Granary Commercial Centre, 105 Robinson Street, Oakville, Ontario, on Tuesday, August 30, 1988

VOLUME 170

APPEARANCES:

T.R. Lederer and H.D. Hodgson	for the Regional Municipality of Halton (Proponent)
J.R. Tidball	for the Ministry of the Environment
T. Vigod J.F Castrilli	for the West Burlington Citizens Group
D. Estrin, F.E. Leitch and H. Dahme	for the Corporation of the Town of Milton
S.R. Garrod and A. Nurvo	for the Milton Area Citizens Coalition and several affected Milton area landowners
R.B. Tuer, Q.C. E.A. Cronk and F. Perrier	for National Sewer Pipe Limited
L.F. Longo	for Azova Investments Limited
M.J. McQuaid, Q.C. and C.J. Tzekas	for the City of Burlington
C. Mansfield	for the Ministry of Natural Resources
P. Renaud	for Cumis Limited

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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Per: C.F. Nethercut, CVR

---Upon commencing at 1:00 p.m.

MR. LANCASTER: Please be seated.

STANLEY FEENSTRA (Resumed):

EXAMINATION IN CHIEF BY MR. HODGSON (Cont'd):

Q. Mr. Feenstra, will there be any potential impacts on surface water at Site F?

A. The potential impact of landfill leachate on surface water in the vicinity of Site F was a concern expressed by Mr. Bowen in his testimony and I would like to make a few comments with regard to that potential impact. I would first like to refer to the results of the Gartner Lee 1987 monitoring program for the Burlington landfill, H-625, referring to page 1, paragraph 2.

Paragraph 2 is one of the conclusions developed by Gartner Lee with regard to their 1987 monitoring program and I will read from the second paragraph:

"Based on the available surface water quality data there does not appear to be any detectable leachate impact on Falcon Creek to the west of the landfill. Minor leachate impacts may have slightly affected water quality in Falcon Creek south of the landfill, however this has

not been confirmed. Interpretation of the 1987 data is complicated by the following: Highway 403 road contamination, saline ground water discharge, semi-stagnant flow conditions on three of four sampling occasions and laboratory quality control problems for some chemical parameters. The water quality in Falcon Creek downgradient of the landfill remains similar to that in a background stream located far from the landfill in an urban setting downstream from Highway 403."

Based on the monitoring in the vicinity of the Burlington landfill as indicated by Gartner Lee, there doesn't seem to be a significant impact on the water quality of Falcon Creek, certainly to the west of the landfill.

Falcon Creek flows along the western margin of the Burlington landfill and although there are some water quality changes in Falcon Creek south of the landfill, those changes can't be directly attributed to the landfill itself at this time.

One of the most likely explanations for this lack of impact on surface water quality in Falcon

Creek is likely due to the proportion of leachate or the amount of leachate actually collected in the toe drain system which runs up the western side of the Burlington landfill and would intercept any shallow groundwater flow through the upper portion of the shale in that location.

I would also like to refer to the 1987 Conestoga-Rovers monitoring report with respect to the Bayview landfill site, Exhibit B-624 on page 40. The first two bullets on page 40 discuss the performance of the leachate collection system, which again is a shallow toe drain system which extends some distance up the western side of the landfill and cuts off the ravines or valleys at three locations on the south side of the Bayview landfill and intercepts some amount of shallow groundwater flow from the upper portions of the shale. The installation of the leachate collection system has resulted in the reduction of the impact on surface water quality at SW-1 downstream of the Bayview Park landfill. However, because of generally dry conditions, insufficient data was obtained from the majority of the surface water sampling points in 1987 to fully evaluate the effect of the installation of the collection system.

There is no discernible impact on

surface water quality downstream of Bayview Park that can be attributed to leachate seepage alone. Impaired surface water quality is noted at the background sampling locations as well as downstream of the site.

I think the results of the monitoring conducted by Conestoga-Rovers at the Bayview landfill and by Gartner Lee at the Burlington landfill certainly indicates that the impact on surface water quality in the immediate vicinity of those sites is quite minimal if there is an impact attributable to the landfill at all. To a large part that is likely due to the collection of any shallow groundwater seepage through the upper part of the shale by the operation of the toe drain systems which are installed several metres into the upper portions of the shale.

At Site F it would be expected that a perimeter drain system or a very shallow purge well system operated along the southwest, southern and southeastern sides of Site F could be expected to perform in much the same manner as the toe drain systems at Bayview and Burlington and, consequently, with a system like that in operation, I think we would fully expect there to be a minimal effect on surface water from the operation of a landfill at Site F.

I would now like to discuss very briefly

the whole topic of exfiltration of leachate from Site F, and that has been a topic of a great deal of discussion, particularly in testimony by Mr. Petrie, largely because it is Conestoga-Rovers' opinion that a liner is required at Site F to significantly reduce the amount of exfiltration from a landfill compared to the amount of exfiltration they have estimated from an unlined landfill at Site F.

I think it is important in the context of evaluating a landfill at Site F to distinguish between the total exfiltration from the landfill, the amount of leachate that actually exits the landfill and enters the subsurface, from that portion of the total exfiltration which will infiltrate the shallow groundwater flow system and move through the shallow part of the shale, and that smaller portion of the total exfiltration which will migrate deeper into the shale and possibly into the deeper zones which I have referred to yesterday as the inactive zone in the shale, the inactive flow zone.

Just to remind everyone of the various opinions that have been expressed about Site F, this is H-942 again. There have been a variety of opinions and attached to most of those opinions is an estimate of the exfiltration from a proposed landfill at Site F.

These opinions have been put forward by Charlesworth and Rowe, as valued opinions by Petrie, Conestoga-Rovers, Mr. Bowen and of course Trow's original opinions and estimates of exfiltration at the site.

Within the context of evaluating the validity of these various exfiltration estimates, I think one has to look at the assumptions underlying those estimates, those assumptions being the hydrogeological and geological conditions that one assumes in order to estimate the exfiltration from the landfill. If I can summarize some of the findings with regard to the geologic and hydrogeologic evidence and chemical evidence I discussed yesterday, although there has been many opinions put forth with respect to the hydrogeologic conditions, geological evidence from rock cores indicate there are some zones within the shale that are fractured, particularly in the shallow portions of the shale, and I think everyone would agree with that. Likewise there are zones within the shale that are much less fractured and would be considered to be less permeable.

The hydrogeological evidence with respect to the hydraulic gradients observed on this site and the results on the hydraulic conductivity testing indicate that many of the fractured zones again

in some areas in the shallow shale have a relatively high hydraulic conductivity, probably up in the range of 10^{-4} centimetres per second and there are other zones which are more weakly fractured which have a much lower horizontal and vertical hydraulic conductivity.

Groundwater monitoring at the Burlington and Bayview sites suggest that to the extent that it has been identified so far where contaminants migrate from these landfills in the sub-surface, the migration is limited to the relatively shallow portions of the shale and lateral migration has generally been limited apparently to a distance of just 100 to 200 metres.

The geochemical evidence, the chloride concentrations in the shale in particular indicate there is a zone of active groundwater flow, typically in the upper 5 to 10 metres of the shale, although in some areas that zone of active flow is reduced to zero such as in the vicinity of HC8 and in other areas maybe as deep as 20 metres that typically ranges from 5 to 10 metres.

Within the zone of active groundwater flow, tritium is found indicating the water that exists in that area is water that has resided in the system for probably 35 years or less and it is within this active flow zone that any significant pathways for the

migration of contaminants from a landfill, either Burlington, Bayview or Site F, would exist.

Also based on the monitoring at the Bayview and Burlington sites I think it can be see that retrofitted toe drain systems, leachate collection systems around the margins of the landfill, seems to be quite effective in minimizing any impact of leachate migration through the shallow part of the shale which may result in groundwater contamination south of the site in the shallow shale zone or surface water contamination in the vicinity of the landfills themselves.

Now, I would like to within the context of the geological, hydrogeological and geochemical evidence go through each of the estimates of exfiltration from Site F and look at the basis for those estimates.

DR. KINGHAM: I wonder if before you do that you could give us your opinion about the hydrogeology under Site F. We have the opinions of various authors and you have essentially reviewed them or at least parts of them, but what is your opinion of the hydrogeology?

THE WITNESS: If you don't mind I would like to move through these examples first because I am

going to finish up with my opinion if that is acceptable.

DR. KINGHAM: That's fine, as long as we get it at some stage.

THE WITNESS: Certainly. We will first start with the top of the list, the opinion regarding Site F from Dr. Charlesworth and Dr. Rowe. Their assumption was that the shale could be characterized as a block of rock, a thickness of rock 25 metres in depth with a hydraulic conductivity of 4.5×10^{-6} centimetres per second. Based on these assumptions and the various calculations and the models they performed, they determined that a representative estimate of the ex-filtration from a landfill at Site F would be one millimetre per year.

I think based on the geological and hydrogeological evidence we have from the site, there isn't a substantive basis for assuming there is a continuous zone of shale extending to a depth of 25 metres with a hydraulic conductivity that is that low. The results of the hydraulic conductivity tests, in particular the pumping tests, indicate there are zones within the shale, particularly in the upper portions of the shale that have hydraulic conductivities much higher than 4.5×10^{-6} and it is those more permeable

zones that really have to be considered in the context of contaminant migration and in the context of calculating infiltration into the groundwater system.

In addition, and another line of evidence, particularly the geochemical evidence, the chloride concentrations in the groundwater; for a total exfiltration rate from the landfill of 1 millimetre per year, it would suggest that even over a period of thousands of years there should still be significant concentrations of chloride throughout that 25 metre section of shale and it is obviously not what we see at the site. There are zones, although it varies in thickness from 5 to 10 to 15 or 20 metres, there are zones where much of the chloride has indeed been removed from the shale and so the concentrations are less than 1500 milligrams per litre. That would suggest the exfiltration from the landfill -- the infiltration to the shallow active flow system should be considerably higher than 1 millimetre per year. It would be my opinion on this interpretation that an estimate of total exfiltration from a landfill at Site F would be higher than 1 millimetre per year.

If we can move on to two opinions expressed by Mr. Petrie, items 2 and 3 on this exhibit, these estimates of exfiltration, total exfiltration

from the landfill ranging from 50 to 100 millimetres per year depended on the assumption that there is between 15 and 30 metres of shale underlying continuously beneath the site with a hydraulic conductivity of 2×10^{-4}.

Here again looking at the geological and hydrogeological evidence, there is really no basis for making an assumption that there is a zone of this thickness, 15 to 30 metres of shale having a high hydraulic conductivity of 2×10^{-4} underlying the majority of the site. Certainly the pumping tests indicate that some zones within the shale have hydraulic conductivities that are as high as 2×10^{-4}, but those zones are much thinner than 15 to 30 metres.

In addition, looking at the geochemical evidence, if we hypothesize infiltration into the groundwater system, infiltration rates of 50 to 100, to 100 millimetres per year penetrating and flowing through the shale to depths of 15 to 30 metres, at those infiltration rates virtually all of the chloride or most of the chloride should have been removed from the shale rock underlying the site to those depths, and there again that is not obviously what we see on the site. There are some areas where the penetration of low chloride water is 20 metres, but in general the

depth of the active flow where the chloride concentrations are low is only in the range of 5 to 10 metres, and in some areas there are high chloride concentrations that exist right up to the top of the shale and to the shale surface. On this basis, then, I would also conclude that estimates of exfiltration as high as 50 to 100 millimetres per year also do not match the existing evidence that we have.

Moving on to the opinion regarding Site F put forward by Conestoga-Rovers in H-675, this opinion was based on the assumption that 80 per cent of the groundwater flow occurs in a shallow active flow zone in the upper 6 metres of shale. This interpretation as such I think is probably quite consistent with what we see with respect to the chloride concentrations and the indication of the depth of active flow over most of the site and the results of the pumping tests.

However, the estimate of exfiltration which went along with this interpretation of the flow system, H-675, was 100 millimetres per year and that was a number that was adopted from previous work conducted by Gartner Lee and it wasn't a calculation based on the interpretation presented by Conestoga-Rovers in this particular exhibit.

If one tries to estimate exfiltration in the same general way that Mr. Petrie estimated exfiltration in B-617 on page 156, that is making some assumption about the depth of active flow and assigning a representative value for a hydraulic conductivity, if one went through that procedure to get an estimate of exfiltration for this type of opinion as expressed by Conestoga-Rovers in H-675, one would have to conclude that either the hydraulic conductivity of that zone was very high, something in the order of 10^{-3} centimetres per second to achieve an exfiltration of 100 millimetres per year, or if one assumed the hydraulic conductivity of this active flow zone was closer to 10^{-4} as suggested by the pumping tests, it would make one's estimate of the exfiltration something in the order of 10 to 20 millimetres per year. The assumptions about the flow system and the estimate of the exfiltration don't match and one of them would have to change for them to be consistent.

As I indicated previously in the discussion of examples 2 and 3 for Mr. Petrie, I don't feel the exfiltration from the landfill would be as high as 100 millimetres per annum.

If we now consider two additional cases put forth by different authors but whose bases are

quite similar, one is opinion 5, and numbered as No. 5 on H-492, the Conestoga-Rovers FLONET model for Site F and the other is Trow's original FLONET model, an estimate of exfiltration as expressed in H-40, page 63, and these estimates of exfiltration go from 21.5 for the Conestoga-Rovers estimate to 13.7 millimetres per year for the Trow estimate.

As I distinguished earlier, I think it is important and as I noted earlier I think it is important to distinguish the difference between the total exfiltration leaving the landfill and that proportion of the flow which will comprise shallow infiltration into the active flow system and that portion which will comprise deeper infiltration into the shale.

The nature of the FLONET model is such that very shallow groundwater flow, groundwater flow into the shale at depths of less than 5 or 10 metres really can't be simulated because of, what do you call it, the resolution or the size of the finite element grid. So, there isn't a clear distinction of what the infiltration -- exfiltration estimates from the FLONET model really means with respect to total exfiltration from the landfill and proportioning that to shallow groundwater flow or deeper groundwater flow.

Given the fact that we would expect based on the geochemical evidence and the hydraulic testing that most of the flow would occur in the upper 5 to 10 metres, it would be my opinion that the estimates of exfiltration based on the FLONET model, probably more closely reflect deep infiltration estimates; that is the actual flow of water, infiltration of water into the deeper parts of the groundwater flow system.

Now, if we look at these estimates then as reflecting the infiltration deeper than 5 to 10 metres into the shale system, the shale bedrock system, we can go back to the modeling conducted by Dr. Rowe in Appendix C of M-440 which suggests with infiltration rates of fresh water from above greater than 14 or so millimetres per year, it would suggest that over a period of hundreds of years most of the chloride would be removed from the shale in the deeper part of the groundwater system.

I don't believe that estimates of infiltration as high as 13.7 to 21.5 millimetres per year really does represent the degree of infiltration into the deeper portions of the flow system, deeper being deeper than 5 to 10 metres.

Now, we are quickly drawing to the end

of the various opinions and I would just like to discuss the opinion presented by Mr. Bowen with respect to Site F. Mr. Bowen suggested that the hydrogeologic conditions could be described by a shallow active groundwater flow system, although he did not specify what depth that flow system extended to, and based not on any calculations from Site F in particular, but based on estimates of groundwater flow rates in two reasonably nearby drainage basins studied by the Ministry of the Environment on Queenston shale, his estimates for total exfiltration from a landfill at Site F were in the range of 10 to 20 millimetres per year.

However, that estimate was based on not site-specific considerations but considerations for groundwater flow through basically the upper part of the Queenston shale in some adjacent localities. Mr. Bowen also estimated that 10 per cent of this exfiltration, 10 to 20 millimetres per year, might travel deeper into the more inactive flow system, although he didn't actually give a calculation or the basis for that proportion of flow.

If we make the assumption that the active flow system is in the vicinity of 5 to 10 metres in thickness and if we assign a hydraulic conductivity

of approximately 10^{-4} centimetres per second, which is quite representative based on the findings particularly of pumping test PW-2 and PW-3 and did a calculation of the amount of infiltration on that basis, as a coincidence we come up with an estimate of total exfiltration from the landfill of in the range of 10 to 20 millimetres per year, although that estimate is based on a site-specific consideration of the data from Site F and I think it is quite supportive that estimates of exfiltration from groundwater flow evaluated in the Queenston shale and other basins falls within that same range.

DR. KINGHAM: Let me understand. You are saying if you put in 5 to 10 metres at an unspecified depth you would conclude 10 to 20 millimetres of exfiltration?

THE WITNESS: That is correct, yes. The final opinion or interpretation of the site, of Site F that I would like to discuss is the estimate of an exfiltration rate of 1.2 millimetres per year which is described by Trow in Exhibit H-221. As I indicated earlier, this estimate comes from a FLONET model estimate and this value probably represents rather than total exfiltration from the landfill, just that portion of the flow that penetrates deeper into the shale.

However, perhaps we could consider that point for a moment.

If we remember back to the chloride data and the modeling performed by Dr. Rowe in Exhibit H-- M-440, Appendix C, it is suggested that if infiltration rates of fresh water from above were of the order of 1 millimetre per year, it would take several to many thousands of years for the groundwater flow to actually remove chloride from the shale over that time period.

If we are considering not now, but in this estimate not total exfiltration but deeper exfiltration into the shale where the chloride concentrations are higher, an estimate of infiltration of approximately 1 millimetre per year or less is quite consistent with what we find with respect to the chemical concentrations in the deeper portions of the shale.

So, I think that that estimate for infiltration, that estimate being approximately 1 millimetre per year for the deeper portions of the shale only, is probably quite representative.

Now, with respect to Trow's model which developed this estimate of exfiltration or infiltration deeper into the shale, it was on the basis of a

vertical hydraulic conductivity of the weakly fractured shale as Trow identified it of 10^{-8} centimetres per second. I think the difficulty we have in interpreting the travel time or the rate of migration deeper into the shale is largely due to the fact that we can't directly measure the vertical hydraulic conductivity. I think to some degree the estimate of the rate at which chloride can be removed from the shale by fresh waters infiltrating from above, as suggested by Dr. Rowe, and the consistency between the infiltration estimates for a vertical hydraulic conductivity modeled by Trow of 10^{-8} centimetres per second and the rate at which chloride can be removed or could be removed from the shale in the deeper zones and the fact we find very high concentrations of chloride in the deeper zones of the shale, would lead one to conclude that a reasonable estimate of the infiltration rate into the deeper zones in the shale, that is the zone you might call the inactive flow zone, could reasonably be considered to be 1 millimetre per year or perhaps less, and I think that that, taken together with that estimate, one could also reasonably conclude that an appropriate or reasonable estimate for the vertical hydraulic conductivity or the typical hydraulic conductivity for much of the site would be in the range of 10^{-8}

centimetres per second. I think that that is a fairly significant estimate to make because you really need some indication or some estimate of the vertical hydraulic conductivity to be able to calculate any kinds of travel times vertically downward through the shale into the deeper flow zones.

So, just to summarize the various opinions about Site F and to maybe finish up with my opinion and my interpretation of Site F, with respect to total -- let me describe the geology firstly. Based on the geological evidence from the rock cores and observation from the core logging, the results of hydrogeologic investigations, the packer tests, the pumping test results from PW-2, PW-3 and PW-1, the geochemical evidence from the chloride and the tritium data, it would lead me to the interpretation that there is indeed a shallow active groundwater flow system which is typically in the upper 5 to 10 metres of the shale and in some areas because the degree of vertical interconnection or vertical fracturing is less, the thickness of that active flow zone will be less. In some areas where there is more extensive vertical connection or vertical fracturing such as in the vicinity of HC4, the thickness of the active flow zone will be somewhat greater, but in general terms based on

the majority of the boreholes south of Burlington and Bayview and on the Site F site, the thickness of that active flow zone would be in the range of 5 to 10 metres.

Then, based on the results of the pumping tests on PW-2 and PW-3 in particular, there are zones within that active flow zone, areas within that active flow zone that have hydraulic conductivities in the range of 10^{-4} centimetres per second and on that basis it would lead one to estimate that the total exfiltration from the landfill on Site F would be something in the range of 10 to 20 millimetres per year. Of that 10 to 20 millimetres per year, the majority of that, probably greater than 90 per cent, is going to comprise flow in the shallow active groundwater flow system and the proportion of the total exfiltration from the landfill which penetrates deeper into the shale, that would be into the zones of the shale with much higher chloride concentrations, will likely be in the range of a millimetre per year or less. So, the majority of that flow would occur through the upper portion of the shale.

DR. KINGHAM: Do we understand you then to not be endorsing any of those opinions itself in stating an opinion which is a hybrid essentially of CRA

and THCL, is that correct?

THE WITNESS: I guess it is a hybrid, that is correct. We have heard a great deal of evidence in the course of the proceedings and there has been a lot of analysis and re-thought done by various authors on site F and in my final conclusion I believe, or I hope I draw on the most reliable evidence we have at the present time and to some extent maybe I take the strong points from several of the interpretations and integrate them together.

MR. HODGSON: Q. Mr. Feenstra, with regard to the 10 to 20 millimetres you indicated, your evidence is that 10 to 20 millimetres will be the total exfiltration from the landfill site and that approximately 90 per cent of that will move in the active shallow groundwater flow system?

A. That is correct, yes.

Q. What will be or what will potentially be the destiny of that 90 per cent of the exfiltration from a landfill at Site F?

A. The destiny of that water in the absence of a perimeter drain system to control groundwater flow through the upper part of the shale, would likely be discharge to the adjacent shallow surface water streams and possibly marshy areas to the

southeast, southwest, and the southern part of Site F, south of Site F. Given the performance of the toe drain, the very shallow toe drain collection systems at Bayview and Burlington, it would certainly be my opinion that a perimeter drain system installed in the upper portion of the shale around the southwest, south and southeast sides of Site F would also perform very capably in intercepting the shallow groundwater flow.

Q. Is that something you would recommend?

A. Yes, I would recommend that.

Q. With regard -- I think your evidence was the millimetre or less of exfiltration that would enter the deeper groundwater flow system where we find the high chloride levels currently; what is your opinion as to the destiny and likely impact of that portion of the exfiltration at Site F?

A. That portion of the exfiltration will move downward and on its way will have to traverse zones of quite low vertical hydraulic conductivity. It may ultimately reach zones, particularly in the area of the unit identified by Trow as the highly fractured shale where there are horizontal fractures that are areally continuous, or continuous over a fairly significant distance, through which any leachate

derived from infiltration into those zones could move laterally away from the site. In the event that type of migration does occur during the contaminating life of the landfill, and the impact is actually noted by monitoring, I believe the results of the pumping tests at PW-1 indicate that purge wells are a viable contingency for the control of that off-site migration, from the deeper fracture zones.

Q. Do you have an opinion for this Board as to whether or not a liner is required at Site F?

A. Yes, I do. Based on CRA's original estimates of exfiltration from Site F, and those are estimates in the range of 50 to 100 millimetres per year, Conestoga-Rovers argued that a liner would be required to significantly reduce that amount of exfiltration.

During the cross-examination of Mr. Petrie and Mr. Crutcher, CRA calculated what the exfiltration through the proposed liner for Site F would be under normal operating conditions, and I didn't write down the exhibit number on which this was calculated, but it is my understanding that that estimate for operating conditions was 8 millimetres per year. Maybe we could just take a moment and get that

exhibit number.

Q. I think it is Exhibit B-691.

A. If 8 millimetres per year is considered to be the exfiltration from a lined Site F, and our best estimates for the amount of total exfiltration from Site F in an unlined condition are 10 to 20 millimetres per year, then the addition of a liner could reduce the total amount of exfiltration from the site by the order of from 60 to 20 per cent, really not a very significant reduction. Given that the bulk of the exfiltration that does exit the landfill is going to occur as shallow infiltration into the shallow active zone in the shale and should be quite capably captured by a perimeter drain system or a very shallow purge well system along the southwest, southern and southeast margins of Site F, it is my opinion that a liner is not required at Site F.

Q. I think that takes us, Mr. Feenstra, to your conclusions?

A. My conclusions, yes. My first conclusion, to just restate what I indicated, is that in my opinion Site F is suitable for landfilling for the Region of Halton without a liner. There should be no significant impact on groundwater or surface shallow water environments in and around Site F.

The main reason for the lack of impact, even though there is some degree of exfiltration from the landfill itself and moving into the shallow shale, is the expectation that the perimeter drain system would be effective in capturing the shallow groundwater flow in and around the southern portions of Site F.

In the event that my interpretation of the site, particularly with respect to deeper flow from Site F, may differ from the actual conditions beneath Site F, because there are no water supply wells immediately threatened by this deeper migration, and given the performance of pumping test PW-1 which shows that the horizontal fracture zones which do exist are areally quite extensive and can be pumped quite capably by a pumping well, it is my opinion that there would be ample time for the implementation of effective contingencies such as a purge well system to deal with that migration if it did become evident.

Q. Is that something that you expect?

A. That is not something that I would expect, no.

Q. Can you state your conclusions with regard to Site D, please?

A. My conclusions with regard to Site D are a little bit more lengthy.

Q. Then I will sit down.

A. It is my opinion that at Site D the site can be made suitable for landfilling. In the event -- or while the hydraulic trap is functioning, there should be no release of leachate from the landfill into the underlying subsurface environment. However, in the event of failure of the hydraulic trap, leachate could escape the landfill and move downward into the granular units underlying the site which could result in contamination of private well water supplies which lie closest to the western side of Site D.

If the unweathered upper till unit as identified at the site is unfractured, then contaminant migration through that lower part of the unweathered till will take years, and most likely in the order of 10 years to 20 years, and there will be ample time for the detection of failure of the hydraulic trap and the implementation of any contingencies that might be required based on a failure of the hydraulic trap.

Seasonal fluctuations which result in temporary or short-term failures of the hydraulic trap under that condition will be of little significance because the rate of travel across the unweathered upper till is so great. However, if the unweathered upper till is indeed fractured, then the travel times for any

contaminants from Site D in the event of failure of the hydraulic trap will be very short, and it is possible that the underlying granular units could become contaminated over a very short period of time.

It is my opinion that based on the evidence from other sites, that is not Site D, but the observations of fracturing in similar clayey materials at other sites would lead me to the conclusion that it is a reasonable possibility that such fractures do indeed exist in the deeper part of the unweathered upper till at Site D.

Because of that possibility, it would be my opinion that alternatives such as a more detailed monitoring program combined with the installation of a purge well system at Site D prior to landfilling, or the connection of the private residences in the area to piped water or the construction of a compacted liner or a liner of recompacted native till on Site D should be used to avoid the possibility or eliminate the possibility of rapid contamination of the underlying upper granular unit.

Based on my assessment of Site F and Site D, and the possible eventualities at Site D and the fact that I consider some very detailed monitoring and very careful monitoring is going to be required at

Site D, depending upon precisely how the site is developed, it is my opinion that Site F would definitely be preferable to Site D for the proposed Region of Halton landfill.

MR. HODGSON: Thank you, Mr. Chairman, those are my questions.

MR. LANCASTER: Thank you, Mr. Hodgson. That completes the Region's examination of this witness and now we will set down until Monday, September 12, at 9:30; is that your understanding?

MR. FEENSTRA: Yes.

MR. LANCASTER: The Board will adjourn until Wednesday, September 12 at 1:00 p.m. Is there anything further at the moment?

You might consider the order of cross-examination.

MR. HODGSON: Perhaps that could be discussed now with my friends.

MR. McQUAID: Why would it be any different than it was when Mr. Feenstra was in the box previously?

MR. LANCASTER: I wouldn't think it would be. The Board wouldn't want to start Monday morning with an argument.

MR. McQUAID: I can't remember where

Mr. Tidball was at that time.

MR. TIDBALL: I was last.

MR. LANCASTER: So we will adjourn until Wednesday, September 7, at 1:00 p.m., and we will be sitting at 1:00 and at 7:00.

MR. GARROD: Mr. Chairman, I can't attend that day as I have previous commitments, but I have no objection obviously.

MR. LANCASTER: You said you wouldn't have people appearing.

MR. GARROD: That is correct.

MR. LANCASTER: They may if they wish. Ms. Vigod, do you have something?

MS. VIGOD: No, sorry, sir.

MR. LANCASTER: Thank you.

---Adjournment at 1:55 p.m.

CERTIFIED CORRECT:

C. F. Nethercut, C.V.R.

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