RED HILL VALLEY PARKWAY INQUIRY

TRANSCRIPT OF PROCEEDINGS
HEARD BEFORE THE HONOURABLE HERMAN J. WILTON SIEGEL
held via Arbitration Place Virtual
on Wednesday, April 27, 2022 at 9:30 a.m.

VOLUME 3

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Arbitration Place Virtual

--- Upon resuming on Wednesday, April 27, 2022
at 9:30 a.m.

MR. LEWIS: Good morning, Commissioner and counsel. Today we're calling Russell Brownlee. Mr. Brownlee is with us today. Yes, he is.

RUSSELL BROWNLEE; A WITNESS HEREIN

EXAMINATION BY MR. LEWIS:

Q. The first document to call up is EXP74, Mr. Brownlee's CV. Good morning, Mr. Brownlee.

A. Good morning.

Q. I just want to take you through portions of your CV and maybe jump back and forth a little bit, but just to start off with the basics and your academic background. You have a bachelors in science in -- bachelor of science in civil engineering from University of Manitoba in 1993 and a masters in civil engineering from University of Waterloo in 1996; is that correct?

A. That is correct.

Q. And you are a member of the Professional Engineers of Ontario and have been since 1996?

A. That is correct, yes.

Q. And I understand you're also a member of the correlative professional engineering organizations in British Columbia and Alberta. Is that right?

A. Yes. Yes, I am.

Q. Okay. And if we could jump to image 19, Registrar. Thank you.

At the bottom left indicates your professional engineer's memberships that we just discussed, and there's also indication there of the -- in the fifth bullet point, the Ontario Provincial Standards Traffic Safety Committee, CEO representative from 2011 to 2019. Could you describe what that is, was?

A. Yes. The Ontario Provincial Standards Traffic Safety Committee sets standards and design guidance for Ontario municipalities and for the province. It's made up of members of the Ministry of Transportation of Ontario, the Ontario Road Builders, the Municipal Engineers Association and the Consulting Engineers of Ontario, and I was appointed to represent the CEO, the Consulting Engineers of Ontario, on that committee for a number of years.

Q. And right above that is the Canadian Institute of Transportation Engineers, district director, and ITE Board of Direction, 2010 to 2012. Just briefly what was that about?

A. The Institute of Transportation Engineers is an association in North America and throughout the world. The Canadian -- CEIT is the Canadian arm of that, and it sets direction and guidance and policies for various transportation components in association with other organizations such as TAC and AASHTO and other North American organizations.

Q. Okay. And going back to image 1, Registrar, please.

So currently you're at True North Safety Group, and you've been at it since 2017?

A. Yes.

Q. And it says there you're president, but I gather you've just changed title to CEO; is that right?

A. That is correct, yes.

Q. And were you a founder of True North?

A. Yes, I was the primary founder of the company.

Q. Okay. And you have a number of employees at this point; is that right?

A. Yes, there's 11 employees.

Q. And prior to that you were at 30 Forensic Engineering and IBI Group going back to 2001?

A. That is correct, yes.

Q. Is it similar sort of work -- we'll get to your type of work, but a similar sort of work as you do at True North?

A. Yes, it's road safety consulting services and forensic engineering services. Yes.

Q. Okay. And you describe that at the top of page 1 in a summary form under "Expert Summary." So traffic safety and forensic, if you could just unpack those two categories a little bit.

A. The transportation safety consulting, we provide consulting services to various provinces, provincial agencies, municipal agencies as well, and cities, regions, counties throughout Ontario mainly related to road user safety, traffic engineering from a multi-modal perspective, so vehicles, pedestrians, you name it.

Q. Forensic investigations?

A. We provide forensic investigations and expert opinions to insurance companies, legal counsels, private individuals, municipalities on a regular basis, all related to transportation facilities. So the design, operations, maintenance of those facilities and how they may have contributed to a particular incident or collision.

Q. Okay. And you referred to design as part of that. How does road design and highway design, generally speaking, enter into the practice -- your practice in the categories you described?

A. Generally we get involved in that respect in terms of if somebody's suggesting that the design of the roadway, it's horizontal or it's vertical alignment, the sight lines, the way it's being operated, the width of the lanes, you name it, contributed to a particular collision. So that's -- we complete somewhere in the order of 100 to 120 legal liability files and many of them would relate to both roadway and intersection and interchange design.

Q. And sorry, that was -- when you said 100, 120, I think you said, is that per year you meant?

A. Yes, per year, yes.

Q. Okay. And does part of that deal with relevant guidelines or -- whether it's design standards or other standards that are in place or guidelines?

A. Yes. We would be completing in all those situations a compliance review of what conditions were present at a particular incident or collision site, and how they related to the prevailing standards, and how the road users, you know, were able to interact with that design and do that successfully or not. And in all those instances we would be looking at the vintage of the -- in the intersection, the interchange, the roadway because, you know, we would be going back to what year that particular facility was constructed and was any major maintenance or rehabilitation done on it, and supplying whatever the most current standard is for those particular situations.

Q. And there's a large number of projects that you've listed, and we're certainly not going to go to all of them, but maybe we could just go to image 3, Registrar.

And on this page there's -- just -- I want to talk representatively rather than, you know, necessarily specifically, but there's a number of items on this page that deal with transporta- -- safety reviews --

A. Yes.

Q. -- and so forth involving in some instances highways and not. If you could just sort of describe this sort of work.

A. Yes. We undertake safety reviews of existing facilities, so ones that are out there and operational. Typically when there is specific collision issues or motorist understanding or road user understanding issues, at a particular intersection along a corridor that have sort of increased its collision potential or its, you know, misunderstanding.

For example, the one the top left, the Highway 410, Highway 10, Valley Wood

Drive Operational Review was an operational safety review that we completed. There were -- it was a new interchange that was constructed, and individuals were having a tough time trying to figure out on some of the approaches where to be travelling to get to their eventual destination. So we were hired to look at the safety and positive guidance aspects of the interchange for the Ministry of Transportation. That's a pretty typical project that we do on a regular basis.

Q. Okay. And you referred to forensic work that you do, which isn't specifically listed in your CV. Is that -- in the context of the forensic work, does that often involve limited access highway collisions and the like?

A. Yes, it would involve design, the operations and the maintenance. So from a design perspective we would -- we've been involved in situations such as, you know, sight lines on a ramp around -- you know, through a weaving section between two ramp interchanges. Generally not sight lines along the main line too much because they are designed to pretty high design speed, but more interactions around the interchanges and things of that nature.

Q. Okay. And if we could go back one image to image 2. And you talked about municipal safety reviews that you do as well, and I think there are some on here. So you describe that kind of work.

A. Again, these are corridor or area wide safety reviews of particular intersections, of road sections that we complete for municipalities. We've worked for most major municipalities in Ontario, region of Durham, City of Toronto, City of Ottawa are some more recent ones. You know, in some cases we'd be looking at multiple intersections such as the region of Durham one in the top left. That was 22 skewed intersections in their rural road network where we looked at the risks associated with the design, the operations, the signage, the illumination at a particular intersection.

MR. LEWIS: Okay. Thank you very much.

Commissioner, I would like to make his CV an exhibit. I believe it's Exhibit 15, if my count is correct. Is that right, Registrar? 15? I'm told it is.

THE REGISTRAR: Yes, Counsel, it's 15.

EXHIBIT NO. 15: Russell Brownlee curriculum vitae, EXP74.

BY MR. LEWIS:

Q. Now, if we could pull up Mr. Brownlee's report, which is EXP72, dated March 9, '22 entitled "Red Hill Valley Parkway Inquiry: Principal Design and Maintenance Standards Guidelines and General Practices For Ontario Highways" with a total of 20 images, 18 pages. There is a two-page discrepancy between page and image, so I'll simply be referring to image today. It's because of the cover page and the contents I believe.

This is your report, Mr. Brownlee?

A. Yes, it is.

Q. And written by you?

A. Yes.

Q. And I understand there is one correction that we should make. If we could go to image 9 for a moment, and footnote 11 at the bottom there refers -- if you could call that up. It's a little bit -- thank you. That's much better.

Number 11 refers to similar lateral friction values are assumed in table C2-1 minimum stopping sight distance on wet pavement in the 1985 MTO Design Guide. And we'll be talking about longitudinal friction and lateral friction later without getting into the details.

I understand there is an error in the reference to lateral friction; Is that correct.

A. Yes, it should be longitudinal friction.

Q. Right. Okay. And I think -- so note 12 deals with the lateral friction, I believe.

So I just wanted to highlight that up front, and when we get to that point, we will deal with that.

And could we make the report an exhibit, which would be 16, please, Commissioner.

THE REGISTRAR: Noted, Counsel.

EXHIBIT NO. 16: Expert report of Russell Brownlee, EXP72.

BY MR. LEWIS:

Q. If we go to image 4.

And under section 2.1 "Scope," I understand the Ontario Highway Traffic Act defines a highway in a very broad, broad way which refers to, I gather, virtually any public road. But for the -- in the second paragraph you indicate:

"For the purpose of the report the term 'highway' will be used to define a free flow facility with grade separated interchanges, restricted access and prohibition of pedestrians and cyclists by a controlled access highway, freeway or expressway."

So just when you use the term "highway" in this report, that's what we're talking about; is that right?

A. Correct. Yes.

Q. Okay. And one question is, "grade separated interchanges." Could you just describe what you mean there.

A. It means that the freeway facility and its -- the roadways that are crossing it will not be meeting at grade or together. They will be grade separated. One would be at a higher elevation than the other and would be connected by ramps.

Q. Okay. Part of the limited access point?

A. Yes.

Q. And is there a design classification for urban freeways that is different from other types of limited access highways?

A. Yeah, there's different classifications of freeways. Essentially there's a designation between urban and rural, and that's mainly due to the other activities, the adjacent land uses and some of the constraints that would be involved in urban areas versus rural facilities.

The next designation is whether it's divided or undivided; essentially does it have a physical barrier in the middle versus not having that division.

And then the third would be the design speed of the roadway, and it would be a designation that would be given to that particular facility.

Q. Okay. And what,

generally speaking, defines an urban freeway as opposed to rural?

A. Essentially the context that it's placed in. So again, it would be traversing through an urbanized area, more built-up area versus, you know, if you looked at, you know, some of the facilities as you head out towards -- between Waterloo and London where you're generally traversing farmers' fields and open space, or in northwestern Ontario where you're traversing open -- you know, just land around you versus the, you know, built up area such as travelling through the City of Toronto or City of London, et cetera.

Q. So the 401, for example, is both urban and rural depending on the location?

A. Yes.

Q. Okay. And is there a major difference in terms of design between urban and rural?

A. There are some distinctions in that the urban designation does recognize that there would be more constraints. The roadways crossing in many cases have been -- will have been established as part of the original road network as the area urbanized. So there might be more latitude to tie into those facilities. Likewise, the -- you know, the constraints of building interchanges and things of that nature typically don't like to take down peoples' homes and other, you know, fairly significant things that are already constructed. So there might be some more physical constraints, and therefore the design guidance for -- in some cases for urban areas allows some more latitude.

Q. We'll get into some -- one specific later.

If we could go to image 5 and 6, could we call them up together.

And so before we get into the specific items of major -- I mean, the principles of geometric design for highways, could you tell us about the principal sources of design standards or guidance for highways in Ontario, and it's in your report at the bottom of page -- of image 5, page 3, and the next image 6 speaks to two of them.

A. Yes. The principal guidance in -- that is applied in Ontario from my experience is the -- and in the -- the period that we're looking at is the 1985 Geometric Design Standards For Ontario Highways, that's published by the Ministry of Transportation of Ontario, and the 1999 Transportation Association of Canada, Canadian Geometric Design Guidelines For Canadian Roadways, or roads, sorry. So I'll be referring to those as the 1985 MTO design guide and the 1999 TAC guide.

Q. Okay. And TAC, Transportation Association of Canada -- a little bit about it, but what is it? What does it do?

A. Essentially it's a association of municipalities, provincial agencies, consulting firms throughout Canada that -- they work together to create standards, guidelines and other practices for application throughout Canada, and one of their key documents is the Geometric Design Guide.

Q. And you describe in the part about the '99 TAC guide, that it was updated in 2017. And putting that aside, the 2017 guide for the moment aside, generally speaking, are the 1985 MTO guide and the 1999 TAC guide, are they materially different with respect to their guidance respecting highway geometric design, or are they reasonably consistent?

A. They are reasonably consistent. There are some small nuances between them, and there's specific Ontario policy in the 1995 (sic) guide, but for the most part the things -- the items --

Q. Right. '95 guide or '85?

A. Sorry, 1985 guide. Sorry. There are some nuances, but for the most part the items that we'll be speaking about today are pretty standard with some minor nuances.

Q. Okay. And you've indicated that since its promulgation, the 1999 TAC guide was most commonly applied in your experience by cities and towns in Ontario; is that right?

A. The main cities and jurisdictions in Ontario would be applying the 1999 TAC guide. There are some smaller communities, some counties, some indigenous communities that take a lot of their lead from the Ministry of Transportation because that's where they get their technical knowledge from, from the local regional office, and so they have adopted those.

I did the other day just come across the City of London who applies much of the MTO guide. So there are large municipalities that do chose the MTO guide, but for the most part my experience is that the major municipalities would be using the TAC guide.

Q. And of course, though, if it was prior to 1999, then it -- at that time the source of guidance is that the -- only the MTO guide or their prior TAC iterations?

A. No, there's a number of TAC iterations. Transportation Association Canada has been around for many decades, and there was a 1985 guide of the TAC guide as well and in the '70s as well.

Q. Okay. And I expect that today will -- in each category that we talk about, various types of guidance that are available, that we'll -- I'll be asking you about whether municipalities are legally bound or required to follow various sources of guidance as distinct from industry good practice or industry -- what industry does, but -- or what is typically followed. In that vein with respect to either the MTO 1985 guide or the '99 TAC guide, were -- are municipalities in Ontario legally bound to follow either of those?

A. No. They are provided there as guidance. There's provisions in both the MTO and the TAC guide to have some latitude within designs, some engineering judgment that can be applied, and they are not legally bound to use them, but in practice it is good industry practice to apply the guidance in those manuals when you're looking at roadway design.

Q. In the sense that one has to follow something?

A. Yes.

Q. And you indicate in section 2.3.2 in image 6 that it is -- it's industry good practice to apply one or the other?

A. Yes.

Q. And you indicate -- you refers to juris- -- in the first paragraph under 2.3.2 that it being industry good practice to apply one of them for your -- with jurisdictional design exceptions. What does that refer to? Is that what you were alluding to before?

A. Yes. Essentially within any design what's provided in the manual are typicals and are the beginning points. There is always latitude for specific situations and combinations of situations to deviate from the guidance to exceed it, in some cases to sometimes look at not meeting that particular guideline to meet other project goals and objectives and constraints.

Q. Okay. And if we could go to image 7. This is an excerpt from the '99 TAC guide about application, as I understand it, application guidance.

A. Yes.

Q. Is that right?

A. Yes.

Q. Okay. And is this generally what you were talking about in there about -- just a moment ago?

A. Yes. There's always the -- and you'll see in the front matter of most of our engineering guides there's always guidance to say, here's industry good practice aligned in this manual, but there's always going to be tradeoffs, design exceptions, engineering judgment that needs to be applied in all those situations to meet your project goals and the funding that you have, the constraints you are dealing with on each project.

Q. Right. And in the first excerpt there, for consideration of design tradeoffs, particularly those related to safety and introduction of the design domain concept certainly serve to discourage table-picking. So what -- could you describe the -- what you -- I mean, I understand colloquially what a tradeoff means, but what a tradeoff means in this context and what table-picking is.

A. Well, maybe I'll start with table-picking. Essentially the engineering world needs to balance a bit between providing very definitive strict guidance and being able to provide some design domain or domain in which it's still acceptable to design within because everything doesn't fit into a nice box when you get out into the real world. So essentially table-picking is a term that was used in the past where individuals may look at a particular table and say, here is my criteria; here is the answer; I'm using this exact number.

And in many cases if we do that for many different components of a particular highway or roadway and combine them together, it may not be the proper solution for your condition. It may not be something that our road users may be able to understand. So it is discouraged to just pick numbers out of a manual and start applying them rigidly, and -- in hoping that you're designing something that the road user can understand and that is going to operate safely. So there are always design tradeoffs. So whether that be a tradeoff with, you know, operations, maintenance, property acquisition, costs, you name it.

So, you know, to give you an example, if we were designing a highway, a nice straight tangent highway, and all of a sudden there's a piece of property, an environmental area, a particular property that is going to be in our way, we could choose to go straight through that property and acquisition it, or, you know, go through a sensitive wetland, or we can choose to go around it. How we go around it and how we design curves and intersections to circumvent that piece of property, there's numerous different options. So those would be the tradeoffs that a designer would deal with on a regular basis to say, here's the different aspects of how we could deal with this design, and they need to measure those in the criteria that they are applying within their jurisdiction.

Q. Okay. And so table-picking actually is a literal description about picking the tables in the design guides as opposed to, you know -- it's not talking about a table or chairs. It's actually the tables in the design guide is what you are referring to?

A. I don't know if it's that literal, but it's the same concept, yes.

Q. Okay. And in the second entry, in second paragraph, it starts off with:

"Design dimensions that do not meet standards, do not necessarily result in an unacceptable design and dimensions that meet standards do not guarantee an acceptable design."

Is that -- I think that's along the lines of what you were talking about there; is that right?

A. Yeah. We have a very similar statement in safety. Just because, you know, a particular intersection design doesn't meet a standard, doesn't mean that it will operate unsafe, and if it does meet a standard, doesn't automatically mean it's safe. We need to look at the total project and design concept that we're putting together and how that would be used by a road user on a regular basis.

Q. And then it does go on there to indicate that the design has to be reviewed with judgment. I guess it's talking about engineering judgment in that context?

A. Exactly, yes.

Q. Okay. And then -- this guide therefore does -- standards merely assist the reviewer in making those judgments. This guide therefore does not attempt to establish standards and indeed does not use the term.

A. That's correct. You'll see the term used in the MTO manual in terms of the standard given its vintage. Newer manuals are mostly guidelines and good practices versus setting a very strict standard for the reasons we just outlined in addition to legal liability.

Q. And if we could go back then to image 4 -- actually maybe image 4 and 5 would be good.

And so you've got section on

2.3 "Highway Design" which goes on to the next page and which you indicated the primary components of highway geometric design guidance.

And before we get into those specifics later on in the report, which we will get to, there's a full section on design speed. But we hear about it -- from time to time we will hear about it, and you mention it in your report when talking about individual items. So could you just give a brief explanation of the concept of design speed and posted speed before we get into the specifics -- the specific items that are listed in section 2.3.

A. Yes. I apologize to the inquiry. Having written this report, if I were to do it again, I would have put design speed first.

Essentially the design speed is the cornerstone of -- one of the cornerstones of the overall design of an intersection, a road section or a freeway. Essentially you need to decide what kind of facility you're designing, how it's going to function and what the road user speeds are going to be potentially on this -- on each facility.

So if you're designing a local

residential roadway you would -- we'd choose a lower design speed. You'd know there would be driveway accesses and frequent intersections. And on the very other end of the spectrum, freeway facility where you were trying to move traffic, a large amount of traffic, high speed with no stops and no -- and as little turbulence as possible.

So from a design speed perspective we select at the beginning this is going to be a freeway, an arterial or a collector or local roadway and how it's going to function, and then the intended design speed, and that is generally based on what the expected posted speed is on the facility.

So if, for example, we're going to design to 100 kilometres per hour -- for a posted speed of 100 kilometres per hour, we would generally pick a design speed that would be in excess of that to add a level of safety. So typically on a major freeway would be 120 kilometres an hour, but there are some exceptions to that.

Q. Okay. And the next thing which is not listed, but as an overall concept, could you describe the principle of design consistency?

A. Yes. So a designer needs to understand that they're dealing with the motoring public. And as much as we think they understand some of our design standards and our traffic control devices, we need to make sure that we're meeting their expectations and that they understand, based on travelling along a particular roadway, the nature of it how it functions and what they essentially expect as they are driving down the roadway. And we don't want to violate those expectancies.

So essentially design consistency deals with looking at the various components of the roadway, whether it be horizontal or vertical alignment, the lane widths, the cross section out to the roadside and making -- and the ramp interchanges as well and ensuring that -- a consistent message about speed and choices, amount of workload that they are going to expect.

The cross section that they would encounter as they travel along the roadway doesn't change significantly, that it's relatively consistent, and that the operations of the freeway are relatively consistent in that if they have been travelling on it for a period of time that they expect if they have comfortably done, you know, a 110, 120, like many of our road users would in those situations, that there wouldn't be an expectation that all of a sudden there would be a corner, a hill, a particular aspect that they wouldn't be able to traverse at those speeds unless they are warned about it. So the design of the roadway is relatively consistent with generally the design, speed and the function that they expect.

Q. And is that something, that concept, is that something that is found in the guides, the '85 MTO guide and the TAC guide?

A. Yes, both have general guidance on consistency and each one of those components.

Q. Thank you. Okay, and then -- so I would like to go through the individual components that you've referenced in your report. And starting with sight distances, which is at the bottom image 4 going on to image 5, there's three components that you set out there, and if we could take them in turn. The first being stopping sight distance, which you describe as:

"...the distance to allow motorists to perceive, react and stop for an object in their path at the design speed, i.e., sufficient sight distance over a hill to observe and react to an object or a stopped vehicle in the travel lane on the far side of the hill."

Describe for us the concept of -- I mean, you set it out there briefly, but if you could elaborate on that.

A. The stopping sight distance essentially is a measure at the design speed of the ability for a road user to see what's in front of them and make decisions as to potential actions that they need to undertake and/or a hazard that's in the roadway -- could be a vehicle that's disabled, it could be something that's fallen onto the roadway -- and that is provided along the entire length of the roadway and on-ramp interchanges for the design speed that's expected for each one of those components. So essentially as a road user travelling down the road and they identify something that could be a potential hazard, they are given a period of time to perceive and react to it.

Our design manuals assume 2.5 seconds of perception, reaction time as we call. So that's from the point of going, wow, there's something that I need to be concerned with that I might need to come to a complete stop for in my path, and they have 2.5 seconds. Most motorists would be able to react with within one second. A more conservative number that's used in collision reconstruction by the OPP and others is about 1.5 seconds, unless it's a really complicated decision. So in our manuals we've been a little more conservative and we allow 2.5 seconds.

So assuming somebody is travelling at the speed -- posted speed and/or the design speed, they would have time to perceive and react over 2-and-a-half seconds with no braking, no reaction, no steering, and they would travel a certain distance, and then full emergency braking on the remainder of the time, and that would collectively put together the distance that the vehicle would travel during perception, reaction and that full braking. So that's an emergency situation where there is a real and obvious hazard or a real and obvious traffic control device that I need to be able to stop -- come to a complete stop for.

Q. Right. So in your report you refer to, you know, sufficient sight distance over a hill to observe and react. So if I understand it correctly, if I'm driving and I'm coming up to the crest of a hill and there is a traffic jam, so the car is stopped or an accident, whichever, it's the distance I need to react to it and then come to a complete stop.

A. That is correct.

Q. As I come over because as the horizon is compromised, if I put it that way, with the crest of the hill?

A. Yes. Likewise with a vertical curve around -- like travelling around a curve, the sight distance needs to be provided so that if something comes into your purview, you'll be able to perceive and react to it.

Q. Sorry, you said vertical curve. Is that a horizontal curve?

A. Sorry, horizontal curve.

Q. Okay. Right. And -- right. Okay.

The next item right at the bottom of image 4 moving on to image 5 is "decision sight distance," which it --

"...to allow motorists sufficient time to make a decision regarding manoeuvring their vehicle or adjusting the speed in complex situations where information may be perceived incorrectly, decision are required or control actions are required as opposed to stopping sight distance which involves a complete stop for an obstacle."

You describe the stopping sight distance -- decision sight distance that -- it's not about coming to a complete stop; is that right?

A. Exactly. I mean, it would be a pretty tough drive to and from work every day if each decision we had to make we had to jam on our brakes and come to a complete stop. So decision sight distances are much longer distances. They are more complex situations where you would make a decision -- or where you would -- required to make a decision. It might be on a freeway facility, a weaving manoeuver where you're trying to get off the freeway and other vehicles are attempting to get onto the freeway. It may be a lane choice. It could be coming up on a traffic control device, a traffic signal at a ramp interchange, and you need to make the decision about whether you're going to stop or potentially if you're going to travel through the intersection. And so those distances are obviously a lot more generous than purely putting on your brakes and coming to a complete stop. They allow you to make a decision about, do I just need to slow down a bit and allow others to react to my position, do I change lanes because I no longer want to be in the through lane, I want to be on the interchange that I'm trying to diverge onto. So the design of a decision sight distance at those locations are obviously quite large.

Q. And so -- again, for example, if I'm driving along the outside lane approaching an interchange onramp where vehicles are coming on and a vehicle is merging in more slowly than I'm driving, the decision sight distance, it's the decision I need to either move to another lane to avoid them or potentially just to ease on the brakes to slow down to allow that to -- to avoid a collision as that vehicle merges in. Is that one example?

A. Yeah. Speed up, slow down or change lanes. It's --

Q. Or speed up.

A. Yeah.

Q. And in footnote 2 at the bottom of image 5 there's a reference to complex -- adjust their speeding complex -- complex situations, and -- for example, complex intersections or interchanges, unusual or unexpected changes in the roadway environment, construction zones, demanding driver workload areas due to a heavy traffic conflict, advertising and/or traffic control devices.

So first of all, there's a reference to workload there, which is a term you used before. You mean the number of decisions that have to be made as well as braking and turning. Is that what workload means?

A. Workload is your environment that you're in. So as -- say, you're driving down a rural road, two-lane rural road with -- so bush on either side of you and no real driveway access, your workload is pretty low, and your attention, the number of conflicts you're dealing with, they are very low.

As you get into a more urbanized area, say, an arterial roadway in the middle a city or a busy freeway environment where there's weaving manoeuvers, your workload goes up. The number of users that are around you, the number of queues that you are attempting to deal with, lane keeping, you know, steering, speed, control, all those things become a higher workload on you to make decisions in relation to other road users so that you can get where you need to go and also not collide with others in the process.

Q. All right. And a complex interchange versus an uncomplex interchange, is there -- you just used the work complex, so I'm wondering what the non-complex is?

A. Well, there would be -- interchanges might have dedicated ramps. They may have overlapping weaving sections between either their ramps themselves or ramps with other interchanges. There could be a number of things that could make it more complex, but -- you know, something standard would be a single loop ramp coming off of the freeway or a diverge straight tangent ramp would be something that was very straightforward.

But when we get into more unique designs such as, you know, some of the classic ones we know, the Highway 407 from the QEW and Burlington area where we've got a left ramp instead of a right ramp going to the 407. And anybody who knows the history knows that it was redesigned and resigned about 50 times before they actually got something that motorists could understand and recognize and react to.

Q. And is -- does that go -- pointing back to design consistency that motorists tend to expect and typically along a road your exits are to the right?

A. Yes.

Q. And if you have one on the left that confounds, to use a word, driver expectations of consistency, is that one of the concepts of consistency?

A. Yeah. It's one that's pointed out in our design guidance quite frequently as, you know, one of the key things not to do. We can sign it as best as possible but the expectation -- sometimes motorists' expectations of the facility they're on are overwhelming until

they are immediately upon that decision.
Q. But I guess the point is sometimes you might to have do it that way. Is that the other -- even if it confounds -- if it is inconsistent with expectations, sometimes you might to have do that depending on the geography and the existing terrain?
A. Yeah. There is always those situations that there's certain aspects of the design that you can't overcome, and you may need to conform to certain things around you and that may be the case, yes.
Q. Okay. And sight lines is the third one at the top of image 5. And your reference there refers to sight lines approaching and at the at-grade intersections to observe and react to traffic control and conflicting road users. And so does -- this is talking about intersections. How does it apply to highway design of the sort that we're talking about?
A. Yeah. Essentially we don't have at-grade intersections along the main line of the freeway facility. Where we do come into at-grade intersections that may be stop controlled, they might have yield approaches for

some of their turns or traffic signal control. Some of them also have roundabouts, we shouldn't forget that.

But essentially that's where we would need to deal with what we call approach and departure sight distances. So essentially when you approach an intersection to -- as you're coming up and your -- you need to be able to see as a road user, and we design to be able to see those other road users, what their actions are, whether they're pedestrians, bicyclists or vehicles, and that's typically what we would call sight triangles in an intersection, or daylighting triangles, and it allows you to be able to see opposing traffic flows and make decisions on what your actions are going to be.

When we get to the intersection, whether it's stop, yield or traffic single control, we also need what we call departure sight distance. So that's essentially -- most easiest way to explain that is you're sitting at a stop sign, there's traffic going back and forth from your left and right, you need to pick a gap in traffic, you need enough time to either cross the roadway or enter that traffic stream making a left or a right turn onto that roadway, and we provide sight distances so -- or there's design sight distances for different speeds so that you can make that turn and get up to speed and not put yourself in harm's way.

Q. Does it relate to ramp design for limited access highways? If there's a -- when it comes on -- when an off-ramp comes onto -- from an interchange to the local road --

A. Yeah.

Q. -- and there's traffic signals and so forth?

A. Yes. That's where you would -- be where you would be applying that guidance.

Q. And does that tie into then the stopping sight distance? If the cars are backed up, for example, waiting for the light and cars are coming off the -- onto the ramps off of the main line highway, and if they are backed up?

A. Yeah. It's the same -- the same concept would be as we just discussed earlier for the main line. As you're travelling along that ramp there is going to be the design speed for that ramp. There will probably be posted advisory speed if it goes through any kind of horizontal or vertical alignment, and stopping sight distance should be provided along the entirety of that ramp to see other vehicles, other road users and also the traffic control devices that are controlling that intersection.

Q. The next bullet there is "lane and shoulder widths." What those are is obvious, but what considerations go into determining their width?

A. There would be mainly the functional roadway again. The traffic composition that will be using the roadway, whether it's, you know, a local road in a residence where we're essentially designing for mostly passenger car vehicles. If we get into arterials and freeway systems, we need to design for busses and large trucks. So as the function of the roadway goes up, the larger vehicles that are permitted on that facility and the design speed go -- as they all increase and go up in importance, the lane and the shoulder widths on those facilities also become wider for not only larger vehicle but off-tracking and also lane keeping. So as you are travelling at 50 kilometres per hour, a little turn in your steering vehicle doesn't make much of a difference, but if you're travelling 100, 110 or 120, we need to provide a little bit of extra lane width so that road users can keep their lane with minor deviations within that lane at those speeds.

Q. When you use the word "lane keeping," it's about just keeping in your lane with minor changes in your -- which increases the speed. The effect of those minor changes you make in your wheel have a greater effect at a higher speed?

A. Yes.

Q. So you need a wider lane. Okay.

A. And likewise with shoulder width on a local or minor rural roadway with no volumes, we may provide very narrow shoulders because they are not used for emergency situations as much and the speeds, the operating speeds are lower. When we get up to high speed facilities, we obviously want to provide a wide shoulder for emergency breakdowns and individuals to be able to seek refuge. And if there is some excursion from the lane, that there is some latitude and some recovery area for those vehicles at those types of speeds.

Q. Right. And just from my own experience, you don't always have shoulders that are generous on highways or bridges and so forth; is that right? There are deviations from that guidance; is that correct?

A. Exactly. When we get -- there might be localized areas underneath a bridge structure or across, you know, a river or a rail crossing where the shoulder width for a very short duration or distance will be reduced to essentially save money in most cases. Larger structures cost millions of dollars more. So if there is proper remedial action at those locations, that you would see reduced shoulders in certain locations.

Q. Okay. Next item is "vertical curves" representing the hills and valleys experienced as you travel along the highway alignment. And so is that also the -- that's -- vertical alignment is another way of talking -- when you talk about vertical alignment, you are talking about vertical curves; is that right?

A. Yes.

Q. Okay. And so if I am driving up and over a hill, from a geometric design perspective that's a vertical curve?

A. Yes. It's a --

Q. Or into a valley and up?

A. Yeah. If you're going underneath a bridge structure or you're coming to a low lying area and you're going down an incline, you go through a properly designed vertical curve and you come up on the other side, yes.

Q. Okay. And the next bullet are grades to the overall uphill, a rise, and downhill, a fall, of the highway surface:

"Roadway grades are positive if rising in the direction of travel and negative if falling in the direction of travel. The grade along a roadway is expressed as a percentage that is rise or fall in metres over a horizontal length of 100 metres."

So is that -- again, the grade is part of the vertical alignment? It's the rise up to a hill potentially or down?

A. Yes. So a vertical curve would have different components of grades. If you're going up over a crest vertical curve or a hill, you would have a grade going up to the top of that hill, the curve that would transition you from an upgrade to a downgrade and then a downgrade on the far side of the hill. There are also just standard grades that would be traversable that may not be a curve itself, that would be a general uphill on a roadway or general downhill. So that's dealt with separately in some respects to deal with those situations.

The way we express a grade, whether it's longitudinally along the freeway facility or the highway facility or the crossfall across the pavement is a percentage. So essentially if there was a 2 metre fall over 100 metre distance, that would be expressed as 2 percent, so a 2 percent grade.

Q. Okay. For our -- and minus 2 percent if it's a downgrade?

A. Yes.

Q. And so, yeah, 10 metres over 100 metre horizontal distance, a rise 10 metres over 100 metre horizontal distance, that's a plus 10 percent?

A. Correct.

Q. And minus 10 percent if

it's above. Okay. And I used the example of 10 percent, is that an unusually steep grade for a highway?

A. It generally would be. Most our longitudinal grades -- on some of our newer facilities, if there's no major topography issues to deal with we would generally be designing to 2, 4, 6-type percent. As you probably have seen in your travels, driving along a roadway where there is more challenging topography, they'll start signing longer grades of 7 percent, 8 percent because that's where vehicle speeds can be more challenging and be harder to maintain your speeds, and we warn road users of that. When we get into more mountainous-type terrain or grade differentials along a roadway, we may get into an 8 and 10 percent grade, but we generally try to shy away from it for higher order facilities.

Q. And you referred to "pavement crossfall" which is the next bullet. Could you just describe that, please.

A. So essentially we need to be able to drain surface water from the roadway. It's, you know, not good for ponding as you are driving along. So for our typical two-lane or four-lane section-type roadway the highest point is generally taken on a straight section of roadway as the middle of the roadway, and essentially the pavement has a crossfall which slopes towards the edge of the shoulder or the edge of the curve and gutter, and that is where water either is dissipated or collected, and it takes it from the road surface. Essentially when we look at a typical crossfall on a roadway, it's generally in the order of 2 percent.

JUSTICE WILTON-SIEGEL: If I can add a question. If you have a divided highway, do you tend to have a crown, if I can use that term, as the centre of the highway for each of the sections of the divided highway with the water spilling into the median? Is that the way you design these?

THE WITNESS: Generally if it's a four-lane facility with a median, there may be design choices that may be specific, but for the most part a two-lane facility in each direction would go from the median, whether it's a concrete median or other, and it would still drain to the edge of the pavement into the ditch area.

If we do get into a three-lane section in each direction, so a six-lane freeway or wider, obviously that's a lot of water to bring across the surface of the road. The passing lane, the fast lane in those cases might be the break point between the crown. So essentially the passing lane may go to a median drainage system, which would be catch basins, and so each direction of travel would sort of donate one lane of surface water into the catch basins, and then the other two lanes would still drain to the outside.

There's various configurations and options, but as a rule of thumb that is generally where we go from straight crossfall to the shoulder to potentially a median drainage system as well.

BY MR LEWIS:

Q. So the next item is "horizontal curves," and there's three principal curve classifications that you refer to, circular, spiral and superelevations, and I understand that there's a relationship between all of those, but perhaps we can talk about them in turn just to, so to speak, to unpack them.

And so first, circular curves,

what makes a curve circular? Seems obvious but please.

A. Well, maybe I could sort to speak to both spiral and circular curves in a sort of --

Q. Sure.

A. -- layperson's perspective. So as you're driving along a particular facility and you're on a straight section roadway, a tangent section, and you come up on a curve, a higher speed curve is -- at lower speeds there you might just go straight into a circular curve. If it's a design speed of 50, you may not have the transition. But on a higher speed curve, you're -- essentially you're driving; you're holding your steering wheel straight with some minor deviations for lane keeping. And as you go into the curve, you are going to start turning your wheel.

A circular curve is a constantly changing radius curve that transitions you into a -- into the circular curve. And then that's the point -- as you're driving you would be transitioning through the circular curve, and you would -- or transitioning, sorry, through the spiral curve; you would hold your wheel roughly steady -- other than, you know, general deviations for lane keeping -- and then you would transition out through a spiral curve. The spiral curve is there to help with that transition that you are not immediately going from a tangent and jerking your wheel into a potentially, you know, a tighter circular curve. So if --

Q. I think in a couple of instances there you changed sort of -- I just want to make sure I understand. You are on the straight tangent --

A. Yeah.

Q. -- and then move into the spiral curve which transitions into the circular curve?

A. Correct.

Q. Okay.

A. So if you were to stay on a circular curve and it was extended, you would be essentially going in a circle along a constant radius, and your steering wheel, again, would just stay relatively steady with, you know, minor deviations as you would on a tangent roadway.

Q. So if you stayed on a

circular curve, you would eventually come literally full circle?

A. Yes.

Q. Okay.

A. It would be a constant radius. A spiral curve starts out gentle and begins to tighten up until such time as it gets to the radius of the circular curve. So if you were on a constant spiral curve for a while, you would continually be getting tighter and tighter until such time as you couldn't turn any harder. So spiral curves are just the transition, and they're there mainly for comfort so that drivers don't -- and also, sorry, lane keeping so that you're not surprised by the need to be turning immediately.

Q. And typically I take it if there is a -- if it's a tight circular curve, that is the certain circumstance where that might be signed, for example, if it creates -- maybe I'm getting ahead of it -- but if it creates a situation where there isn't a transition, you might have signage about speed or a warning about it?

A. Yeah -- because if the circular curve is designed much less than the expectations for that roadway.

Q. Sorry, I may have cut you off if you were....

A. No.

Q. Okay. Good.

And is there a relationship then between design speed and the -- and again, circular curves and spiral curves. If you could describe that.

A. Mainly it's the circular curve that we're designing to. The spiral is -- would fall out of what the circular curve is. So essentially at a design speed of 50 kilometres an hour, a circular curve could be quite tight. It may be in the order of 100 metres radius that you would have to travel around.

As we increase the design speed, the size of the circular curve becomes much larger so that you can traverse it through -- or you can traverse it at those speeds without losing control and having some level of comfort in travelling through that curve.

Part of that is also the superelevation of the pavement surface. So essentially superelevation, in the easiest terms, to understand is we're in a crown situation where we've got the centre of the roadway on a two-lane facility or four-lane facility are both sloping outwards. When we get into a superelevation, the roadway on the outside of the curve goes up. So that if you picture a racetrack that stock cars are going around, or race cars, the outside of the track is banked to the high side, and the inside is banked down to a low side. That allows us to travel through that curve as motorists at a higher rate of speed based on the circular curve that's provided.

So -- whereas a typical crossfall is 2 percent downwards, a superelevation may be 2 percent on a gentle curve, so it would be constantly 2 percent towards the inside of the curve that you're going around. It may be 4 percent or 6 percent on many freeway facilities. Again, higher superelevation allows you to create the -- to travel through the -- or to design a curve to a design speed without taking up a large radius like, you know, 2- or 3,000-metre-type radius. And in more extreme cases we typically wouldn't see it.

You can see 8 percent grade,

but that would generally be if we're dealing with a very constrained area, such as a ramp terminal, a curve within a ramp that you would be designing to, and there's property constraints and other things that you're trying to build into. You may bank it even more so that you can get a tighter curve to maintain that same design speed. So superelevation and the radius of the curve are the two key components, and they work together on the design of a -- of curve in the roadway.

Q. And the superelevation and the extent of the superelevation as it increases allows the reduction of the curve radius -- reduction of curve radius depending on the superelevation which allows you to travel at the design speed --

A. Yes.

Q. -- right?

A. Yes.

Q. Okay. The next bullet is "interchange design." And I gather that interchange design has a certain number of complexities to it. But could you describe generally what are the sort of considerations that go into interchange design.

A. Well, the interchange design, yeah. As you mentioned there's quite a few different configurations and aspects to it. Essentially the forced design component of interchange design is where to place your intersections. If you are in a greenfielded development or a greenfield area or an open space or a rural area, the intersection spacing is a choice you need to make where you would like to put that. In a lot of cases you may be traversing areas, especially as we're travelling up north of Toronto here through cottage country, et cetera, a lot of the roadways dotted the areas. You know, you could pick where you want to put the interchange design.

When you get into more urban areas and you're traversing an existing road network, typically you're going to try to tie into the roadways that are already there within their rough alignments and be able to provide access to the adjacent land uses. You are building that facility to provide that access. So intersection spacing is one of the key criteria that you would start with.

Q. Sorry, you are saying

"intersection." Are you using that interchangeably with interchanges at the moment?

A. Thank you for catching that.

Q. Okay.

A. Yes, interchange spacing. And then from there the type of interchange, and there's quite a few that are covered off in our manuals. Whether they're a series of loop ramps or diverging ramps, there's quite a few different configurations, but that would all be part of the design that the designer would have to look at and say, what kind of traffic do I have entering and exiting from each one of the directions and how am I going to accommodate that with a single-lane ramp, in some cases dual-lane ramps, to deal with the amount of traffic that needs to enter and exit the freeway facility and the directionality of that traffic. So quite a few different configurations that obviously we want to get into today.

Within that -- both those two key components, the spacing and the configuration, there may be situations where there will be overlap between what we call the functional area of those two interchanges. So essentially we have an interchange that's got an on-ramp coming on and there's -- and a short distance after that there's a off-ramp or a series of ramps for another interchange. So we would -- in that case we would get into weaving sections.

So there is a whole design process to that, it's iterative, to look at what kind of configuration we provide for those ramp interchanges and the type of traffic, the amount of weaving traffic, who is trying to get on, who's trying get off on a typical design day and be able to design to that.

When we get to the actual ramp designs, the same fundamental components that we've just talked about for the main line, the sight distances along those ramps, whether they're the loop-type ramps or other ramps that have horizontal, vertical alignment to them, the vertical components of those ramps. As we mentioned before these are all situations where there's a grade separation, so not only are you diverting off the freeway facility or onto it and your potentially going through vertical -- sorry, horizontal curves, there's also going to be a vertical alignment to it because you're getting from one elevation to the next whether you're travelling from the interchange to the cross street or vice versa, and then, you know, all the components of sight distances, vertical curves, all appropriate for the design speed for that ramp.

For the most part our ramps aren't designed to freeway speeds. So if we got a freeway posted at 100 kilometres per hour, in most situations the ramps themselves are going to be posted at lower advisory speeds to allow road users to understand that those components, the vertical, horizontal alignment and sight distances are no longer a appropriate for the freeway, free flow speeds.

Q. And in terms of the spacing between interchanges you talked about weaving. And is there also provision for acceleration and deceleration?

A. Yes. In those situations we're taking traffic that's coming from a low speed environment and we need to accelerate them or decelerate them onto the freeway. We need specific -- there's design guidance on how much parallel length and taper length the -- where the roadway tapers down in order to provide for those transitions in speeds.

Q. And sorry, by taper you mean when the lane becomes smaller and forces, essentially forces the driver into the main line traffic? Is that --

A. Yes.

Q. Okay. I use force in a non-pejorative way. You have to get onto the main line.

And in terms of the spacing around -- of interchanges. Is that something that guidance is given in the guides with respect to distances?

A. Yes. Both the 1985 MTO guide and the 1999 TAC guide as well, they both have general provisions and guidance. The range of spacing that is recommended out in rural areas is anywhere between 3 and 8 kilometres -- 3 being the minimum, 8 being mostly a maximum -- to provide some sufficient land access to future uses. So in many respects even if you're traversing a wide open area, in some situations MTO will put in an interchange for future use and tie into a local road network.

When we get into a more urbanized area, the general guidance is do you have spacing between interchanges of 2 to 3 kilometres. But there are going to be situations to tie into the existing road network that they may need to be less than that, especially in very dense urban areas with a number of arterials that would be crossing the freeway system. There's those options of how you would accommodate that, and/or you may consider situations, and you've probably seen it, where it's just a complete flyover of that arterial road to the freeway system. So essentially there's no ramps provided, but there is grade separated travel on each one of the facilities across each other.

Q. Okay. And we talked earlier about overall the principle of design consistency. Is there guidance design consistency given for interchange design as well?

A. Yes. I mean, the -- as with other aspects of the road network, we always strive to provide a consistent message as best we can to the road users as to the location of the interchanges, how we sign them, the lanes that we need to be in as we are attempting to enter or exit that freeway facility, the appropriate speeds to be leaving that facility. And as we go from one interchange to the next that is going to vary because there's always challenges at each location.

As with regular at-grade intersections there's always different design aspects of it, but we generally try to keep it as consistent as possible to give that message and that expectation to the road user as to when they should make certain decisions and what speeds they should be doing those at.

Q. Okay. And I -- both the MTO guide and the TAC guide both give -- is it similar guidance around those issues?

A. They have different -- somewhat different guidance, but essentially the concepts are the same of, you know -- the consistency between geometric features and how we sign those features are pretty consistent, yes.

Q. Okay. And the next item is "roadside safety, including ditches, fixed hazards and protection." There's a section on that later, so I'll just flag that for the moment, and we'll come to that later in the presentation.

The next item is image 8, if you could jump to there. It's "pavement friction design," and it says section 2.4.1. And we heard yesterday from Dr. Gerardo Flintsch respecting pavement friction science and measurement and so forth. And I just want -- as a starting point Dr. Flintsch was principally dealing with friction measurement and so forth, and I just want to be clear at the outset, your report here is dealing with assumed values in the design of a highway; is that right?

A. That is correct.

Q. Okay. And in footnote nine at the bottom of that page, I'll call that out -- it says:

"Friction values assumed in design do not represent the available, i.e., actual friction between tires and road but a much lower value with safety and driver comfort factors considered."

So maybe just -- you've described what assumed means in this context. We'll get into the details of longitudinal and lateral friction, but if you could just give us an entry to that about what assumed values mean.

A. Yeah. As the footnote says these are not the actual friction values that are available on a roadway for a stopping sight distance. They're very conservative. They're based on worn tires, wet pavement, and they are much less than the values that you would have been discussing yesterday with -- or Mr. Flintsch would have been discussing. Likewise, when vehicles are going around a curve, the friction values that are assumed in design are based more on comfort factors of centripetal force that a person may encounter as they're going around the curve, versus a friction value where if they exceed that design speed or they exceed that, that their vehicle is going to lose control. There's quite a bit of safety factor built into both longitudinal and lateral friction values in design.

Q. Okay. And if you could reduce that, please, Registrar.

Above the figure there which is a -- figure 1 is a representation of a vehicle in a horizontal curve, but we'll talk about longitudinal friction and design first. And there's -- for longitudinal, and I think you mentioned this before, for longitudinal friction this relates to the stopping sight distance; is that right?

A. Yes. So essentially as a motorist encounters the hazard, or something they need to slow or stop for and apply their brakes, the stopping sight distance and the friction that is assumed in the stopping sight distance is for, as I mentioned, wet pavement and worn pavement, and it assumes that at those braking -- at those friction values that you would be able to brake within the distance that's included in the design of that roadway.

Q. And at the bottom of image 8 if we could call up image nine as well.

THE REGISTRAR: Apologies. I just have to restart OnCue.

MR. LEWIS: Okay. Let us know. We'll wait.

(DISCUSSION OFF THE RECORD)

BY MR. LEWIS:

Q. And so actually perhaps before going further, we don't have to go back to another page, but in section 2.1 you had indicated that you don't have extensive expertise in friction testing; is that right?

A. That is correct.

Q. Right. So this is -- in terms of the kind of things that Dr. Flintsch was talking about, that is not something that your -- you have expertise in or feel qualified to opine about; is that right?

A. I opine about pavement friction values in some cases, but in terms of testing and the in-depth knowledge, no.

Q. Right. And here we're talking about the assumed values as opposed to the measured value, so....

A. Yes.

Q. Okay. And so you talked about there being -- in your report about conservative design values. In footnote 11 where you talk about longitudinal -- and this is the bottom of image nine, Registrar.

And this is where the correction to your report came in about similar lateral friction values are assumed in the MTO design guide as the TAC guide, and corrected that to similar longitudinal friction values.

On that point, when we're

talking about longitudinal values and we're going to be looking at the TAC table, is the MTO guide similar?

A. Yes. So for most -- for the majority of the range of the design speeds that's just different minor rounding differences between the two. As we get up into higher operating or design speeds of 120, 130, they do diverge a bit but not substantially from each other, like there are some minor differences.

Q. Okay. Sorry, and that's for longitudinal?

A. Yes.

Q. Okay. So if we could go to -- sorry, unhighlight that. Thank you. One moment, please.

Okay. And so the -- at the top of image nine there you speak of reduced friction conditions due to snow, slush or icy road surface conditions. So is that a -- that's a separate point I take it, then, from the longitudinal friction assumptions and the stopping sight distances; is that right?

A. Yeah. The conservative in the safety factor that's built into the stopping sight distance assumes wet pavement conditions. When we get into situations where there is looser snow, slush, icy conditions, the assumption is by the guidance is that motorists will adjust their speeds at this point. Maybe not so much when it's raining and various degrees of raining, we need to account for that, but if it's sheer ice we don't expect that they would be able to travel at freeway speeds without any issues.

Q. Okay. If we could then go to the next image, image 10. There we are.

And we'll get into the specifics of it, but you -- the text at the bottom refers to the next figure, which is lateral friction. This table 2 deals with stopping sight distance with anti-lock braking systems from the '99 TAC guide, and if we could expand that please, Curtis.

THE REGISTRAR: Sorry, Counsel, the chart?

MR. LEWIS: The chart, table 2, figure 2. Thank you.

BY MR. LEWIS:

Q. So the -- this is Stopping Site Distance For Automobiles and Trucks

With Anti-Lock Braking Systems and we just (video freezes) --

(DISCUSSION OFF THE RECORD)

MR. LEWIS: So if I ask, are all the participants' counsel on now? Is everyone on? I can't see.

THE REGISTRAR: Sorry, Counsel. Everybody is still connected. I think it was actually just a Zoom problem. So I think Zoom just cut out for a number of people for about 30 seconds.

MR. LEWIS: Okay.

THE REGISTRAR: Might just be the area that everybody is in.

BY MR. LEWIS:

Q. All right. All right. So I'll go back. I'll just introduce this table again, figure 2 from the '99 TAC guide entitled Stopping Site Distance For Automobiles and Trucks With Anti-Lock Braking Systems. And it sets the -- in the left-hand column there's the design speed which is -- we spoke about earlier, and it's at a -- I'll use 100 for the purposes of going through this, as I said, because it's a round number and easy for me anyway for math.

So if the design speed is 100, the next column then says the assumed operating speed is 85 to 100. What's the assumed operating speed, and it gives a range.

A. So that is what I referred to earlier as a design domain. Essentially when we look at a design speed of 100, chances are we have a facility that's going to be posted at 80, maybe 90 kilometres per hour in that range. So within that -- you know, with that posted speed, we would expect most traffic to be travelling between 85 and 100 kilometres per hour, and that's our design domain. So you will see the ranges carry across based on those two different initial operating speeds of 85 kilometres an hour to 100.

Q. Right. That's why we see two numbers across that row and all the others.

A. Yes. So if -- we can still have a design speed of 100, but if we have speed studies on a particular roadway or a similar facility and we know that people are travelling 90 kilometres an hour, we may choose to look at some of our components of our road network that potentially might be at the lower end of some of these ranges. But if we know that in most of these instances traffic is at the upper range of that assumed operating speed, we would definitely be looking at a minimum of the upper ranges of all those values.

When we move over a column you'll see there's a perception and reaction time and distance. That time I mentioned before is 2.5 seconds. So that's essentially as somebody is travelling at the design speed and they perceive or react to something -- perceive something they need to react to, we allow 2.5 seconds. So over that period of time, they will continue to travel at 100 kilometres per hour from a design perspective, and that's the 59.0 to 69.4 essentially, 100 kilometres an hour for two-and-a-half seconds, that is when they decide they need to break. From that point forward --

Q. And just to be clear, that gets you the -- just if you're using 100 rather than 85, that gets -- that's how far -- the 69.4 is how far you'll travel in those 2.5 seconds?

A. That is correct.

Q. Okay. And then -- yeah,

moving on. The coefficient of friction is the next one, but I think we need to talk about the braking distance before we get to that; is that right?

A. Well, the braking distance is a function of the coefficient of friction.

Q. Right. Okay.

A. So essentially as speeds go up the assumed coefficient of friction goes down. And our presentation yesterday can speak better to why that is based on the two different types of friction between the tire and the surfaces of the asphalt. But essentially at 100 kilometres per hour our design manuals assume a coefficient of friction of .29. And you can compare that in your mind to what you heard yesterday in terms of what available is typically provided on pavement surfaces.

So at the point where the vehicle is hard braked, the 98.0 to 135.6 is the distance it will require at that coefficient of friction to come to a complete stop. So 98 would, again, relate to the 85-kilometre-an-hour assumed operating speed, and the upper value would be the

100 kilometre an hour. When we take the amount of time or the distance that is travelled during perception, reaction, and you add that to the physical braking of the vehicle, the last column gives a rounded stopping sight distance to perceive, react and come to a complete a complete stop along that highway facility.

Q. Right. So the stopping sight distance of, we'll call it again 210, just to use 100 rather than the range, is when you add together the 69.4 under the perception, reaction distance to the braking distance, and that gets you your stopping site distance rounded?

A. That is correct.

Q. Okay. And if we could reduce that then and go to image -- sorry, yes, thank you. And then there's a description of -- actually if we could pull up as well image 11 to go with 10.

And there's a description there at the bottom of page 8, image 10 of the table 2.1.2.1, again from the TAC guide, about lateral friction. So if you could describe this to us. It's a somewhat different concept as I understand it, but please describe it.

A. Yes. And so lateral friction is equivalent value of what the vehicle would experience as they travel around a horizontal curve, a curve in the roadway. So it is not -- while it is expressed as a friction value it's not related to the actual friction between the tires and the roadway. It is based on the equivalent of the tolerable degree of occupant comfort and a -- with a very large reasonable margin of safety.

So if you look at table -- in figure 3 the table, you can see at a lower design speed the maximum will allow friction built into our design guidance is 0.17. As you increase to 130, you can see that number goes down to 0.08. It is a bit counterintuitive when you first look at it. As speeds go up, you need less friction. No, as you -- as speeds go up, people are less comfortable travelling around curves feeling that equivalent amount of lateral -- the equivalent of that lateral friction.

So let's look at it this way. If you are in your local neighbourhood and you're turning at an intersection and you decide to turn at, you know, a higher rate of speed, you know, most speeds turning at an intersection in local neighborhoods would be 20 kilometres an hour. Say let's try to do that at 30 or 40 or even higher, if you really want to push things. You're all right with that from a occupant perspective. You feel that discomfort as you're turning your wheel sharp, and you're feeling your body being pushed to the outside of the car, and you know you're at lower operating speed, so your risk of a collision or losing control is quite low. You might to have encroach on adjacent lanes, but, you know, the volumes are low.

When we get up to freeway speeds we don't -- occupants aren't as comfortable feeling that kind of level of acceleration through the -- to the outside of their car. So we design our horizontal curves and the superelevation, the radiuses and superelevations to lower equivalent friction levels as the design speed goes up. So as you're going around a 120-kilometre-per-hour design curve, you're going to feel some lateral acceleration to the outside of the car, but nothing that would create you discomfort or be anywhere near the risk of losing control because your tires are going to start skidding on the roadway surface. So that's where those -- you can see the differences between the table on the left and the right. That's there -- you know, half if not more of what we need to physically stop on a wet pavement.

Q. So would this be reflected in larger and larger radii?

A. Yes, and greater superelevations as well.

Q. And greater superelevations. As between the TAC guide and the 1985 MTO design guide, how do those compare in terms of the lateral friction table?

A. For the lower design speeds in the neighborhood of, you know, 80 kilometres an hour and less. They are essentially rounding differences. The MTO manual expresses the lateral friction to three decimal points, and the TAC manual rounds it to two decimal points, but essentially from that rounding perspective they are the same. As we get up into higher operating speeds, 100 kilometre an hour, 110 -- sorry, not operating, design speeds of 110 to 130, the MTO manual allows for larger lateral frictions.

So let's give an example. At 110 the TAC manual is assumes 0.10. The MTO manual assumes 0.122. Again, it appears, you know, when you look at the straight numbers they are significantly different, but when we're dealing with such low equivalent friction values to start with, they are not -- you're not night and day. Somebody driving around an MTO-designed horizontal curve at those speeds versus a TAC one is not going to feel an extreme discomfort or be concerned that they are going to lose control using either one of those values. You would feel roughly the same.

Q. And these, again, are the assumed friction values as you describe?

A. Yes.

Q. And you've already said overall with the MTO guide and TAC guide about the legal requirement to follow them, or lack thereof. Is that the same with the -- with these components specifically?

A. Yes. They are not legally binding, and they aren't required to follow them. However, my experience in the industry is that we generally apply these values.

We don't question the friction or the perception reaction time, and we apply them in most of our design.

Q. Okay. And then if we go to image 14. We talked a little bit at the outset of the design component portion about design speed and posted speeds.

And actually if we could bring up image 15 as well, Registrar, so we have them side-by-side.

And you spoke briefly about the selection of design speed and posted speed. And here you set out the various sources of guidelines for selection and design of design and posting of speeds. And could you describe that in relation to the following page of your report, and how these are typically applied.

A. All right. So first of all, there's a number of different aspects. Highway Traffic Act itself, it outlines statutory speeds, so the rates of speed for roadways that aren't posted, whether they're in an urban built-up area or outside in a higher speed rural environment. So those would be typically your statutory 50 kilometres an hour in a built up area, and 80 kilometres an hour in rural townships and rural high speed areas.

Outside of that the Highway Traffic Act allows for the province and municipalities to set speed limits as they see fit for their road system. So there's not too much other guidance provided in the HTA.

From there both the MTO design guide and the TAC guides have general guidance on posted speeds and design speeds. Again, that would go back to the roadway function that we spoke of, whether it would be a freeway, arterial, local-type roadway and the chosen design speed. And generally the posted speed is going to be understood as to what you would like to post it based on industry good practice and what is common in your jurisdiction for that type of roadway, might be built into some of your policies and practices. And the design speed is typically set at -- could be anywhere from the posted speed in very extreme situations up to 10 or 20 kilometres over the posted speed. So if you have an anticipated posted speed of 80 kilometres per hour, most of those facilities and their components would be designed to 90 to

100 kilometres per hour.

The guidance that's provided in the TAC guide is -- for lack of better words, no disrespect to the authors -- is a little bit meandering and -- because design speed and what a roadway should be designed to is -- in some cases there's certain individuals like to see lower speeds on their roadways, and why should we be designing to much higher speeds and allowing people to drive roadways much faster, balanced with the level of safety that we'd like to provide, those that choose to operate on our roadways faster.

So MTO guidance is a little more definitive in that they suggest 10 to 20 kilometres an hour, and on higher speed facilities when you get up into the 80s to the 110 posted speeds, they suggest a 20-kilometre-an-hour differential. So that's the guidance that's provided.

The two bottom documents on image -- you have to -- I think it's image 14, "Methods and Practices For Setting Speed Limits in the Canadian Guide For Establishing Posted Speed Limits," generally are applied after the fact when you're evaluating an existing roadway and/or evaluating a roadway that has gone through change in its environment that you would look at potentially what speed should be more appropriate for the environment that that roadway is now operating in or the users that are using it. Typically it wouldn't come into play at the beginning of a highway design project because you don't have that roadway to evaluate and the things that are around it.

So essentially for the most part, design speed is a function of posted speed and needs to be selected as a matter of policy at the beginning of the project. The Ontario Traffic Manual Book 5 dealing with regulatory signs and OTM Book 6 deal warning signs --

Q. Registrar, can you pull that down. Thank you.

A. -- which are the second and third bullet points on image 14 on the left, provide guidance on how to post signs, where to post them, how frequently the applicable -- not necessarily the rate of speed that you would post, but when you do post a speed, they give you guidance on that. Likewise, the Ontario Traffic

Manual Book 6 on warning signs and -- outlines that should there be components within your road network, whether it be a horizontal curve, a vertical curve, a ramp that is not appropriate for the intended design speed or operating speed on that facility overall, that warning signs can be provided for various degrees of curvature and other hazards such that road users can be given that information explicitly without reducing the posted speed on that particular section of roadway. In some instances we do do that.

If it's something very specific where a certain segment of a highway, but for the most part we would provide a warning versus -- with -- through an advisory speed being the yellow-on-black type sign versus changing the posted speed for that particular component.

Q. And in the second paragraph on image 15 you speak of the common practice. And then in the last paragraph -- sorry, the sentence of the second paragraph, it says:

"The 1985 MTO Design Guide allows a design speed range of 90 to 100 kilometres an hour to be selected for highways with a 90-kilometre-per-hour design speed to be considered only in the instance of urban freeways."

A. Right. So the MTO has provided guidance to their staff and to their consultants that typically when you're looking at a freeway environment they would -- in a rural area, they would be looking at 100 to 120 kilometres an hour. Generally most freeway facilities in Ontario are designed to 120 kilometre hours (sic) throughout with some minor deviations, as I said at very select locations. But in an urban environment obviously the MTO Design Manual recognizes there might be some significant constraints vertically, property-wise, cost, topography, you name it, that might be more conducive to a 90-kilometre-an-hour design speed in an urban environment.

Q. And on the second last paragraph, I think that is what you were addressing, I just want to make sure we've covered it, about:

"Once the design speed is selected the highway features are designed at a minimum to the prevailing guidance outlined previously in section 2.3. Where specific highway features or operations cannot be provided to meet the design speed criteria and/or motorist expectations of the posted speed, regulatory and warning traffic control devices are used to set expectations for appropriate operating speed."

That's what you were talking about earlier about derogations?

A. Yes. Yes.

Q. What about exit ramps and on-ramps. If you've dealt with that, I apologize, but you were covering a number of things. So how are -- how is ramp speed dealt with as part of design speed?

A. Again, that's one of those localized components that typically aren't designed to the freeway speed. So as somebody is travelling along a 100-kilometre posted freeway, they would enter a ramp, and we typically would provide a ramp speed sign and/or a curve warning sign with an advisory speed tab on the bottom that would give the road user an appropriate speed from -- to navigate that particular ramp.

Q. Yes. Ramps are idiosyncratic, if I can put it that way. It has to be localized?

A. Yes. Yeah.

Q. Okay.

A. I apologize. I should mention that there may be ramps from a freeway-to-freeway facility or a freeway to a pretty major highway that would be designed to give the equivalent free flow speed of the freeway, and in that respect you may end up with some delineation, but there would be no warnings because the road users can travel through that horizontal curve at free flow speeds and they would be provided no warning or change in posted speed.

Q. When you say "delineations," in that context what do you mean?

A. Just pavement markings and general jersey bearings and other things you'd see on the side of the roadway. But travelling at those free flow speeds, they could do that under most road conditions.

MR. LEWIS: Commissioner, it's almost 25 after 11:00. Normally our morning break is 11:30. I'm at a natural break.

JUSTICE WILTON-SIEGEL: Why

don't we take a 15-minute break at this point.

MR. LEWIS: All right. And I -- just to advise everyone, I think I'll certainly be done by the lunch break, and likely before that. And so we would ask participants' counsel to confer about the allocation of time as between counsel, and if we need to take another break when I'm done, we can certainly do that if that works for the commissioner.

JUSTICE WILTON-SIEGEL: Yeah, that's fine.

--- Recess taken at 11:24 a.m.

--- Upon resuming at 11:40 a.m.

BY MR. LEWIS:

Q. Before I move on to another topic, before -- if we could go back to image 10.

Again, using the design speed of 100 on the table 1.2.5.3 and the coefficient of friction being -- the assumed coefficient of friction being 0.29 in that instance, what does that mean in terms of actual measured friction in a constructed highway? Does that mean if the coefficient of friction is .29 that a vehicle will be able to stop within that braking distance and the extent of the stopping sight distance is what is stated on the table?

A. Yes. Yeah. They would be able to stop in that distance.

Q. And do you know the origins of the coefficient of friction that's used in the tables?

A. It was -- I mean, it's based on a regional -- a reasonable level of -- safety factor built in there. Do I know the origins? No, that was -- those were established much -- when I was a young lad and before.

Q. All right. And if someone is travelling over the design speed, what's the -- can the effect be in those instances?

A. Essentially there will be a longer stopping sight distance because within that perception, reaction time, they are going to travel a further distance, and then from the elevated speed, it's going to take them additional time to brake to a stop.

Q. And if the actual measured coefficient of friction is lower what about -- on the table, what about in that case?

A. The stopping sight distance will increase. So if you're in snow covered or slippery conditions and coefficient -- the friction available is less than those values, your vehicle is going to travel further during the braking time.

Q. Thank you. If we could move to image 11, please. I guess 11 and 12.

At the very bottom there is traffic control devices, section 2.5, moving on to the next image. And just to start off, what are traffic control devices? It seems perhaps obvious, but signs, markings and so forth.

A. It's signs, marking and delineation.

Q. Delineation is what we just discussed right before the break, being the markings?

A. It could be a combination of the markings and also delineator signs and chevrons around curves and things of that nature, yes.

Q. Okay. And you list principal sources of standards and guidelines for traffic control devices being the Ontario Traffic

Manual and the 1985, 1995 Manual of Uniform Traffic Control Devices For Canada, including later updates in the 2014 and '21. Could you just describe these briefly?

A. Yes. Both Canada and the United States both have a Manual of Uniform Traffic Control Devices that is a -- developed by one of the federal associations I mentioned. In this case it's TAC in Canada. It is a manual that provides guidance on signs, markings and delineation. In the U.S. it's mandated to a number of the states and their agencies. In Canada it is not a mandate. It's is a choice. And there are provinces that have created either supplements to the manual or complete standalone documents, such as in Ontario we have the Ontario Traffic Manual.

So in an Ontario municipality they have the choice. They can follow the Canadian Manual of Traffic Control Devices in whole or in part, and/or the Ontario Traffic Manual. It's been my experience that while there might be some specific components of the Canadian MUTCD that municipalities use, majority of the municipalities in Ontario apply the Ontario

Traffic Manual.

One of the reasons being is that the Canadian MUTCD puts -- does not provide the level of guidance in some respects on certain types of signs, certain types of markings, and that the Ontario Traffic Manual provides that additional guidance on implementation, design guidance and things of that nature.

Q. And then there's a chart there, which in table 2. As I understand it, this sets out the date of publication of each of those sections in the Ontario Traffic Manual; is that right?

A. Yes. So essentially prior -- it's a series of books essentially. Prior to year 2000 and earlier years, we did have an Ontario MUTCD, Manual of the Uniform Traffic Control Devices. You can imagine it was a pretty monumental effort to incorporate new guidance into a very large manual. Takes a very long period of time. The Ministry of Transportation and the participating stakeholders in municipalities, they decided to update the different sections of the book so that it could get out there in a timely manner. And you can see that they have developed those over a number of years and updated them as well.

Q. Right. And I understand that there's one book that you omitted from that table; is that correct?

A. Yes, I apologize. Another key one for highway traffic control devices would be OTM Book 11 which is Pavement, Hazard and Delineation Markings. It was provided in the documents that were provided to the inquiry, but I omitted it in this table inadvertently.

Q. Okay. And what does it deal with?

A. It deals with your pavement markings, your yellow centre line markings, your dashed lane lines, your edge line markings, or fog lines some might call them, up to delineating of curves and other hazards on the side of the roadway through to signage and a series of chevron-type markings.

Q. Okay. And so can you give a couple other examples of the kind of -- I mean, I appreciate the OTM covers a huge number of issues, but what sort of things as they pertain to highways? Like, the size of speed signs, for example? The content of speed signs?

A. So yeah, I mean, just going through some of the -- sort of the highlights. Like, regulatory signs would be speed limit signs, stop signs, yield signs, do not enter signs, signs that you may see on a ramp, all the sort of black on random black -- sorry, red on white black on white and the green on white signs that provide permissive or restrictive guidance as well as speed signs, thing of that nature. Warning signs would be your black-on-yellow-type signs that would warn you of curves in the roadway, various hazards, traffic signal ahead, stop-ahead-type signs. They would also be delineation; those black and yellow chevron arrows that you would see on the outside of a sharper curve, those types of signs.

Book 8, Guide Signs would be the large black -- green information signs you would see on a freeway. In some cases they would be blue or brown, depending on if they were other types of information, but essentially those large format and ground-mounted signs would give you directions, destinations, things of that nature.

Dynamic message signs, obviously those are the dynamic signs that you would see with messages on them based on traffic backups or just safety messages when they are not in use, things of that nature. And then last but not least, Book 12 deals with traffic signals that we would experience at ramp terminals on a freeway system.

Q. If we could go to image 16.

And this is your section 2.7 on illumination, and you set out four sources of principal guidelines, and could you describe these, please.

A. So -- yeah, the Transportation Association of Canada publishes illumination guidelines for -- it provides some guidance on when a roadway may or may not be illuminated, and then once it is illuminated, the design of that illumination to provide a sufficient amount of light for the purposes that are being applied. So it might be partial illumination of an intersection just to let you know that there is an intersection there and highlight potential approaches. It can be full illumination at an intersection when, you know, there's high pedestrian volumes and then higher volumes going through the area and higher order roadways, things of that nature.

And then they also provide another guide which is the second one in the bullet point for rural illumination. So again, similar-type information provided in there, illumination warrants. And then also, you know, once you decide that you want to implement illumination, the design standards that you want to follow.

Q. You use the term "illumination warrants." Can you just describe what that means? What is an illumination warrant?

A. Yeah. Assuming they are using the word "warrant" back in that vintage, but we have changed them to 'justifications' in some instances. Essentially they're criteria that you would look at your particular roadway, whether it's being designed or it's in service. It would be criteria that would be related to the environment that it's in, so design speed, traffic volume. There may be things such as driveway accesses, pedestrian levels, a whole bunch of criteria that you could -- it's a spreadsheet essentially. It gives warranting and criteria and weights to different components, and it gives you a score at the end that can you compare relatively to other warranting factors or -- sorry, other facilities in your road network and is a threshold when you would illuminate or not illuminate, but they do provide some guidance in that regard.

Q. When it is warranted? Is that --

A. Yeah.

Q. Okay.

A. And again, that term seems pretty restrictive. You know, not warranted, don't do it; warranted, illuminate. It's definitely not conveyed that way in the manual. That is a policy decision of the road authority. Generally when we get into looking at legal liability aspects, that comes out very clear that it's not a mandate, but once you decide to illuminate, there are minimum levels that you should as a -- from a good industry practice should provide under those conditions.

Q. Right. And then in that table 4 without going into it, there's some very clear language for the TAC Illumination Guide, for example, of -- that they don't have -- the contents don't have legislative authority, are not to be interpreted as minimum standards, and they're not to be used as a -- intended to be used as basis for establishing civil liabilities. So there's quite clear language around those points.

A. Right, and I mean they have been applied in civil liability but more related to the illumination levels versus to light or not light under certain key cases. Yeah.

Q. Image 17.

A. Sorry, Mr. Lewis --

Q. Yes, sorry.

A. -- I think there was two other items in that bullet point; the fourth one is not as critical, but the third one is.

Q. Please do. That's my error.

A. There are a number of municipalities in Ontario that are applying the ANTSI standards from the U.S., RP8-00 and their updates throughout the years. So that is one that is more commonplace. The illumination standards in TAC and ANTSI are starting to converge, and probably next year they will be essentially the same document, but they are different standards that are applied on a frequent basis in Ontario municipalities.

Q. Right. And is there -- like the TAC guide, for example, it's -- the TAC Illumination Guide, were there prior iterations of that or no?

A. Yes, they were. The contents of such -- it's been a long time. I wouldn't able to say how it differed or anything, but those are the ones that have been in place for the last 15-plus years.

Q. So image 17, Registrar. 17 to 18.

And this section is "Road Maintenance." And again, it's a reasonably descriptive term, but could you describe what is meant generally by the scope road maintenance.

A. Road maintenance is essentially the maintenance of our roadways and the traffic control devices and the roadside that is adjacent to those roadway facilities. So it's everything from the condition of the pavement to the condition of the signs, and the illumination whether it's -- they're working or not, whether they're standing, functioning, doing all those types of things. The maintenance in terms of debris and snow and ice, so winter maintenance aspects of the roadway. So pretty well keeping -- the infrastructure, keeping it operating and functioning as it was intended.

Q. Everything post construction or installation as the case may be, basically?

A. Yes.

Q. Okay. And then you set out the sources of guidance being the minimum maintenance standards for municipal roadways and the 2003 Ministry of Transportation and Ontario -- of Ontario Maintenance Manual.

A. So the minimum maintenance standards for municipality highways is a -- even though it says "standards," it is not a mandatory standard or requirement. Municipalities are not mandated to use it, but for the most part many municipalities do adopt those standards. It provides guidance on how often you should patrol the roadways, the types of common elements such a potholes and signs down and traffic signals not working and snowy roadways, and identifies reasonable responses to those components when a deficiency is identified so that we can be all working from a common standard on those components.

Now, it by no means covers off a wide range of maintenance that's required on a roadway on its roadside and to its traffic control devices. It deals with the -- pretty well the very high level and primary components of our road surfaces and our traffic control devices.

Q. Okay. And that's prescribed by Ontario regulation, but it's not a required adoption by municipalities?

A. No. They can choose to deviate from that and add -- and there's municipalities that add to it, that try to exceed it within their policies and practices. And any -- and in a lot cases anything that falls outside of the confines of the minimum maintenance standards scope, there are municipalities that have produced their own maintenance policies and practices to deal with those particular aspects.

Q. Then you -- there's the 2003 MTO Maintenance Manual?

A. Yes. And so that governs

MTO's practice of inspecting and maintaining their roadway facilities, much of the same areas. But from my perspective while I see reference to it in some cases by municipalities in Ontario, for the most part it's applied by the Ministry of Transportation.

Q. Okay. And do the -- the minimum maintenance standards, do they provide any guidance around pavement friction?

A. No, they do not. No.

Q. Or the MTO manual?

A. The MTO manual is based on visual inspections of the roadway. So while they may identify pavement-related friction issues such as polished aggregate or polished surfaces or what we call bleeding or fleshing of the binder material out of the asphalt, it doesn't deal with identifying friction levels on roadways on a regular basis from a patrol and maintenance perspective.

Q. Okay. And image 18 is "Roadside Design" at the bottom, 18 to 19 I guess, if you could pull that up as well.

I appreciate roadside design is a significant scope, but can you explain generally the concept of roadside design and what it encompasses.

A. So roadside design relates to I guess everything on the side of the roadway under the travelled portion of the road. So in the event that a road user departs from the travelled portion of the road, the lanes and the ramps and things of that nature, we typically -- as a design industry we want to make sure that that roadside is forgiving, that there's not steep slopes, fixed objects, you know, drainage channels, culverts, et cetera, that is going to cause the vehicle to come to an abrupt stop, to roll over, to have a very serious consequence. We try to make the roadway forgiving.

So the roadside design guide identifies, or the roadside design guidance identifies the types of features and fixed objects on the sides of our roadways that would be hazardous at different volumes and design speeds. So as the design speed goes up, those areas we call clear zones on the side of the roadway, that forgiving roadside area is expanded based on obviously operating speed. The faster you are going the more you depart from the side of the roadway, all else being equal. So essentially, you know, it provides design that is forgiving and/or guidance what kind protection to put on the side of the roadway, whether it be guide rail, whether it be concrete barrier, whether it just be delineation or removal that have hazard, so that once -- in the event that somebody leaves the travelled portion of the roadway, that they have a sporting chance of making it through the incident and recovering on the edge of the roadway.

So in that regard we've got -- I've identified three key source documents. The Roadside Safety Manual from the Ministry of Transportation, and again the TAC guide. Both provide guidance on roadside safety. The 1993 manual is the one that was generally in place so within that last many number years you can see both the TAC and the Ministry of Transportation guides have been updated in 2007, but the 1993 and 1999 manual were the two main guidance that were provided. In addition to that in Ontario --

Q. Sorry, if I can interrupt for one second. The 1993 MTO Roadside Safety Manual, was that -- I think you said 2007, but your report says 2017? Is that --

A. Yeah, sorry, that's when it was updated. Yeah.

Q. It's 2017 is the right date?

A. Yes.

Q. Okay. Thank you.

A. And then within Ontario once there's a decision to provide roadside protection and delineation, then there are Ontario provincial standards for typical design layouts, applications and also designs and products that would meet that roadside protection. So it would be guide rail, the crash cushions, concrete barrier, breakaway signs, things of that nature, that would be mandated out of that. So -- and that's pretty commonly applied in many contracts are in Ontario, both municipal and provincial. For the most part the TAC guide is applied in most Ontario municipalities, but I've come across a number that again have referred to the MTO roadside safety guidance as well.

Q. And again, is this something -- I think you indicate, is this something that's required of municipalities or sources of guidance which good practice would have a municipality adopt?

A. Yes, it's not mandated. It's not legislated in any manner for compliance, but it is -- does -- these two manuals represent industry good practice, and currently they all -- throughout North America they pretty well converged on the same guidance, 2017 versions.

MR. LEWIS: Commissioner, I have reached a conclusion to my questions. We had built in time for the first couple of days of course to deal with using new technology and potential -- any issues that arise technically and so forth. We now have -- so we may have potentially, depending on how long participants' counsel wish to question Mr. Brownlee for, we may or may not have an earlier end to the day before tomorrow we move on to Mr. Uzarowski. I don't know if participants' counsel have had a chance to confer or reach a conclusion as to how much time they would like to have for their respective questioning, if any. And we can take a break to discuss it.

JUSTICE WILTON-SIEGEL: Yeah, I think it would be most appropriate if we took a break, and perhaps you join their breakout room to see whether there's consensus on the part of the counsel as to how much time they require.

MR. LEWIS: I think they're in separate breakout rooms, so I wonder --

JUSTICE WILTON-SIEGEL: They're in separate breakout rooms?

MR. LEWIS: Yeah. I wonder if the best thing to do, subject to our registrar's guidance on this, is if counsel stay in the main room, if we stop the live feed, after we've agreed to do that, and we stay in the main room while Commissioner and Mr. Brownlee are sent to the breakout room. Would that -- does that make sense, Registrar, or is there a better way to do it?

JUSTICE WILTON-SIEGEL: Instead of doing that, because I'm rather reluctant to break the feed, why don't we take a 20-minute break and you can communicate by e-mail or call, whatever, with counsel to see whether there's consensus on how much time they each require. Ms. Roberts?

MS. JENNIFER ROBERTS: Just a proposal, can we all be put in one of the breakout rooms? Like, can everyone -- can counsel go to

Golder's room, and that would suffice for having that communication? I think it would be --

JUSTICE WILTON-SIEGEL: That would be fine.

MS. JENNIFER ROBERTS: Perfect.

JUSTICE WILTON-SIEGEL: I appreciate the suggestion. I think that's the best way to do this. Can we do that, Mr. Registrar.

MR. LEWIS: Yes, Counsel, whenever you are ready.

JUSTICE WILTON-SIEGEL: Okay, then we'll take a 20-minute break. All counsel, including commission counsel, to go into the Golder breakout room, and we'll return I guess at 12:30.

MS. JENNIFER ROBERTS: Thank you.

--- Recess taken at 12:09 p.m.

--- Upon resuming at 12:30 p.m.

MR. LEWIS: Commissioner, I've conferred with participants' counsel on the break, and they have advised a relatively short period of time for two or three counsel to ask questions for

Mr. Brownlee, and I expect that will then be completed by the lunch break at one o'clock.

And I believe Ms. Jennifer Roberts, counsel for Golder, is going first. And I will always try to use both names going forward.

EXAMINATION BY MS. JENNIFER ROBERTS:

Q. Thank you, Counsel.

Mr. Brownlee, hello. I'm Jennifer Roberts and I'm counsel for Golder. First of all, thank you for the thorough survey of what is definitely a complicated area of design. I have a few questions, and I just want to kind of go back and address a couple more points in a little more detail.

So if I can ask you to sort of go back to where you started this morning with the concept of design speed and horizontal design. One of the points that you made is that features like curvature and superelevation are directly related to the design speed, and I understand that the design of the radius of turns is directly related to the design speed, and I want to ask you a little bit about that.

My understanding is that the minimum curve speeds are set based on the design speed; is that correct?

A. That is correct.

Q. Okay. And the TAC guidance, the '99 guidance talks about the minimum radius should be avoided whenever possible. And that that -- and the -- designers should attempt to use as open flat a curve as possible. That's correct, is it not?

A. Yes. And the one thing I did mention was in relation to the design domain. So while the design speed in the example we used was 100 kilometres per hour, there are provisions for certain roadways if, you know, the operating speeds are less than that that you may go down to the minimums. And that's part of their guidance in that regard, is not to immediately sort of table-pick and go down to the minimum value shown in that design domain if you don't have that information in front of you, and there is always benefits to meeting -- exceeding the minimums, especially when we're talking about stopping sight distance and horizontal curves.

Q. Thank you. Am I right in understanding that the area -- that the design issue of minimum curvature is an area where design has evolved between the MTO 1985 guide and the 2017 TAC guide?

A. In which respect?

Q. So under the 1985 guide the minimum radius turn was smaller than what the later design provided -- design guidance in 2017, so that was an area of change?

A. I would have to go back and take a look at those exact numbers.

Q. Okay. I want to talk a little bit about the integration of the design features. So where you've got a series of turns and alignments, do I understand that where you would have a series of turns from a right turn to a left turn, that in order to design for that you have to make provision for the changes in the superelevation?

A. Oh, definitely, yes. Each one of those superelevations would have to be developed as you're coming into the curve and then brought back down to a crossfall, a typical crossfall, and then brought up for the next curve. Or if they are that close, there may be some overlap in between those superelevations, but yeah, they need to be individually developed.

Q. Okay. And just as you discussed this morning with the concept of the spirals at the beginning and the ends of the curves, you've got to design the spiral for the entrance to the curve and the exit and then go into the next turn?

A. That's correct.

JUSTICE WILTON-SIEGEL: Ms. Roberts, if you can give me just a second. I need to get another pen.

MS. JENNIFER ROBERTS: Of course.

I want to go into the notion of interchanges which we talked about this morning as well. As I understand it, the objective is with an interchange is that you are trying to get the through traffic to be as disturbed as little as possible as you get traffic to move off the highway and back on.

A. That's correct, yes.

Q. Okay. And the objective, and we talked about this in terms of design consistency and expectation, is for the driver to understand and anticipate what's coming up in the interchange?

A. Yes. They should have good sight lines to traffic that's entering and leaving the interchange and that they can react to them, yes.

Q. Thank you. So with an interchange you've got a number of driving decisions to make. You've got to both anticipate the turn, but you've got to also anticipate suitable speed for that exit. So there's a series of decisions that a driver has to make in order to successfully exit or enter a highway?

A. Yes.

Q. And you talked this morning about the importance of making or promoting -- so that -- design consistency so that the driver expectation is -- the driver can anticipate the operation and understand what's coming up.

A. Yes. Hence they are approaching; they should be able to see the configuration of where they need to merge or other traffic that's leaving or entering the interchange and be able to anticipate what should occur under those situations.

Q. Okay. And just on that

we've got -- I just want to find the specific reference, but it's lost. I've got -- I take it, then, if you've got an instance where you've got an entrance or an exit that you wouldn't want to put that on a curve because that would affect the driver's ability to anticipate and plan for the exit or the entrance.

A. The -- so yeah, I mean, the designer has to look at all those aspects and how they work together. Depending on the nature of the curve, like if it's a large radius curve that is a essentially tangent with a little bit of steering required, the sight lines, et cetera, might be there. If it's a sharper curve that limits sight lines or create -- they may also create additional challenges because not only is the road user concerned with either their manoeuvering on and off of the interchange or other road users plus navigating a the curve which takes some additional workload as well.

So it goes back to I think the discussion we this had morning on workload. But it also, if sharp enough, obviously that could impact sight lines to critical locations where you need to make decisions.

Q. Okay. And you mentioned this morning weaving. Can we just talk a little bit more about that. As I understand it, it's where you've got two or more traffic streams travelling in the same direction, and the weaving areas are formed when there's a merge area closely followed by a diverge area. Do I have that right?

A. Or overlapping, yes. It could be both. Like what we call the functional area of those locations. There's a number of them on our freeway networks. There used to be one in Waterloo that they got rid of. There's one here in Toronto on the QEW --

(Speaker Overlap)

A. -- that's pretty classic. You may be familiar with it. But essentially you have traffic that's attempting to share three lanes essentially with one coming on, one shared and potentially one vehicle turning off, and they're doing this at the same positions in time.

Q. Okay. And this happens where you've got a lane coming on the highway at the same point as where you've got a lane coming off in close proximity?

A. Yes, yes.

Q. And do I understand it correctly that one of the challenges is that it creates -- that there's a conflict inherent in the entering and exiting traffic and that tends to operate to impede the normal operation of the third traffic?

A. Yes. There's a lot more doubt as to the intentions of the road users that are coming on and off when they are attempting to merge, picking a gap in traffic, and there's two traffic streams that are making those decisions inherently, and one of them is in a freeway lane where they're making that decision.

Q. Okay. And just building on that, I want to talk a little bit about sight distance and the exits and entrances. And again, you talked about this, the importance of drivers seeing the exit terminal in time to make the adjustments.

I understand that there's -- that there are recommended distances for exiting from a highway that you would want to have a sight distance to a bullnose and those sorts of distances. Can I get you to talk about those a little bit because they are fairly lengthy as I have been able -- at least appears to me.

A. Sorry, when you mention --

Q. Sorry. Let me try and rephrase that. That's not much of a question on my part. I'm trying to get a sense from you as to what the recommended distances were -- would be when you are exiting from a highway.

A. In terms of actual numbers, I wouldn't be able to tell you. They are lengthy because you are at freeway speeds, you need to be able to see the interchange to have a sufficient distance to be able to judge the diverge movement and the travelling over to another lane before you end up in the bullnose area, yes. But specific numbers I wouldn't be able to give you, no, off the top of my head.

Q. All right. So -- but maybe we could speak in generalities. If you've got a design speed of 100 kilometres per hour, that you would want a distance of at least 300 metres?

A. Again, I would have to check that exact number.

Q. Okay. And we've got a

similar but opposite issue when you're coming onto a highway that you actually have to go from a ramp, whatever that speed is at the ramp, and then come up to speed to enter the highway. And again, I understand the design imperative is to provide sufficient time in that entrance lane to come up to highway traffic speed?

A. Come up to highway traffic speed and also judge an appropriate gap to pick in the traffic in the adjacent freeway lane, yes.

Q. Okay. And I recognize the unfairness of trying to quiz you on definitive numbers there. Mr. Brownlee, I apologize for doing that. Thank you for your time. Those are my questions. Thank you, Commissioner.

JUSTICE WILTON-SIEGEL: Mr. Lewis.

MR. LEWIS: I believe Ms. Jenene Roberts, counsel for the City, is going on go next.

MS. JENENE ROBERTS: Thank you, commission counsel, the City won't have any questions for Mr. Brownlee. Thank you, Mr. Brownlee.

MR. LEWIS: And the MTO counsel had indicated on the break that they were uncertain but -- whether they had any questions. Mr. Bourrier, do you have in questions?

MR. BOURRIER: No questions for Mr. Brownlee from us. Thank you.

MR. LEWIS: Okay. And counsel for Dufferin indicated that there were no questions. Does that remain the case, Ms. Laurion?

MS. LAURION: That's correct, Mr. Lewis.

JUSTICE WILTON-SIEGEL: Okay. Well, then let me just make a note. Then I think we're through for the day.

Before we adjourn for the day, two things. First of all, I want to thank Mr. Brownlee for his attendance today. It was very helpful testimony which helps us locate a number of the issues that we'll be dealing with later.

Secondly, the experience of the last two days indicates that we may not necessarily require the full day that is scheduled for witnesses. We're two for two thus far. And so I'm going to suggest that in future while we're lining up the witnesses, or counsel are lining up witnesses of their clients for particular days, that they advise them that it's possible that they may well be called the preceding day if we get through the preceding witnesses more quickly than anticipated, and that way we can ensure that we keep proceeding expeditiously. So if I could ask counsel's indulgence with that it would be appreciated.

With that, we'll stand adjourned until 9:30 tomorrow morning. Thank you very much.

MR. LEWIS: Thank you, Commissioner.

--- Whereupon at 12:48 p.m. the proceedings were adjourned until Thursday, April 28, 2022 at 9:30 a.m.