PEACH
RESEARCH UNIT
PLANNING FOR EQUITY, ACCESSIBILITY AND COMMUNITY HEALTH

Findings Report

Visualizing Accessibility Standards: A demonstration with CSA B651

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Visualizing Accessibility Standards: A Demonstration with CSA B651

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Acknowledgement

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Section 1. Introduction

1.1 The Project Team

This report details the results of the research project, Visualizing accessibility standards: A demonstration with CSA B651, led by the Planning for Equity, Accessibility, and Community Health (PEACH) Research Unit of Dalhousie University. Since 2018, the team members of the PEACH Research Unit have been doing research and sharing new knowledge on topics relating to planning, accessibility, and health equity in Nova Scotia and nation-wide. PEACH works on projects collaboratively with community partners including non-profit organizations, government groups, and individuals living with disability experiences. Our research aims to identify and address the physical and societal barriers that prevent equitable and meaningful participation in communities for all.

The CNIB Foundation (CNIB) and the Rick Hansen Foundation (RHF) both partnered on this project and worked with the research team to develop the project findings. Both are national non-profit, charitable organizations in Canada pioneering efforts to improve the content and transmission of accessibility standards for the built environment. The national networks of both organizations, including advocates who have lived experience of disability, accessibility professionals, academics, and building industry professionals, have been assets to this research. The results of this research will also be circulated through this expanding network and can be expected to inform the future work of these organizations.

Finally, the activities of this project were overseen by an Advisory Board of individuals located in Nova Scotia who have lived experience of disability and professional experience working with accessibility standards in Canada. Their guidance was key to reaching the outcomes of this research.

1.2 Purpose

The purpose of this study was to test methods of visual communication -- a process which this research calls visualization -- to facilitate more frequent and accurate use of accessibility standards by industry stakeholders.

Professionals such as architects, engineers, planners and urban designers are responsible for designing, constructing, and managing the physical spaces that people use daily. An important part of their role is understanding and following required design regulations, including accessibility standards.

The clearer the accessibility standards are to professionals, the better they can be understood and used at various levels of the design and construction process. This project proposes that more effective communication of the standards through the use of visual graphics and media will help professionals apply the standards thoughtfully and accurately in real spaces.

Section 2. Why Visualize Accessibility Standards?

2.1 Disability in Canada

According to the Canadian Survey on Disability (Statistics Canada, 2022), 27% of Canadians, or over 8 million people aged 15 and older, experience one or more disabilities. Several Canadian provinces now have human rights legislation that recognizes the rights of people living with disabilities. At the federal level, the adoption of the Accessible Canada Act (2019) shows that Canadians are becoming more aware of the need to address barriers faced by Canadians living with disabilities. The Accessible Canada Act sets the goal for an accessible Canada by 2040.

The Accessible Canada Act is based on a social model of disability (Government of Canada, 2022). Previously, disability was thought to be something caused by a medical condition, which exists in a person. However, the social model of disability recognizes that disability occurs when a person interacts with a built environment that is not supportive of their needs. The built environment includes indoor and outdoor spaces. Anything that has physically been put in place by people is part of the built environment. It includes buildings, sidewalks, parks, lamp posts, garbage cans, elevators, and more. An inaccessible built environment creates a disabling process. Disabilities that people can experience include physical, sensory, intellectual, cognitive, and mental. For instance, someone with limited use of their legs may use a wheelchair to get around. If the only way into their apartment building is by using stairs, they become disabled when trying to enter their home. But if the way into their apartment is level or ramped, and there is an elevator to get to their floor, then no disability occurs. Therefore, the experience of disability can be prevented by creating built environments that are supportive of all users. Design standards for accessibility in the built environment --- i.e., accessibility standards --- guide the development of accessible communities.

2.2 Accessibility Standards

Accessibility has become an important topic for Canadians. This has prompted governments to create more accessibility legislation, like accessibility acts. Accessibility standards and guidelines are often adopted with accessibility acts. In Canada, the Canadian Standards Association (CSA) has created an accessibility standard for the built environment – called, CSA B651, Accessible Design for the Built Environment (CSA, 2022). Some provinces have also created their own accessibility standards (Kovac, 2019; MAO, 2020; NS,2018).

Standards describe precise measurements for professionals to use. They outline hundreds of measurements for indoor and outdoor features, such as doorways, flooring, lighting, and ramps. Standards are legal documents. Therefore, they primarily use words to describe how to design something. Documents that mostly use words can be called text-based. Sometimes the words that text-based standards use are difficult to understand. Sometimes they use so many words that they can also be confusing to read. Some people who study the standards have argued that researchers should look for ways to make the standards easier to use and understand (Routhier et al., 2019; Nowak eet al., 2023). It has also been said that making more and more text-based standards will not necessarily make professionals more likely to apply the standards (Callway, Pineo & Moore, 2020). How the standards are communicated to the people who use them must be considered. If they are presented in a more user-friendly way, professionals may be more likely to apply the standards to the built environment and apply them accurately. Current standards may also not do enough to address the needs of people who experience disabilities like neurodivergence or sensory disability (Zallio & Clarkson, 2021; Persson et al., 2014). Neurodivergence is an umbrella term including people who display different patterns of thought or behaviour from what is thought to be 'typical' (e.g., people with autism, ADHD, or learning disabilities). These populations have accessibility needs that are not as commonly understood as barriers to physical mobility (Baumers & Heylighen, 2010). Standards for the built environment do a better job of communicating physical measurements that address physical barriers to accessibility than communicating barriers that cannot be seen. Barriers that are not seen include strong smells, the way that sound echoes in a space, or how busy or quiet a space is. Spaces designed with neurodivergent and environmental sensitivities in mind are often called mind-friendly. Communicating standards that address these barriers can be even more challenging using text alone.

Professionals who use accessibility standards often do not have personal experience of disability. They may not even have any professional training in accessible design. Without formal training in accessibility and disability topics, many professionals can feel unprepared to interpret and apply accessibility standards accurately or thoughtfully (Ormerod & Newton, 2005). Therefore, it is important that standards are communicated clearly and in familiar ways.

2.3 Visualization of Standards

Our research in the last several years has shown that visual aids (e.g., images or videos) are helpful tools to make wordy technical documents easier to understand. Most people are visual learners, and planners, architects, and engineers are likely more so (Portman, Natapov & Fisher-Gewirtzman, 2015). When professionals are better able to understand the technical information needed to make spaces accessible, they can be more creative in coming up with design solutions. Images used for the purpose of communicating design standards are called visualizations. Professionals often use visualizations to help communicate their ideas (Portman, Natapov & Fisher-Gewirtzmann, 2015; Ware, 2013; Hansen & Machin, 2013). More visualizations of design standards and guides can teach professionals about what rules they should follow when designing accessible spaces. Once they understand the rules, professionals can use their creative skills to design spaces that suit the needs of the people who are using them (Ware, 2013; Hansen & Machin, 2013; Wagner, 2011).

There are many types of visualizations that can be used to communicate design standards. Visualizations can show two-dimensional information (e.g., line drawings) or three-dimensional information (e.g., photos of 3D spaces). Visualizations can also be portrayed in image or video format. Each of these visualization types have pros and cons depending on what information they need to communicate. For instance, diagrams are useful for communicating measurements, such as required door widths or ramp slopes.

Beyond diagrams, other styles of visualization have the potential to communicate design considerations that are important for people with disabilities that an able-bodied reader of the standards might not have thought about. Not all professionals have experience of disability themselves, and therefore might not understand why design requirements are written the way they are. Visualizations can help to demonstrate to professionals why accessible design guidelines are in place and show what measurements and guidelines are required to make spaces accessible.

This study focused on gaps in professional knowledge of accessibility, especially those having to do with designing for people who are neurodivergent or experience vision impairment, and tested the use of visualizations to fill these gaps.

Section 3. What We Did

3.1 Overall process

This project created different types of visualizations to accompany clauses chosen from the CSA B651-18 standards. The sample visualizations were published on a website and presented to professionals across Canada who rated the visualizations' usefulness out of 1 to 5. They also provided over 200 pieces of feedback in their own words. More details about this process are described below.

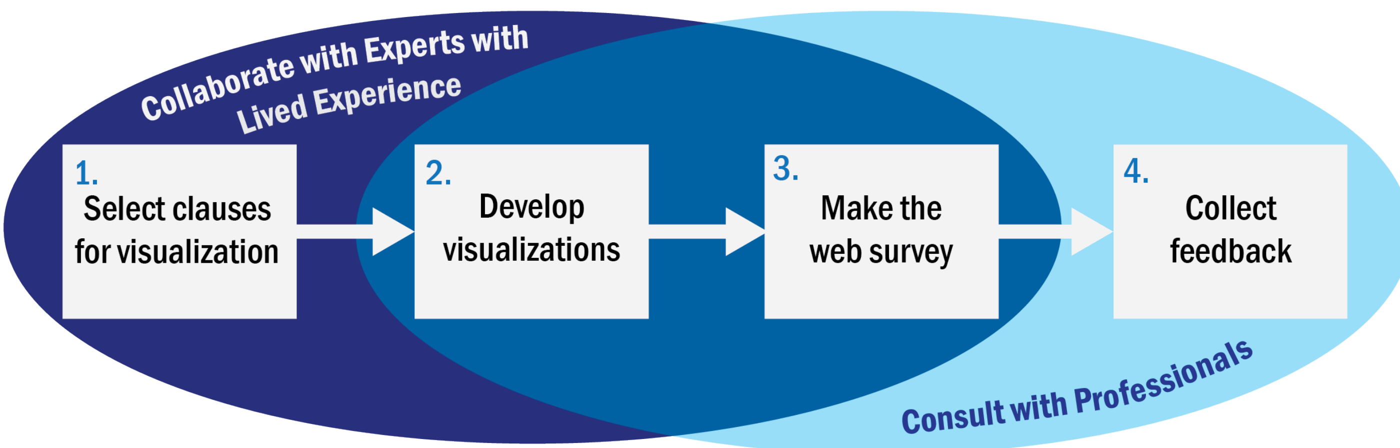


Figure 1. Flow chart showing the project's four steps.

3.2 Selecting clauses for visualization

Accessible design experts with lived experience of disability helped the project team select sections of B651 for visualization. Experts included leaders in design standards for blind and partially sighted populations from CNIB, accessibility assessment professionals from RHF, and advocates for people living with disabilities who experience diverse barriers to access who volunteered with the project. Experts drew on their their knowledge of gaps in standards from disability perspectives.

The sections collaboratively selected for visualization were "Section 4. General requirements" and "Section 8. Exterior circulation, spaces, and amenities". Since many clauses refer to other sections of the document, some content from "Section 5. Interior circulation" were also visualized to pair with clauses from Sections 4 and 8. The selected clauses were approved by all members of the project's Advisory Board.

3.3 Developing visualizations

Different types of visualizations are better suited to communicate different things. It was, therefore, important to consider what needed to be communicated by different types of clauses from B651. For instance, it was agreed that standards for acoustics, wayfinding, or those addressing cognitive barriers could most benefit from visualizations that enhance understanding of disability experience (Jenkins, Yuen & Vogtle, 2015; Black et al., 2022).

Options for types of visualization were brought to a sample of industry professionals to inform the creation of the project's visualizations. These included photographs, drawn diagrams, and 3D modelled images.

This initial consultation helped the research team determine the types and formats of visualization that professionals were most familiar with or would most like to see. These initial consultations were performed by a Master student and Honours Bachelor student as a required study component of their respective programs.

Between the two studies, 16 individuals working in public and private sector planning and development positions in Nova Scotia were interviewed.

The professionals who were part of the initial consultation helped to confirm types of visualization to demonstrate and explore in this study. They also informed a set of guiding recommendations for the content of visualizations, for this research to follow. These include:

- Take or select photographs that represent the perspective of a user in an environment;
- Use examples that showcase multiple guidelines, rather than one isolated guideline, wherever possible;
- Use consistent graphic language between visualizations;
- Pair photographs with additional visualizations such as 2D drawings or vidoes/ animations to convey complex or non-visual information; and,
- Clearly convey information using highlights, labels, etc. (Horner, 2022)

3.3.1 Types of visuals prepared

In total, 101 visualizations were produced as part of this research study. Through the process of developing the visualizations, the types of visual media were further subdivided into seven types: photos with annotations, photos without annotations, 2D diagrams, 3D model diagrams, videos of 3D models, narrative videos, and CSA original diagrams. Please see Appendix 1 for a full list of visualized clauses.

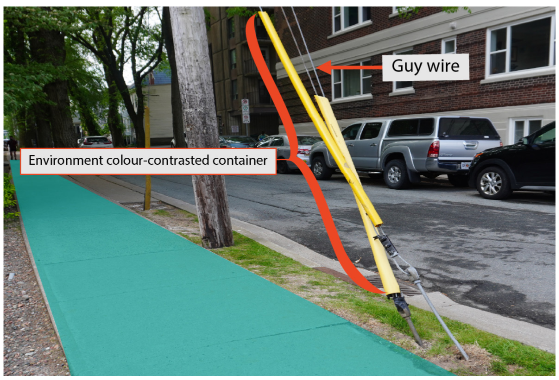


Figure 2. Example image of a photo with annotations.

Photos with annotations (n=41)

Photos with annotations were photographs taken of real spaces in Nova Scotia and Ontario. Photos showed the application of a design requirement, or to show a barrier to be prevented. Annotations (i.e., textual content) were added to these images to label important elements, measurements, or considerations as written in the B651 standards text.


Figure 3. Example image of a photo without annotations

Photos without annotations (n=14)

Photos without annotations were photographs of real spaces in Nova Scotia and Ontario. Like photos with annotations, photos without annotations were also used to show the application of a design requirement, or to show a barrier to be prevented. Some symbols or mark up may be included, but no text.

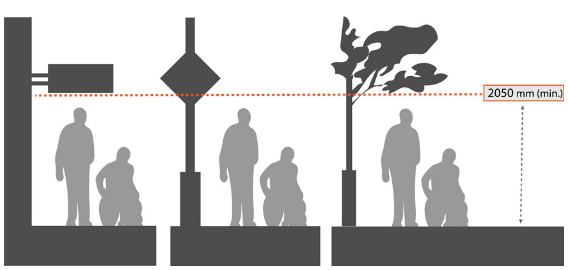


Figure 4. A stylized elevation diagram.

Two-dimensional (2D) diagrams (n=14)

Two-dimensional (2D) diagrams include line drawings, silhouettes, and plan-view illustrations. They were used to show measurements in an isolated context, often when a direct comparison between measurements was required. They are often annotated to label important elements, measurements or considerations as written in the standards text.

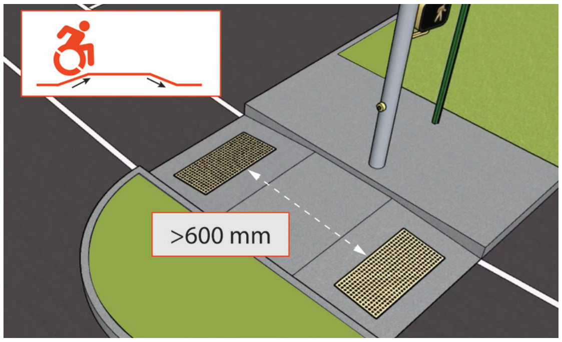


Figure 5. A computer modelled image of a median.

3D model diagrams (n=10)

Three-dimensional (3D) model diagrams were created using computer graphics software to show dimensionally accurate representations of built spaces. Static images were taken of the 3D models and annotated.

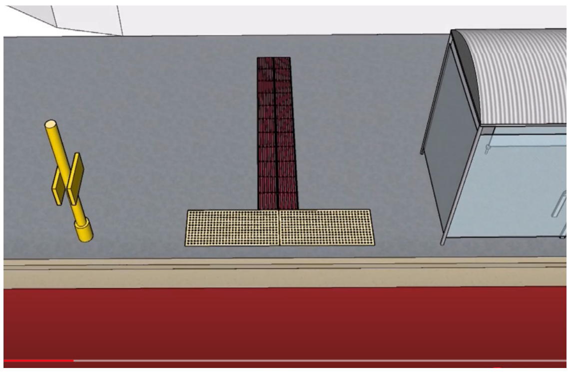


Figure 6. A screenshot from a video moving through a computer model.

Videos of 3D models (n=8)

Videos of 3D models were created using the same models as described above. The videos explored the environments in sequence to show how each clause component related to one another. These videos often combined more than one sequential clause to show how they are applied together in an environment. Videos included annotations.

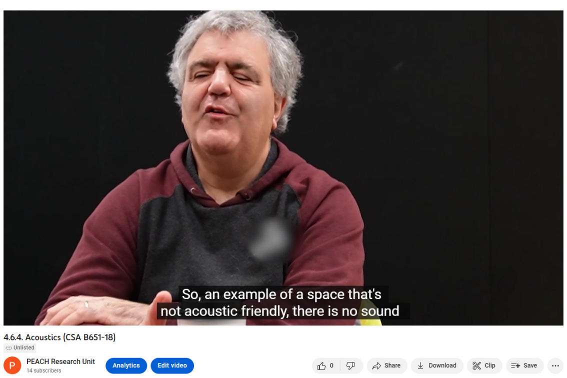


Figure 7. A screenshot from a narrative video.

Narrative videos (n=14)

Narrative videos were short, interview-style videos with individuals living with disabilities. They were filmed and edited to present expert experiences and show how they are affected by specific clauses. The longest was 1 minute 50 seconds long, and the shortest was 37 seconds long. Some of the videos contain reference footage showing the barriers or accessibility features that the interviewee talks about. Videos were equipped with captions.

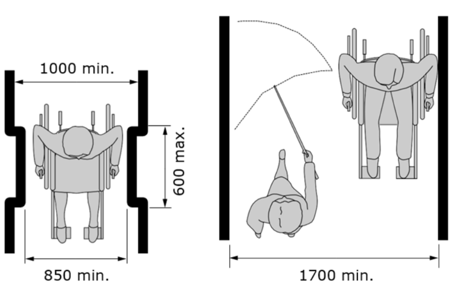


Figure 8. CSA B651-18, clause 5.1.1., pg. 62

CSA original diagrams (n=8)

Finally, a few CSA B651-18 original diagrams were included to examine visualizations that are already presented with accessibility standards. Responses to these images could be compared to the project-created visualizations for additional insights on the use of images.

3.4 Making the web survey

The project team created a web application with the help of a professional web designer to catalogue and display the visualizations with their B651 text content. We named the application, Canadian Accessibility Standards (CAS) Viewer.

Before developing the web application, an investigation of web accessibility practices was performed and followed. CAS was developed following A11Y's checklist for accessible web design (A11Y, 2023). This included presenting and labelling images in an accessible way, ensuring videos were user-controlled, ensuring text heading hierarchies were respected, maintaining high colour contrast to separate elements or present text, and for all elements of the web application, using semantic HTML to ensure the site was logical for screen reading applications.

CAS was designed as a guided experience—with the objective of collecting survey data relating to both the user's professional background and their experience of the visualizations. There were three steps to the guided experience. First, an introduction survey collected participant information (e.g., professional sector, province, disability experience). Then, a series of visualizations were presented randomly for professionals to evaluate. Visualizations were displayed on CAS side-by-side with their corresponding B651 clause. Clause text was shown on the left and the visualization on the right. If a single clause was visualized using several images (because some contained too much information to be shown in only one image) then the segment of the clause that was being visualized would automatically highlight in yellow as the viewer scrolled through the visualizations.

Finally, once professionals had rated the random set of visualizations, they were free to explore the full catalogue of visualizations and continue to evaluate visualizations of their choosing.

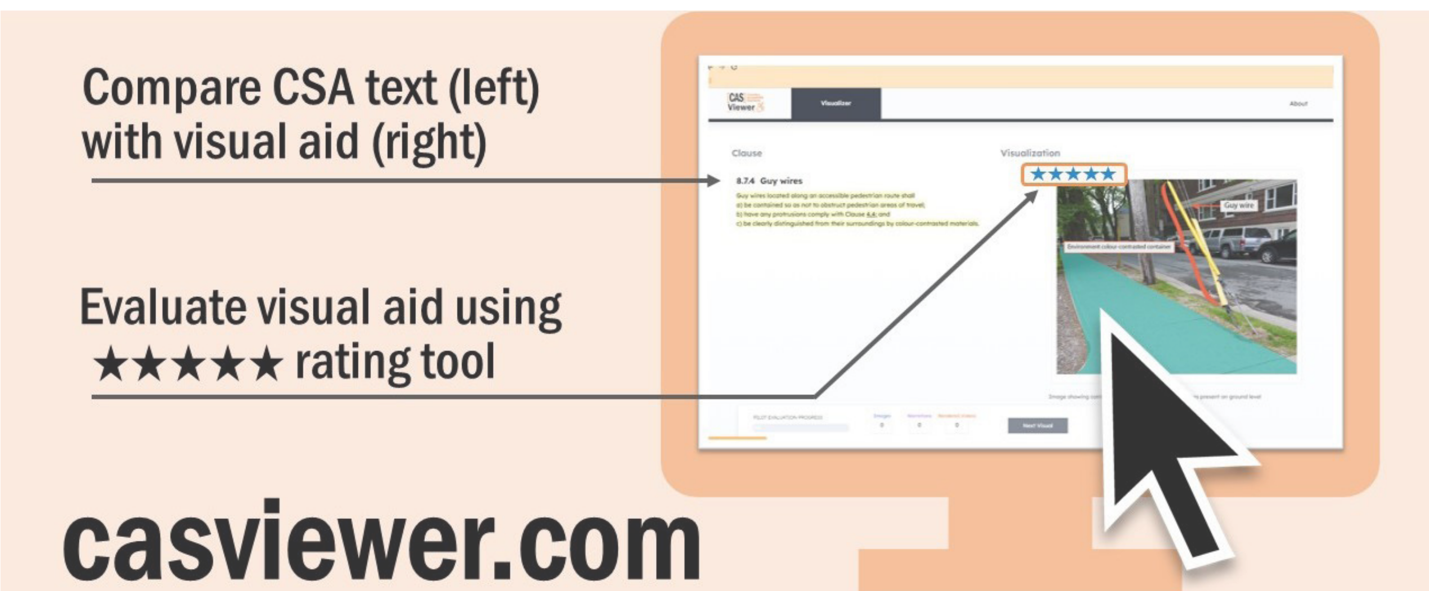


Figure 9. A simplified illustration of the web application display.

3.5 Collecting feedback

In June 2023, the research team launched the CAS Viewer web application at a four-day professional conference organized by the Canadian Institute of Planners.

Researchers were able to engage face-to-face with the hundreds of urban design and policy professionals who attended from across the country. The visualizations were displayed using a projector onto a screen on a wall and shared on individual laptop screens to the conference goers.

Feedback was collected from professionals about their impression and interpretation of the visualizations, and about the web application as an engagement tool. The latter allowed the project's web designer to adapt the website accordingly before it was circulated online to more professionals.

The CAS Viewer website was widely shared via email, newsletters, and social media posts for a period of four (4) weeks. It was circulated through people working in government, professional and academic institutions, and the project partners' members and contacts lists.

The website survey collected anonymized information about the respondents' professional experience and location across Canada, their experience using CSA B651, and their self-rated knowledge of accessibility.

Feedback was collected per visualization to inform comparative analyses and to collect the widest possible range of knowledge about the various types of visualizations.

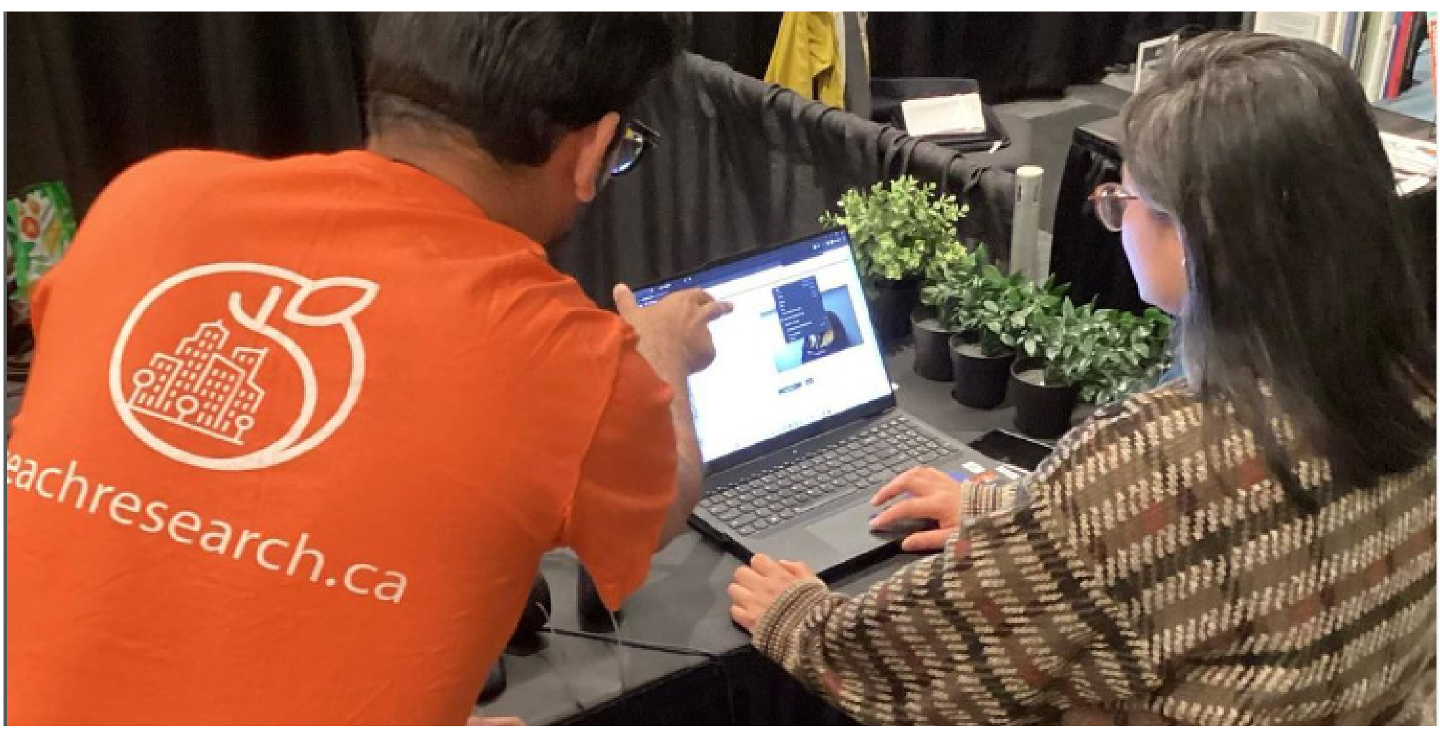


FIgure 10. A PEACH researcher helps a conference goer tour CAS Viewer.

Section 4. What We Heard

4.1. Who gave us feedback?

A total of 552 ratings and responses were collected from the website survey. Participants in the survey (n=87) were professionals working in a wide range of design and policy-making fields.

Approximately 23% of participants (n=20) reported personally experiencing disability (Figure 11). The top disability experience (n=10) reported was learning disability (e.g., ADHD, dyslexia, non-verbal, executive functioning). Other disability experiences included sensory-processing disability (e.g., ASD, hypersensitivity, hyposensitivity, head trauma) (n=4), hearing impairment (n=3), mobility disability (n=3), visual impairment (n=3), and other (undefined) (n=2).

A majority (46%) of professionals were working in planning, land use, transportation, and civil engineering (Please see Figure 12 for distribution by occupation category). Municipal government employees made up 36% of participants, while private industry professionals made up 21%, non-profit/not-for-profit professionals made up 9%, independent consultants made up 8%, and people working for educational institutions and provincial government employees each made up 7%. (Please see Figure 13).

A majority of participants worked in Nova Scotia (n=40), while others worked in Ontario (25), British Columbia (9), New Brunswick (4), Alberta (2), Manitoba (1), Nunavut (1), and Prince Edward Island (1).

Participants were asked to self-rate their knowledge of accessibility. Over half rated their knowledge as 4, somewhat knowledgeable (n=47), out of 5. The next highest proportion of participants said they were 5, very knowledgeable (n=18). There were 7 participants who said they were unsure, 5 who said they were not very knowledgeable, and 1 who said they were not at all knowledgeable.

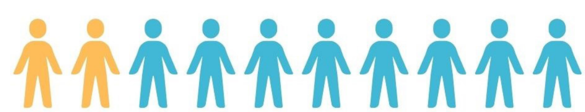
Participants were also asked to self-rate their knowledge of CSA B651. Most selected 1, not at all knowledgeable (n=22). An equal number of participants said they were 2, not very knowledgeable (n=20), and 4, somewhat knowledgeable (n=20), and 8 said they were unsure. Finally, 10 rated their familiarity with CSA B651 as 5, very knowledgeable.

When asked what they used B651 for, 45% (n=39) said as a reference document for policy, 36% (n=31) said to check compliance, 23% (n=20) said for research, 17% (n=15) for design inspiration and 16% (n=14) for education.

The above tells us that participants' had some interest and/or training in accessibility but were not active users of the National Standard, CSA B651. Therefore, how they related the visualizations with the text was likely based on first impressions and not aided by extensive knowledge of the standards.

They also approached the standards as more than just a regulatory document. Many professionals were referring to the standards to inform other policy, research, or to educate themselves or others about accessible design practices and possibly disability experience. This suggests that there may be demand for an educational or awareness-building component to the standards.

Figure 11. Proportion of respondents' disability experience



Over 2 out of 10 respondents reported experiencing one or more disabillities.

Figure 12. Number of respondents by occupation category

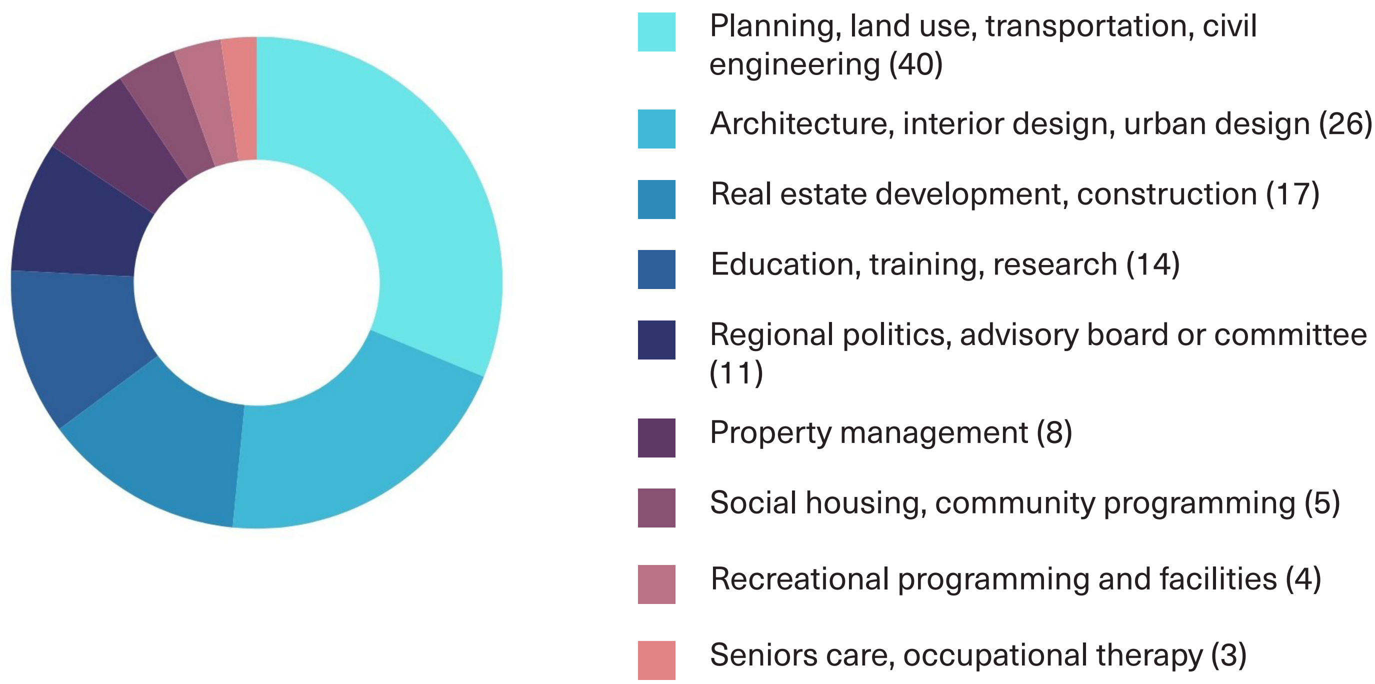
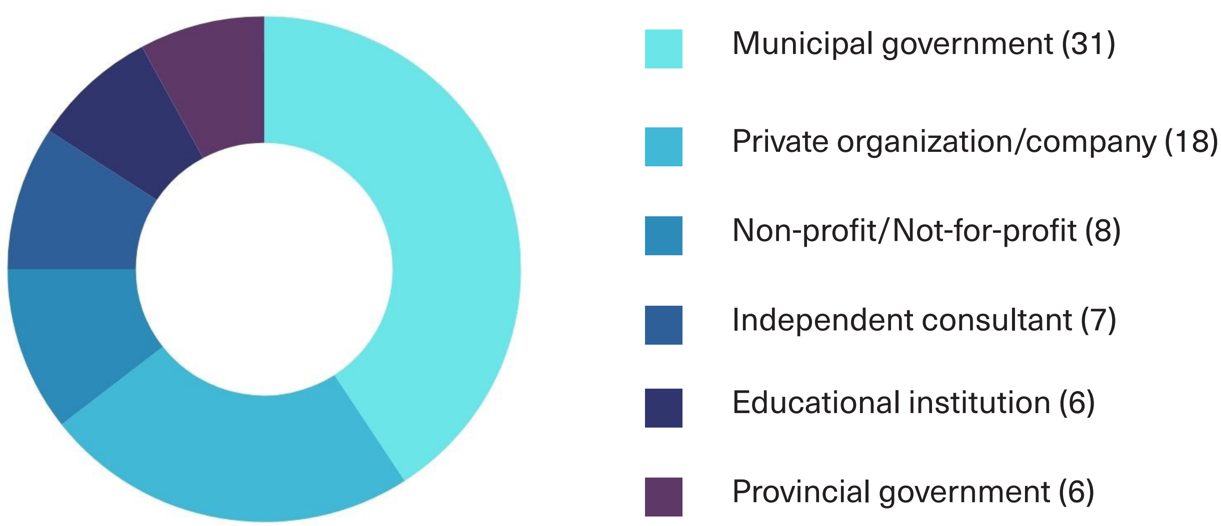


Figure 13. Number of respondents by professional sector



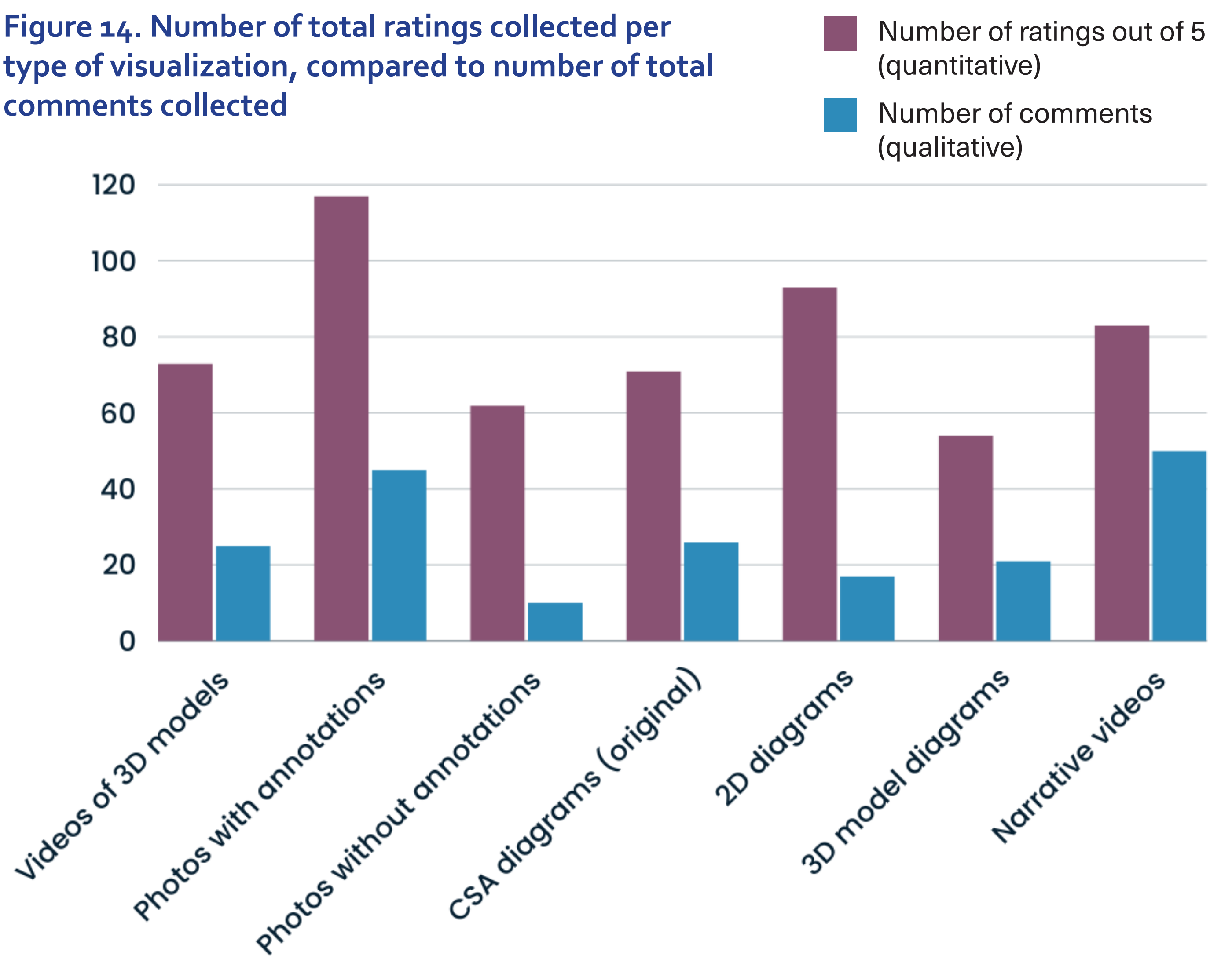
4.2. Distribution of feedback

Participants were free to submit ratings and comments to any number of visualizations. They were also not restricted to providing their feedback equally among the types of visualizations. Participants could choose to submit a rating without providing additional comments. This resulted in varied total numbers of ratings and detailed comments to compare between the types of visualizations.

The greatest number of individual ratings (out of 5) were received for photos with annotations, which were also the most plentiful type of visualization the project created (n=117). The greatest number of detailed comments collected for a type of visualization, however, was for narrative videos (n=50). Please see Figure 14 for full numbers of rating and comment responses by type of visualization.

Additionally, 60% of all ratings left for narrative videos included some comment left in their own words. The average occurance of comments accompanying a numerical rating for all other types of visualizations was only 30%. Therefore, professionals comparatively had a lot more to say about the narrative videos.

Figure 14. Number of total ratings collected per type of visualization, compared to number of total comments collected



4.3. How participants rated the visuals

Professionals rated each visualization of their choosing based on a scale of 1 to 5 stars, with 5 being the highest possible score.

They could add more detail to their rating by leaving a comment in their own words, or by selecting from three prefilled statements which reflected three performance measures. These measures were:

- Application: How helpful a visualization is for assisting the viewer to apply the standards.
- User-friendliness: How well a visualization makes the standards more user-friendly to the viewer.
- Communicating relevance: How well a visualization communicates the relevance of the standards to real-world users.

The average scores overall are shown by Figure 16. Average scores are broken down by the three performance measures in Figure 17.

4.3.1 Trends in the ratings

Professionals most preferred the visualizations of modelled environments. Videos of 3D models performed best, receiving an average rating of 4.47 out of 5. The next highest average score (4.37) was also for 3D model diagrams.

Static 3D model diagrams were rated as more user-friendly than the videos. Static models were likely more familiar and fit in better with professionals' workflow than a video medium. Videos of 3D models, however, presented substantially more information than a single 3D diagram, therefore making them more effective at communicating the relevance of the standard for accessibility. Both scored highly in application, meaning that seeing the modelled environment helped professionals understand how to apply the standards in a real environment, too.

Traditional types of diagrams (2D and CSA) performed relatively poorly compared to other visualizations, and diagrams original to CSA B651 were less preferred for all three performance measures. Professionals found 2D diagrams harder to apply than other visualizations, perhaps because they did not provide enough spatial or function context within which to apply them.

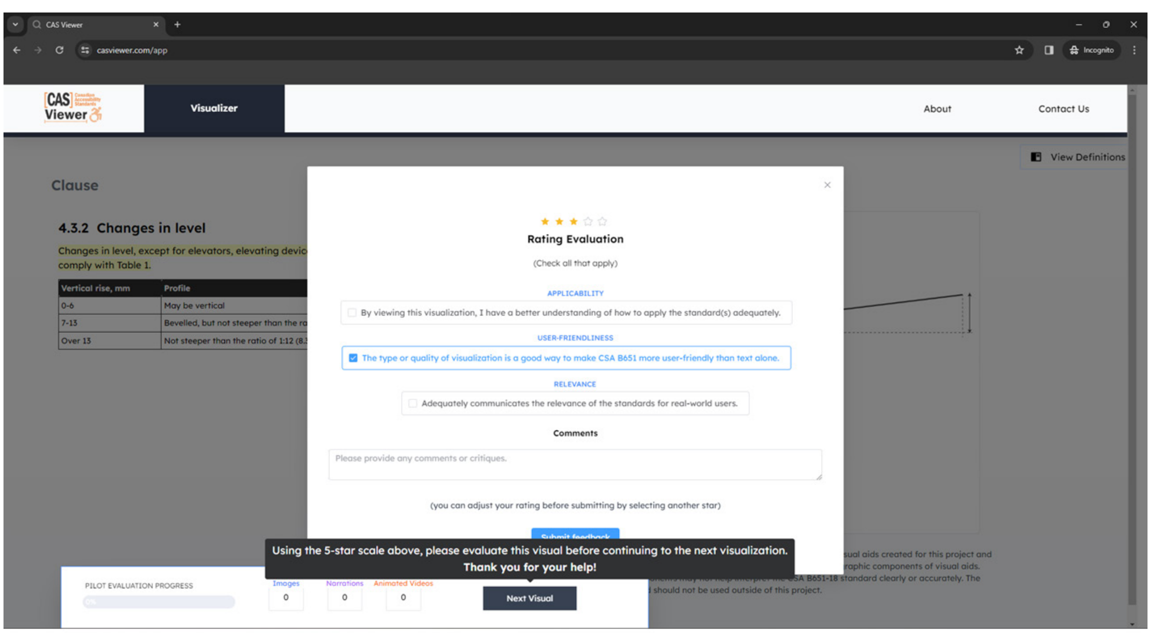


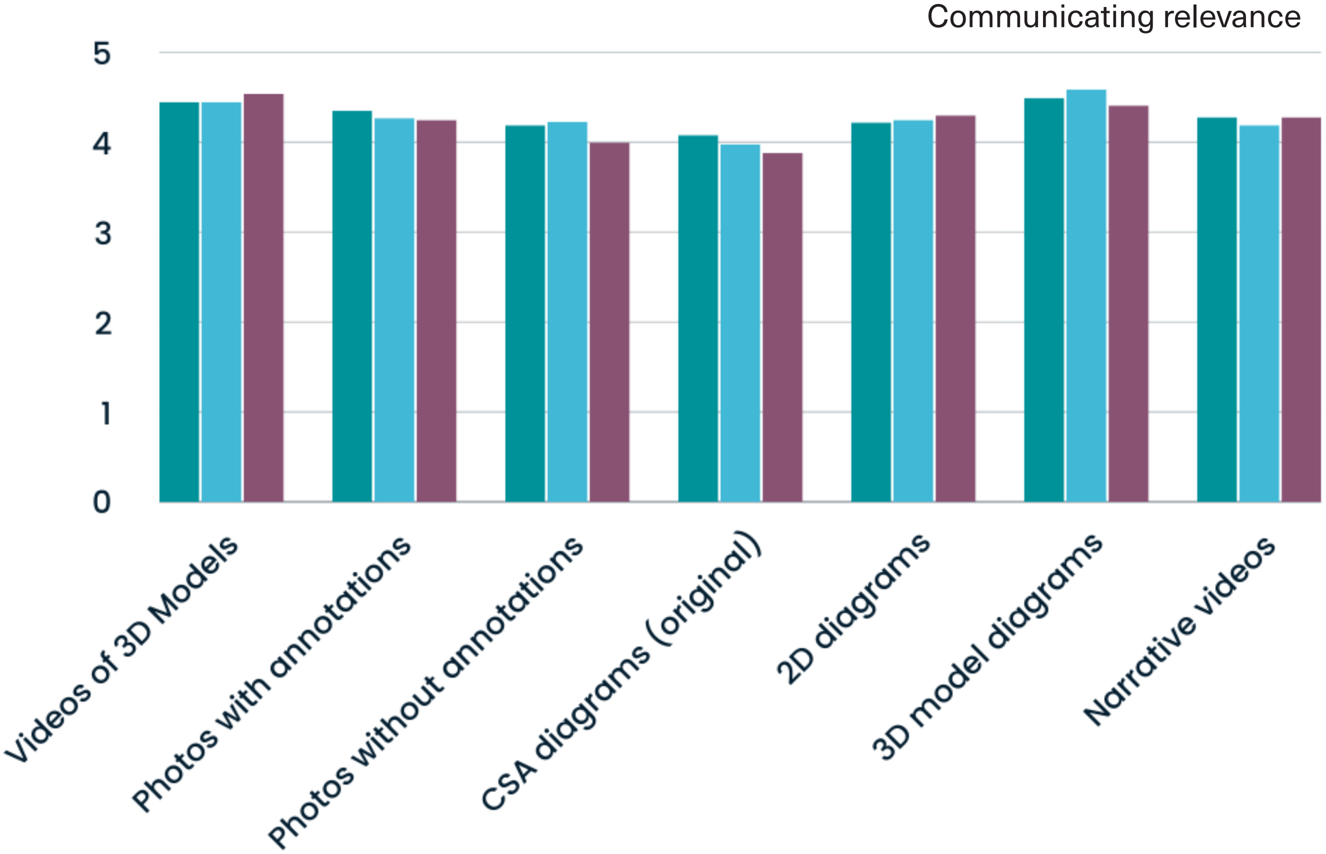
Figure 15. Screenshot of the pop-up shown when rating a visualization.

Combining visualizations with textual annotations was most useful for professionals to apply the standards. Photos with annotations, for instance, scored highly in application, as well as the modelled environments, which also used annotations to identify components, describe intent, or define the scope of a visualization. Photos without annotations received the lowest average rating overall (3.9), also supporting the observation that annotations were helpful.

Figure 16. Average rating overall by type of visualization (from highest to lowest)

Videos of 3D models:	**4.47**
3D model diagrams:	**4.37**
Photos with annotations:	**4.18**
2D diagrams:	**4.14**
Narrative videos:	**4.09**
CSA diagrams:	**4.08**
Photos without annotation:	**3.9**

Figure 17. Average ratings by type of performance measure selected per type of visualization



4.4. What participants said about the visuals

Participants left comments openly expressing what they liked, did not like, and what could be improved about the visualizations.

The comments reflected several common themes listed by Figure 18. Themes were selected based on the interest expressed by a comment, and not based on whether the specific visualization fulfilled that interest. For instance, comments praising a visualization for its use of context was counted with comments asking for more context. Since both are expressing an appreciation/need for context to be included in the visualization, they have been grouped as a theme to be considered.

Each type of visualization received a different proportion of comments expressing each theme. For instance, photos without annotations and 3D model diagrams received a higher proportion of comments suggesting to optimize/add annotations. Figure 18 shows the distribution of comments by theme and type of visualization.

4.4.1 Trends in the comments

Participants most often left a comment to say something positive about a visualization or to express support for the aim of the project itself (total=67). Narrative videos were more likely to receive a positive comment than any other type of visualization (64%, n=32). The professionals who provided their feedback liked the personal, lived experience communicated through the narrative videos.

Videos of 3D models also received a high proportion of positive comments (40%, n=10). These videos were liked for presenting clauses in sequence and relating clauses to one another directly. Professionals also liked that a 3D model video could show a design element from multiple angles and perspectives.

The secondmost occurring theme was for professionals to describe their preferences for annotations (total=55). While one participant expressed that "... a picture really is worth a thousand words!", professionals typically wanted more words integrated into the visualizations.

Photos with annotations and 3D model diagrams received the highest proportions of comments about annotations (47%, n=21, 43%, n=9, respectively), with CSA diagrams coming in second (31%, n=8). Professionals wanted to see direct and obvious connection between the clause text and the visualization content. Additional annotations were suggested as a solution to clarify the context or intent of a diagram.

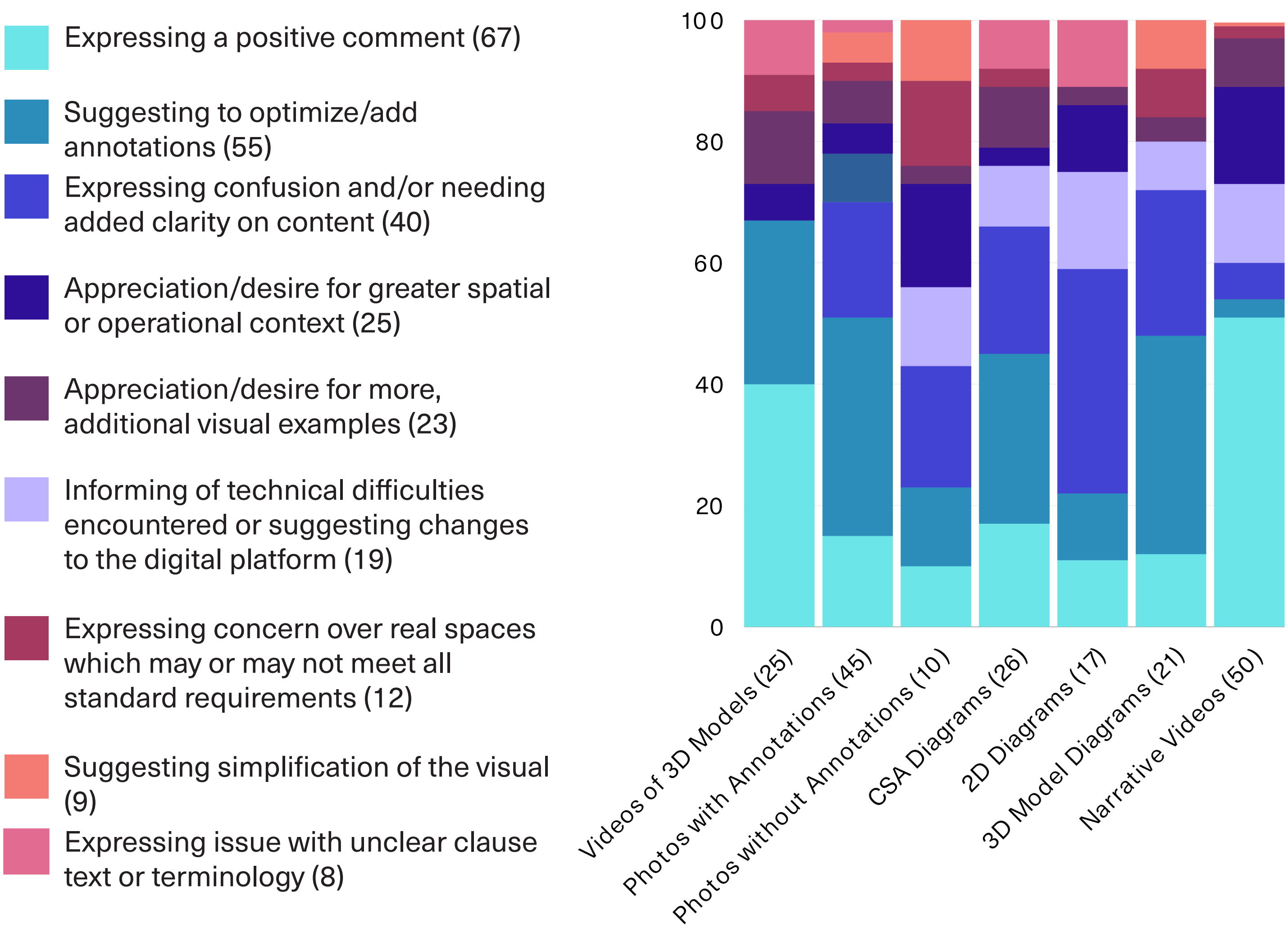
Showing the text and visualization side-by-side as this study did was not always enough to make the connections clear. Combining the clause text with visualizations in other ways may be a preferred solution, rather than the visualization being shown as supplemental to the text. For example, using call outs that contain the full clause text.

Much of the feedback from professionals also had to do with the amount of context shown within the visualizations (total=25). Only videos of 3D models did not receive any requests for further context. This may be because they already displayed a wider spatial area in which to apply the standards.

Comments seeking more context were more common for 2D diagrams than other types of visualizations. Two-dimensional diagrams were also more likely to receive feedback seeking clarity or expressing confusion than other types of visualizations. Professionals said it would help for the design components shown in 2D diagrams to also be shown in use or applied in a wider landscape.

Overall, the more explanation of where the standard applies, its intention, and its specific requirements that could be described by a visualization, the better.

Figure 18. Proportion of thematic qualitative feedback by type of visualization



Section 5. Findings from the Feedback

This section highlights direct quotes from professionals that support three primary findings. Trends in the ratings and comments collected from professionals were used to identify the following:

- Modelled environments have the potential to provide more context and show best practice designs;
- Narrative videos and photographs are valuable resources to inform understanding; and,
- Interpretation of the visualizations is supported through text and vice versa.

Three additional observations are also described in this section. These talk about:

- Informing compliance;
- Using video media; and,
- Challenging terminology.

5.1. Modelled environments have the potential to provide more context and show best practice designs

Context was of key interest to professionals for all types of static visualizations, and for narrative videos. Professionals seeking more context wished to see:

- More examples of the specifications applied in different environments;
- More information about the placement of accessibility features in its spatial context or relative to other features; or,
- The operational context of how some features are used (e.g., comments made to 4.3.5.4.1).

Most professionals were attracted to the computerized modelling of spaces (3D model diagrams and videos of 3D models). They appreciated when a video showed a design component from various angles and with measurements clearly applied. Presenting complex or highly detailed information in a sequential order, or “movie” format was helpful for guiding the viewer through multiple clauses while maintaining the ‘big picture’ (See comment 1 for 8.4.2.3.3 and the comments for 8.5.3). Another way to improve upon this would be to add moving elements (e.g., traffic, pedestrians) which could make the model even more immersive (See comment 2 to 8.4.2.3.3).

Modelled environments were effective at showing the ‘what’ and ‘where’ of design elements within a familiar context without showing unnecessary information which may be seen in a photograph. Models could show exact measurements that might not be acheived in a real setting.

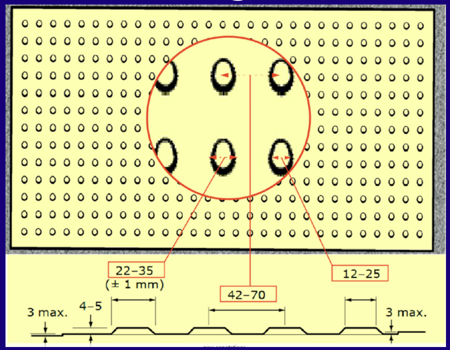
Professionals commented on the importance of displaying high-quality, best practice examples of design through the visualizations. Although photographs can be useful for providing context, they did not succeed at always showing best practice design.

Real spaces tend to be 'messier'. There are often surrounding design components that are not relevant to the intended clause or even inaccurate to the standards as a whole (O'Neill & Smith, 2014; Christmann, 2008). Photographs may unintentionally endorse other design practices that are contained within them. They are also up for interpretation in more ways than a controlled image, like a drawn diagram.

Some professionals pointed to these faults. For instance, a comment made to 5.4.3 was critical of a set of stairs used to visualize tactile attention indicator use at the top of stairs. It is likely that the various details of the building interior distracted from the only feature the photo was meant to demonstrate -- the placement of the tactile attention indicator.

The use of 3D modelling offers an opportunity to fill this gap by providing context while also showing ideal, best practice options.

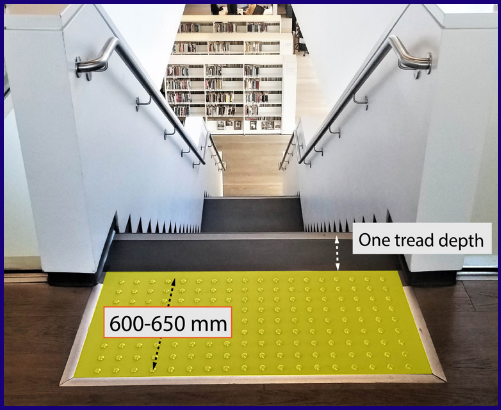
Tactile direction indicator surfaces, Configuration (4.3.5.4.1)



"I get the section but find the plan a bit weird ... could also be shown in context, like on a curb."

"Showing the product but not in use...kinda confusing."

Tactile attention indicator surfaces at stairs (5.4.3)

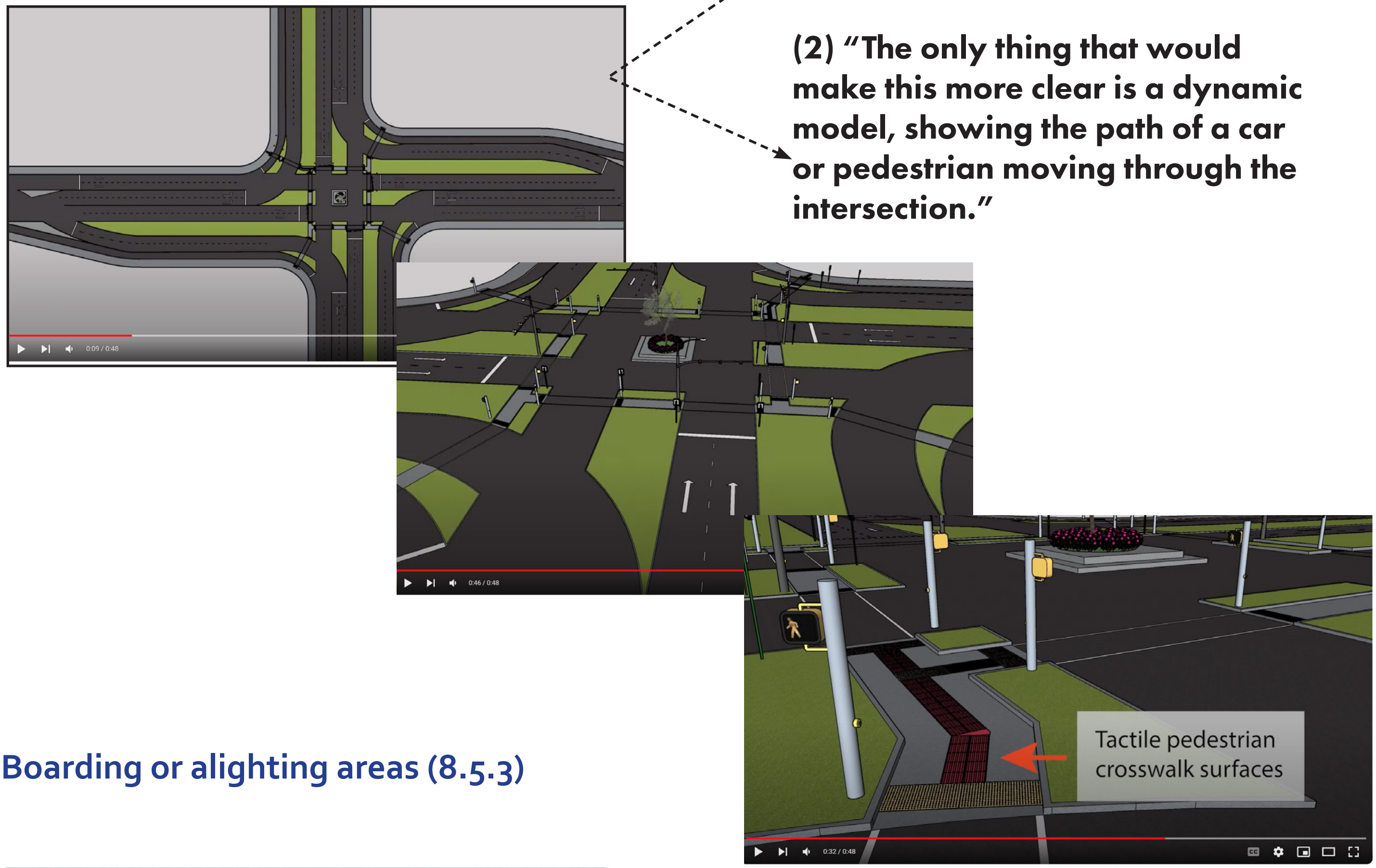


"...It might be illustrating the intent of the CSA, however if something is used as an example it should be an example with higher quality design and level of details. Opting out for abstract drawn images might be a better approach."

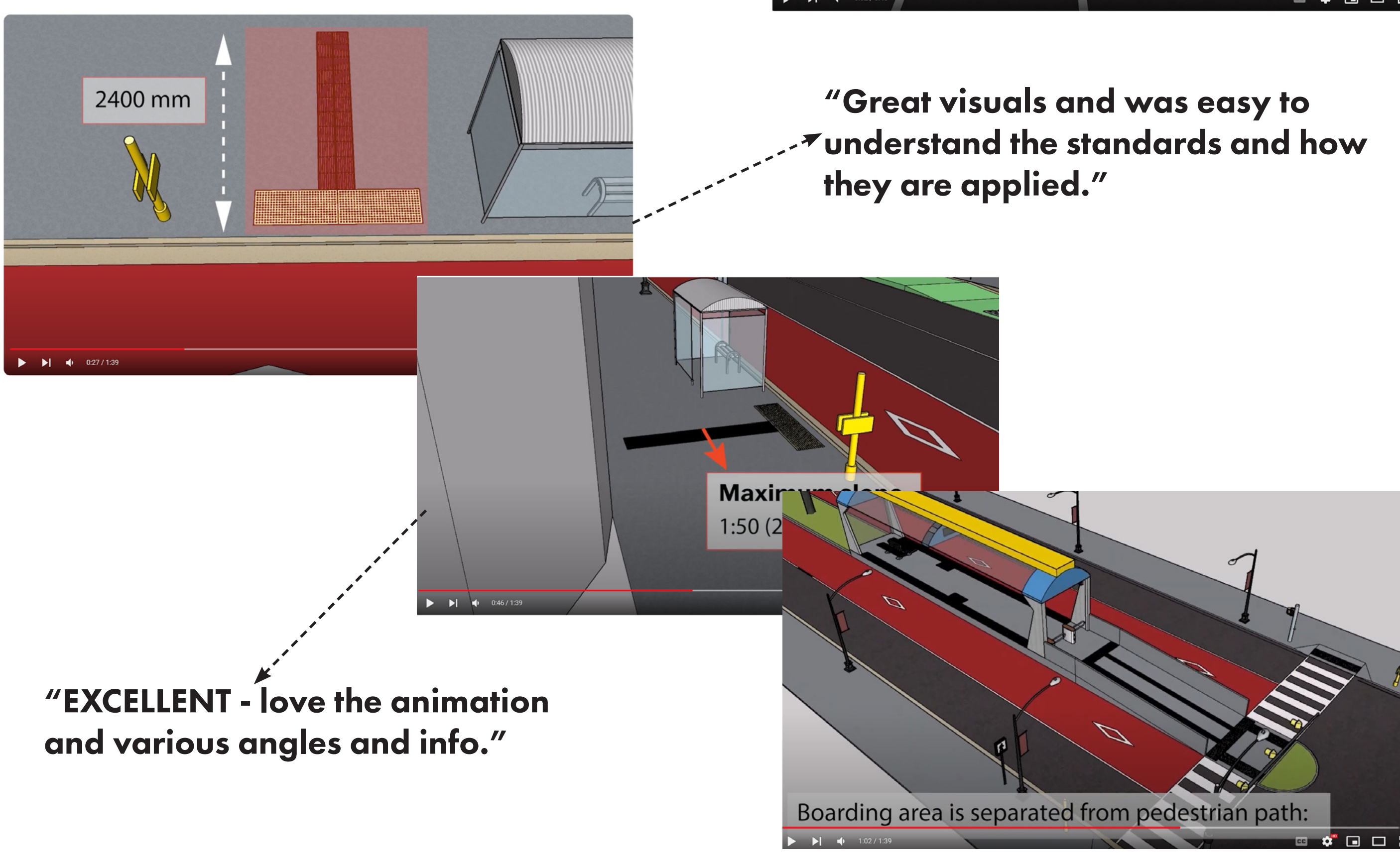
Continuous or parallel flow intersections (8.4.2.3.3)

(1) "The linear style of using a 'movie' can help illustrate multiple steps in complicated areas for select features."

(2) "The only thing that would make this more clear is a dynamic model, showing the path of a car or pedestrian moving through the intersection."



Boarding or alighting areas (8.5.3)



"Great visuals and was easy to understand the standards and how they are applied."

"EXCELLENT - love the animation and various angles and info."

5.2 Narrative videos and photographs are valuable resources to inform understanding

Some professionals expressed that photos were helpful to them for identifying the features or to demonstrate the features in a recognizable space or from a familiar perspective. It was commonly suggested, however, that they may be best used in combination with other types of visualization (See comments for 8.8.2, and 4.4.2.1). A similar suggestion was made for narrative videos. Many said that they would be best used in combination with other, more traditional forms of visualization, so that they may serve an educational purpose but not try to take the place of technical diagrams.

Narrative videos described 'why' the standards prescribe what they do. Professionals said that the explanation provided in the narrative videos was valuable for motivating implementation of the standards and demonstrating how following (or not following) the standards directly affected people living with disabilities. Comments made to 4.4.2.1, 8.3.2.2, and 4.2.3/4.2.4 show this perspective.

Some narrative videos showed the interviewees navigating a space to visually demonstrate the experiences they described verbally. Participants often expressed they would like to see more examples, or more specifications for the accessibility solutions that were verbally described or shown in the footage (See comments to video 8.8.1).

They also pointed out that what the interviewees described were often experiences the professionals may not have considered before. This was especially true for the perspectives of people who were blind or neurodiverse.

The narrative videos received the most comments of all types of visualization, suggesting that they were more likely to make professionals critically reflect on their content, which can be beneficial in practice.

Scaffolding (8.8.2)

"I prefer CAD or diagrammatic renderings generally, but I think the visual photo approach is a great support tool to demonstrate examples in real life."

Protruding objects, General (4.4.2.1)

"I think images are helpful to demonstrate real world examples, but might not be suitable to take the place of illustrations, but perhaps to use as supplementary examples..."

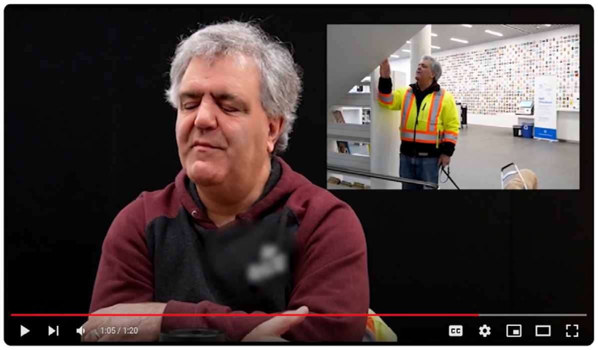
Raised Crossings (8.3.2.2)

8.3.2.2 Raised Crossings (CSA B651-18)

"Love that this personal connection helps understand why this should be implemented."

"Definitely great personal experience stories... could be accompanied with some graphics."

Protruding objects (4.4.2.1)



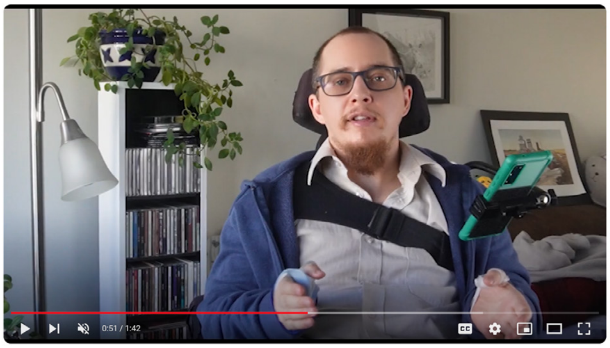
"Good visual and descriptive explanation for those that hadn't thought of it prior."

Operating controls (4.2.3/4.2.4)

"This may be a good video to add as a potential resource, but it does not show a designer how to design the power door operator. A graphic or pictogram would be more useful."

"This is a great instance of demonstrating to the viewer that there is a positive outcome for having better accessibility standards, not just for peoples with disabilities, but also for everyone. The personal example of how better design results in better and more seamless uses of space is very clear and can help potential users of the CSA feel empathy."

Construction along an accessible route (8.8.1)



"Would like to see examples of good or ideal spaces as he explained in the video."

5.2. Interpretation of visualizations is supported through the text and vice versa

The majority of visualizations included some text, symbols, or other ‘markup’ to assist viewers with their interpretation of the illustrative components. For instance, dimensional measurements were most commonly shown, as well as labels for specific landscapes or fixtures relevant to the clause being visualized.

The importance of annotations is reflected in many of the comments. These confirmed that accessibility standards cannot be communicated through visualizations alone.

Professionals expressed confusion when there was not a clear enough connection between a visualization and its associated clause. In some cases, it appeared that the source of confusion may be due to inattention to the clause text itself and an overreliance on the visualization. For instance, for 4.4.2.2 (b)(i) (Please see Figure 19) the participant had difficulty interpreting the visualization showing the use of a long cane as an assistive device. The illustration showing contact between the cane and a protruding object was percieved as an unwanted impact.

This may be a case of needing more examples for professionals to draw from, which would help to clarify the meaning of “cane-detectable”, if it is unknown. It may also further support a need to integrate the text and supportive images so that professionals are not tempted to rely solely on a visualization or vice versa.

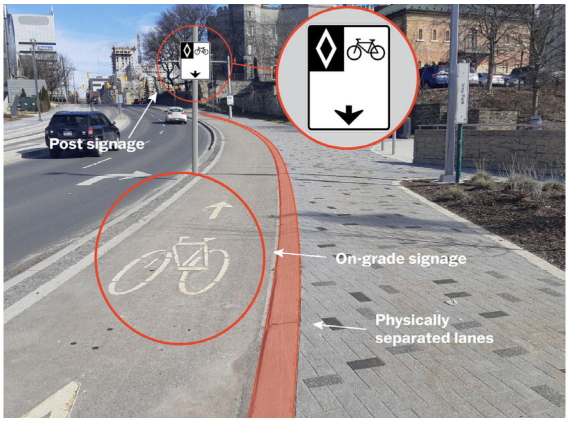
Overall, it was important to professionals that the visualizations leave very little possibility of inaccurate interpretation, and annotations were key to achieving this.

Recommendations were made by professionals regarding the placement, wording, frequency, and legibility of annotations, as well as the preferred use of symbology or metrics.

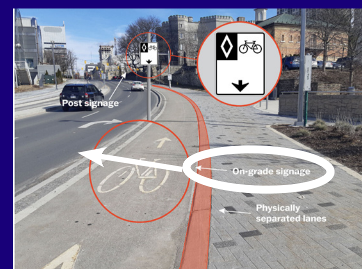
Comments to improve annotations include the following:

- Make the textual annotations bigger;
- Arrange the text to the side or in a linear list to unclutter the image when there are multiple annotations (See comment to 8.2.6);
- Make the annotations of higher contrast to their background;
- Reduce the number of annotations where they are not necessary (See comment from 8.4.2.1);
- Use words instead of symbols where possible (e.g., ‘min.’ instead of ‘>’) (See comment from 8.3.6.1);
- When showing what not to do, make the “No” symbol clearly stand out;
- Using colours to highlight elements of a landscape may make people think the that element is meant to be painted such colour in a real landscape.

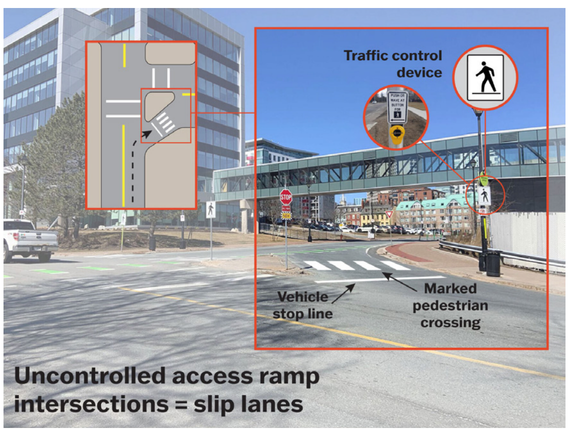
Shared-use routes (8.2.6)



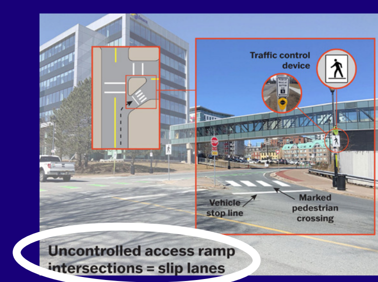
"...the 'on-grade signage' could be put left of the bike pavement."



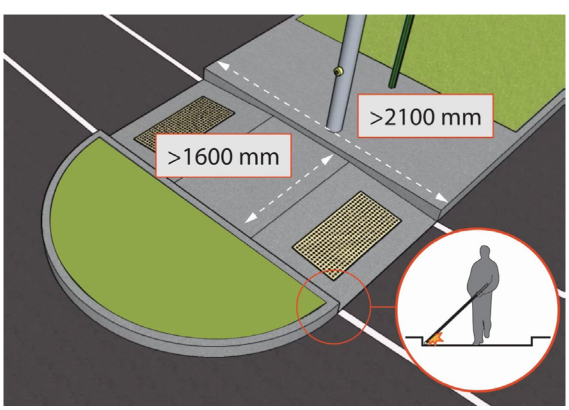
Uncontrolled access ramp intersections (8.4.2.1)



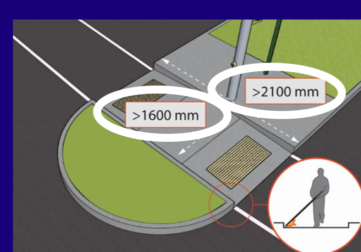
"There might not be a need for the words on the lower left hand. Increase the font size as it is difficult to read."



Medians and pedestrian refuge areas, General (8.3.6.1)



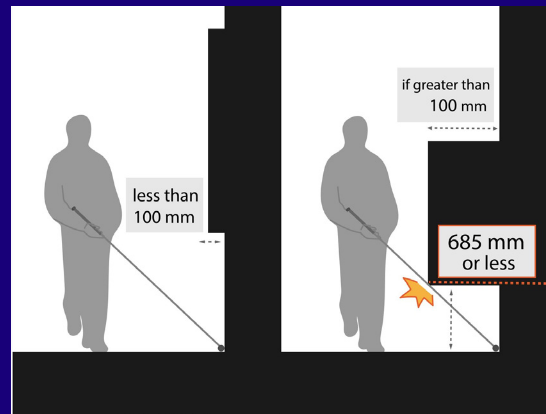
"I prefer MIN. to > as not everyone knows this notation."



Protruding objects (4.4.2.2 (b) (i))

b) objects protruding more than 100 mm from walls, columns, or free-standing supports shall either

i) be cane-detectable at or below 685 mm from the floor



"Unclear about graphic on right. Is it bad where the cane hits the obstruction - or is that a good thing because it has prevented a collision?"

Figure 19. Example of how the visualization was shown with corresponding clause text side-by-side.

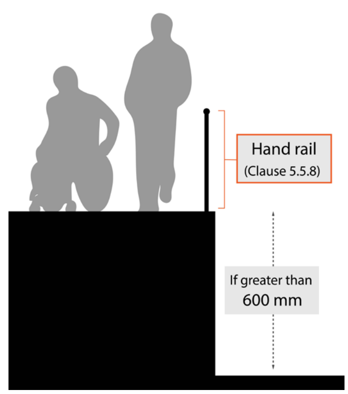
5.4. Additional observations

5.4.1 Informing compliance

Professionals occasionally voiced concern about the use of visualizations in B651 as a legal document. Issues may arise when enforcing compliance with the standards if an image shows anything that is not completely aligned with the text. This is a limitation of the use of visualizations.

However, this research found that many professionals appreciated the visualizations as educational materials. Therefore, there may be a need to provide visualizations that inform and educate, but are not directly used for regulation.

Edge protection (8.2.5 (b))



"Simpler images for regulation is better. Not only will this be more preferable for lawyers in a regulatory doc, it makes interpretation clearer if responding to a quick inquiry."

5.4.2 Using video media

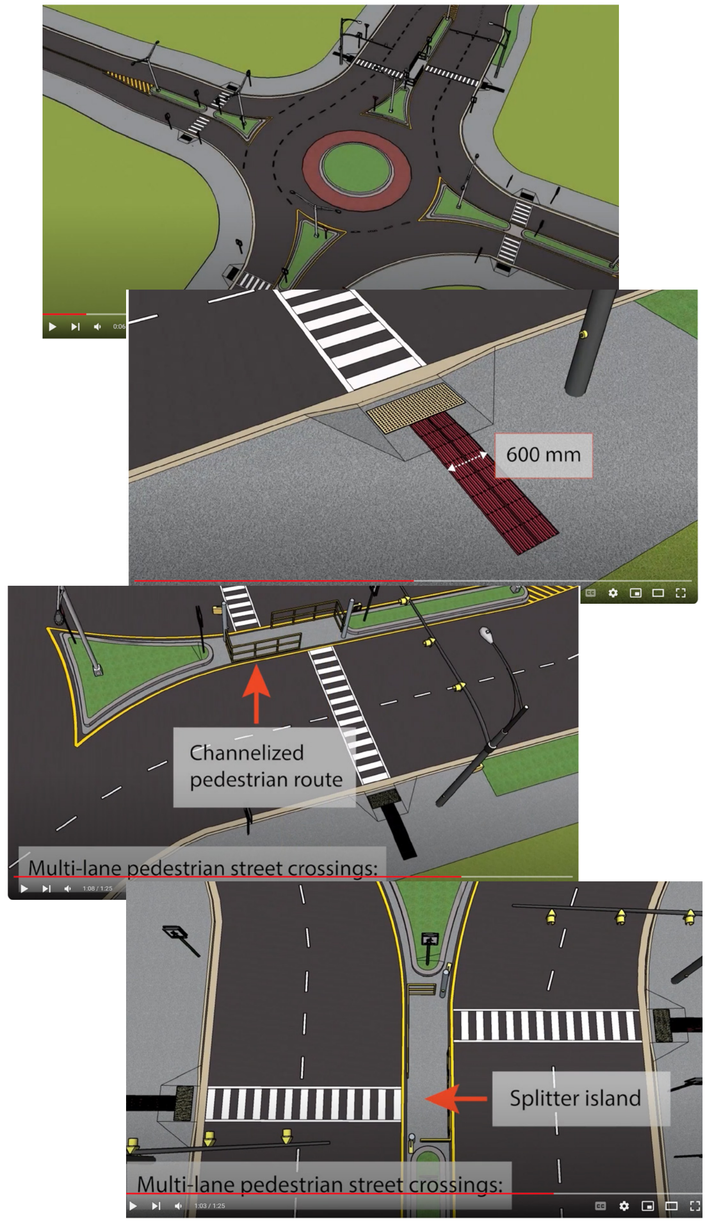
It was more common for professionals to provide feedback about how to improve the digital platform of the website or online video player for both types of videos produced – I.e., narrative videos and 3D model videos – than for the static media.

The majority of these comments offered suggestions on how to improve or optimize the use of audio-video mediums by altering the video length or timing, or adding interactive features, such as clickable links within the videos.

There was some overlap between the latter requests and comments collected about optimizing annotations. Participants similiarly suggested ways that the video could more directly link to the clause text using text annotations, responsive colour coding of the relevant pieces of text to elements in the video, or creating ‘snippets’ of the video that corresponded to more exact pieces of the clause.(See comments for video 8.4.2.4 and 8.3.4.1/2/8.3.5).

Criticisms about both video types were largely about the video progression being too slow or too fast. The videos were equipped with ‘pause’, ‘rewind’, and ‘playback speed’ settings, which each viewer could use to adjust their viewing experience. The CAS Viewer website did not, however, tutorial these features to professionals. Perhaps doing so would have been beneficial.

Roundabouts (8.4.2.4)



“Having smaller video snippets that come up when you click on each clause would be helpful for video interpretations like this.”

Surface (8.3.4.1)
Pavement markings (8.3.4.2)
Alignment of pedestrian crossing components (8.3.5)

"…If possible, it would be great to split the video into smaller 5-10 second videos and allow users to see video specific to the individual requirement. Alternatively, providing links from the individual requirements to jump to time stamps on the video would make it more user friendly (but not as nice as having individual videos)."

"Cool visuals! The text in the video went by too fast - can you leave it there, but moves off to the side? Great option would be ability for user to select the relevant paragraph in the text, and then see the graphic on the right and be able to look back and forth between the two."

"I felt like the timing was a bit slow but maybe if there was narration that would help."

"When transiting between each metric, I would give more time for the user to understand and see the standard (example giving more time for user to see the 1000mm width visual of about couple more seconds before transitioning to minimum headroom 2050mm."

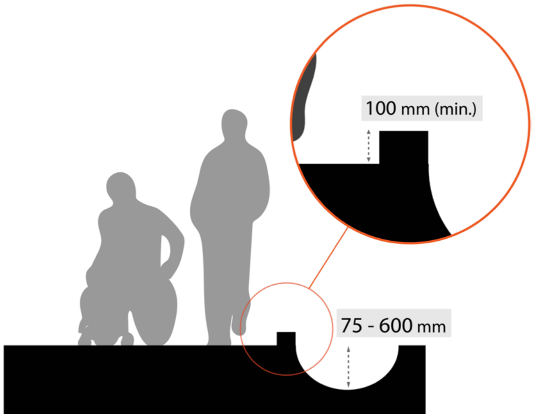
5.4.3 Challenging terminology

A few professionals commented on unfamiliar or confusing language used by the clauses (See comment from 8.2.5.(a)) or to seek clarity on terminology.

Some terminology was still not made clear by the visualizations. For example, in the case of 4.2.1, the visualization tried to show multiple photographic examples of items that may be or may have an "activation device". For at least one professional, the visualization was not sufficient to define what might be considered an activation device.

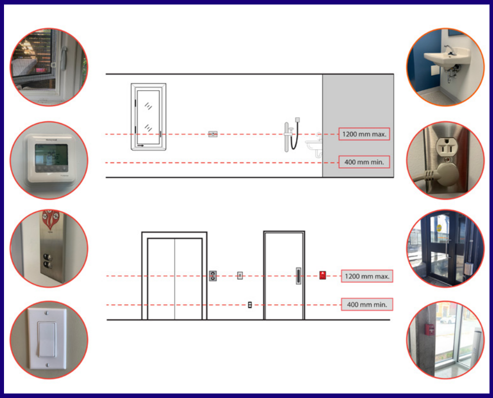
A definition section was provided on the CAS Viewer website taken directly from the B651 document, but viewers may not have navigated to seek it out when they encountered an unfamiliar term. This, again, suggests that visualizations and text are most effective if they work in tandem.

Edge protection (8.2.5. (a))



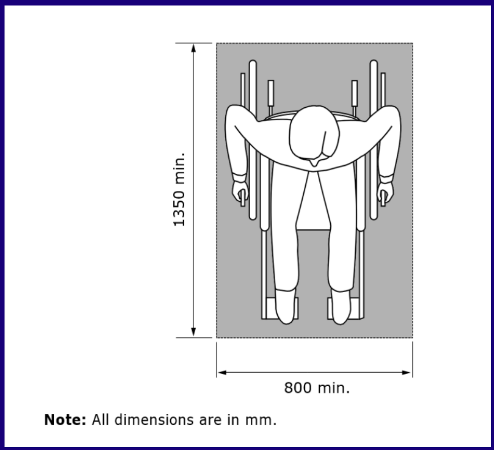
"Very clearly explains a very weirdly written concept."

General requirements, Scope (4.2.1)



"Not clear what an activation device is.."

General requirements (4.1. (a))



"What is a single-wheeled mobility device? The picture shows a wheelchair that seems to have four wheels."

Section 6. Recommendations and Future Needs for Research

Four recommendations have been identified for consideration to enhance the communication of accessibility standards like CSA B651. This research has also pointed to directions for future and continuing research. Both are detailed in this section.

6.1 Recommendations

Recommendation 1: Consider, where appropriate, an alternative approach to describing standards with visuals as a primary mode of communication.

Professionals emphasized that the relationship between the text and the visualizations is symbiotic. Neither text-only nor visual-only description is adequate to support full interpretation of the standards.

In the process of this study, we found creating visuals based on the existing textual explanation was sometimes limiting. Visual materials are, by nature, capable of communicating the characteristics of a space more holistically than text. Often, what visuals convey beyond the specifics of textual description is important and should not be reduced by solely showing a singular feature prescribed by the specific clause. It means, in many occasions the standard requirements should be formulated in a way that includes their relationship with the surrounding environment.

Therefore, it may be useful to explore an alternative approach to the 'writing' of the standards where requirements are primarily communicated using visual means that situate them in a wider contextual space. Textual description can then highlight specifics in the image, or serve as a supplemental explanation of how the specifications and surrounding environments work together.

Recommendation 2: Consider using 3D modelled environments instead of 2D diagrams when it is helpful to understand the requirement in context.

It is often challenging to find local best practice examples of accessible design in built environments in Canada. This means it is unlikely that users of the standards can relate to the standards through their everyday environment. Three-dimensional (3D) images are more relatable in general because they look closer to a real environment even if the viewers do not have a first-hand experience of the design in reality.

Interpretation of two-dimensional (2D) diagrams is also challenging to apply in real contexts because these types of illustrations are often too simplistic and do not convey the necessary design concepts in full. 3D modelled images are often more helpful, as they can describe more complex spatial relationships.

However, the more complex the visuals, the more difficult for the viewer to identify the features directly relevant to the standards. It is therefore important to use 3D modelled visuals effectively, where they highlight the specific standards while illustrating how the entire space works as a whole.

Professionals' responses in the study revealed that 3D models offer 'the best of both worlds' when visualizing a contextual environment, while still showing precise requirements from the technical standards. If done effectively, modelled visualizations can help professionals to more intentionally and consistently apply the standards in real built environments with greater confidence.

Recommendation 3: Use multiple visual media to describe design needs for mind-friendly spaces.

Study participants expressed interest in better understanding mind-friendly spaces. Requirements for mind-friendly spaces are multifaceted and often reflect a spectrum of experiences. Therefore, they can be best described by multiple visualizations showing different aspects of a space rather than a singular visual.

As the current standards will likely expand their scope to include more specifications for neurodivergence, it would be helpful to use more and diverse visual media to explain each specification.

Recommendation 4: Consider developing an accompanying guiding tool to enhance use of the standards.

Accessibility standards are used for more than their regulatory purposes. Professionals and community members refer to them to come up with design solutions, as a basis for policy-making, and to support disability rights advocacy or education.

Throughout this research, professionals have expressed that additional contextual information goes a long way to help them understand and apply the standards. Many of the visualizations were received positively for communicating contextualizing information (e.g., narrative videos, photos with annotations). These findings suggest that these mediums are better suited to contextualizing the standards rather than directly or simply communicating minimum design requirements.

It would be helpful to develop a guiding tool that goes beyond the explanation of standards to support contextual understanding of design needs in a more holistic way. It can serve as a supplemental, technical, and educational resource, presenting visualizations to inform professionals of the 'why' of the standards. It can also build capacity in building professional communities by conveying design considerations from experiential knowledge, which professionals in this study found to be valuable. This can be especially important when addressing complex barriers such as those affecting people who are neurodivergent or people with environmental sensitivities.

Such a tool could be in the form of a guiding or reference document, an online catalogue, or web application that accompanies and can be viewed in conjunction with the standards.

6.2 Future Needs for Research

This study shows that there is significant opportunity to optimize the use of accessibility standards through visualization. Continuing research can further support the type, quantity, and use of visuals by professionals to encourage effective application that is accurate, thoughtful, and streamlined. They can also be used to grow awareness of accessibility needs in more professionals, leading to continuing innovation for accessibility in practice. More research can be done to uncover the full potential of visualizations for educational and capacity-building purposes.

An additional observation of this research was the potential of a digital resource for accessibility standards. Digital platforms allow for various types of media beyond static images or diagrams, such as videos, which were very well received by professionals in this study. However, web platforms require their own accessibility considerations, especially when employing dynamic types of media (e.g., interactive videos or animations). Future research around the potential of these media likely requires targeted investigation of web accessibility for such purpose as communicating built environment accessibility.

6.3 Conclusion

The aim of this study was to learn how best to use visualizations to enhance the communication of accessibility standards. Professionals working in a wide range of design, construction, and policymaking fields provided a wealth of feedback on the usefulness of different types of visualizations for improving their understanding and application of accessibility standards for the built environment. From the findings, it is clear that methods of visualization hold significant potential for future generations of accessibility standards.

The types of visualization investigated in this study were not exhaustive. However, the study confirms an important insight that adding visualizations to the communication of accessibility standards can improve their use, as they build capacity in professionals to interpret and understand the intent and function of various design specifications. In turn, this can lead to more thoughtful and accurate application of the standards by professionals, and foster greater awareness of accessibility across stakeholders including members of the public, private industry, and providers of public services.

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Appendix 1.

The table below lists CSA B651 clauses included in this study and how they were visualized.

Clauses	Titles	Type of Visuals
	Section 4. General Requirements	
4.1	Area allowances	CSA Diagram
4.2	Operating controls	
4.2.1	Scope	Photo with annotations
4.2.2	Floor area	Photo with annotations
4.2.3	Height	Narrative video
4.2.4	Operation	Narrative video
4.2.5	Control devices	Photo, no annotations
4.2.6	Visual displays	Photo with annotations
4.2.7	Illumination	
4.2.7.1	n/a	Photo with annotations
4.2.7.2	n/a	Photo with annotations
4.2.8	Colour contrast	Photo, no annotations
4.3	Floor or ground surfaces	
4.3.1	General	Photo with annotations
4.3.2	Changes in level	2D diagram
4.3.3	Carpets	Photo with annotations
4.3.4	Gratings	Photo with annotations
4.3.5	Tactile walking indicator surfaces	
4.3.5.1	General	2D diagram
4.3.5.2	Surface	Photo with annotations
4.3.5.3	Tactile attention indicator surface	
4.3.5.3.1	Configuration	2D diagram
4.3.5.3.2	Location	Photo with annotations
4.3.5.3.3	Installation	Photo with annotations
4.3.5.3.4	Luminance contrast	2D diagram
4.3.5.4	Tactile direction indicator surfaces	
4.3.5.4.1	Configuration	2D diagram
4.3.5.4.2	Location	3D model diagram
4.3.5.4.3	Installation	a) 3D model diagram b) CSA Diagram
4.3.5.4.3	Installation	c) Diagram
4.3.5.4.3	Installation	d) Photo
4.3.5.4.4	Luminance contrast	Photo with annotations

4.4.	Headroom and protruding objects	
4.4.1	Headroom	Video narrative
4.4.2	Protruding objects	Video narrative
4.4.2.1	General	Photo, no annotations
4.4.2.2	Headroom maintenance	a) 2D diagram
4.4.2.2	Headroom maintenance	b) 2D diagram
4.5	Signage	
4.5.1	Location	Narrative video
4.5.2	Configuration of signs	Photo with annotations
4.5.3	Characters	2D diagram
4.5.4	Pictograms and symbols	Photo, no annotations
4.5.5	Illumination	Photo with annotations
4.5.6	Tactile signs	
4.5.6.1	General	Photo, no annotations
4.5.6.2	Tactile characters	CSA diagram
4.5.7	Symbol of accessibility	CSA diagram
4.6	Additional considerations	
4.6.1	General	Narrative video
4.6.2	Functional and cognitive barriers	Narrative video
4.6.3	Environmental sensitivities	Photo, no annotations
4.6.4	Acoustics	Narrative video
Section 8. Exterior circulation		
8.2	Accessible routes	
8.2.1	General	Video of 3D model
8.2.2	Width	Video of 3D model
8.2.3	Slope	Video of 3D model
8.2.4	Drainage	Photo, no annotations
8.2.5	Edge protection	a) 2D diagram
8.2.5	Edge protection	b) 2D diagram
8.2.5	Edge protection	c) Photo with annotations
8.2.5	Edge protection	d) Photo with annotations
8.2.6	Shared-use routes	Photo with annotations
8.3	Pedestrian crossings	
8.3.2.2	Raised crossings	Narrative video
8.3.2.2	Raised crossings	3D model diagram
8.3.3	Curb ramps and blended transitions	
8.3.3.1	Running slope	Video of 3D model
8.3.3.2	Cross slope	Video of 3D model

8.3.3.3	Counter slope	Video of 3D model
8.3.3.4.1	Surface	3D model diagram
8.3.3.5	Width	3D model diagram
8.3.3.7	Curb ramp drainage	Photo with annotations
8.3.3.8	Turning space	3D model diagram
8.3.3.9	Parallel curb ramps	CSA diagram
8.3.4	Crosswalks	
8.3.4.1	Surface	Video of 3D model
8.3.4.2	Pavement markings	Video of 3D model
8.3.5	Alignment of pedestrian crossing components	Video of 3D model
8.3.6	Medians and pedestrian refuge areas	
8.3.6.1	General	3D model diagram
8.3.6.2	Raised medians or islands	3D model diagram
8.3.6.3	Level medians and islands	3D model diagram
8.3.6.4	Bulb-outs (curb extensions)	
8.3.6.4.1	n/a	Photo with annotations
8.3.6.4.2	n/a	Photo with annotations
8.3.7	Pedestrian crossing signals	
8.3.7.2	APS at pedestrian crossings	Photo, no annotations
8.3.9	Bollards	Photo, no annotations
8.3.10	Overpasses and underpasses	
8.3.10.1	Pedestrian access route	Photo with annotations
8.3.10.2	Pedestrian approach	Photo with annotations
8.4	Intersection design	
8.4.1	General	Photo with annotations
8.4.2	Types of intersections	
8.4.2.1	Uncontrolled access ramp intersections	Photo with annotations
8.4.2.2	Sign controlled intersection	Photo with annotations
8.4.2.3	Signal-controlled intersections	
8.4.2.3.1	Design specifications	Video of 3D model
8.4.2.3.2	General intersections	Video of 3D model
8.4.2.3.3	Continuous or parallel flow intersections	Video of 3D model
8.4.2.4	Roundabout intersections	Video of 3D model
8.4.2.5	Vehicular overpasses or underpasses	Photo with annotations
8.4.2.6	Pedestrian mid-block crosswalks	Video of 3D model

8.4.2.7	Rail lines	Video of 3D model
8.4.3	Intersection design features	
8.4.3.1	Raised intersections	3D model diagram
8.4.3.2	Intersection corners	2D diagram
8.4.3.3	Angle of intersections	2D diagram
8.5	Transit stops	
8.5.1	General	Video of 3D model
8.5.2	Identification	Video of 3D model
8.5.3	Boarding or alighting areas	Video of 3D model
8.5.4	Transit shelters	Video of 3D model
8.6	Urban furniture and equipment	
8.6.1	General	Photo with annotations
8.6.2	Amenity zone	Photo with annotations
8.6.3	Rest areas	
8.6.7	Information kiosks	Photo with annotations
8.6.9	Bicycle parking	Photo, no annotations
8.6.10	Parking meters, newspaper dispenser, or mail or courier boxes	Photo with annotations
8.6.11	Waste receptables, recycling bins, or ashtrays	Photo with annotations
8.6.12	Reflecting pools	3D model diagram
8.7	Landscaping elements	
8.7.1	Flower or shrub planters	Photo with annotations
8.7.2	Planting bed edges	Photo with annotations
8.7.3	Vegetation	Photo, no annotations
8.7.4	Guy wires	Photo with annotations
8.7.5	Grates around trees	Photo with annotations
8.7.6	Tree guards	Photo, no annotations
8.8	Temporary facilities	
8.8.1	Construction along an accessible route	Narrative video
8.8.2	Scaffolding	Photo with annotations
Section 5. Interior circulation		
5.2.6	Thresholds	Photo with annotations
5.2.7	Door hardware	CSA diagram
5.2.8	Door-opening force	Narrative video
5.2.9	Power-assisted doors	Narrative video
5.2.10	Glazed panels	Narrative video

5.2.11	Doors in primary horizontal circulation	Narrative video
5.4.2	Nosing	CSA diagram
5.4.3	Tactile attention indicator surfaces at stairs	Photo with annotations
5.4.4	Stair handrails	Narrative video
5.5.8	Ramp handrails	Narrative video
6.1.3	Floor area	Narrative video