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Vendome Consultation - Let's Optimize the transfer between AMT and STM

“La cible première, l’objectif principal de la STM et de ses partenaires, c’est d’améliorer l’expérience client qu’on tient énormément à cœur.”

Maha Clour, Vendome Access Project public consultations, 2017-02-21

1. Summary

This brief looks at the Vendome Accessibility project, which attempts to make the STM and AMT Vendome station accessible, including a connection to the new MUHC hospital and the residential area to the North.

My primary concern is with the long transfers involving many stairs up and down, complete lack of escalators, and the necessity to take three elevators for any transfer. In fact for able-bodied persons, this new concourse, after spending 76 Million \$, does not improve the experience when transferring between the AMT and STM trains, compared to the existing concourse.

Given the importance of this station especially for AMT users, and the large impact of burdensome transfers to transit trips, I'm concerned that this will discourage transit use compared to a more optimized design which minimizes transfer distance, total number of stairs, total number of elevators, and includes escalators.

I will attempt to provide some context to show the impact of transfers on travellers, the importance of the transfer between AMT and STM, and some analysis of the current proposal. I will then present some suggestions to improve the transfer, in increasing level of difference/difficulty compared to the current design.

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2. Context

2.1. Context A - The Impact of Transfers on Transit Trips

Both transit research and existing transit agencies agree that the penalty of a transfer is larger than the time it takes (several facts taken from [1]):

- 1) The MTA (Metropolitan transit agency of New York) uses a model where transfer time counts as 1.75 times the in-vehicle time [1].
- 2) The MBTA uses a 11minute penalty per transfer (no matter the time), and a factor of 2.25 per transfer time.

We have to understand that an ideal passenger trip (from a passenger's point of view) would involve walking to a station, waiting for a transit vehicle, then spending time on the transit vehicle, then walking to the destination. A transfer will interrupt that in-vehicle low-effort time and make it appear

Stairs

Generally, walking is modelled at a speed of 80m/min (meters per minute). Research by Daamen et al suggests the following penalties for stairs, escalators and ramps [2]:

	All directions	Upwards	Downwards
Level element	<i>l</i>	<i>l</i>	
Stairs	1.86	2.78	n.s.
Escalator	1.28	1.86	0.72
Ramp	1.37	1.66	0.95

n.s. = non-significant

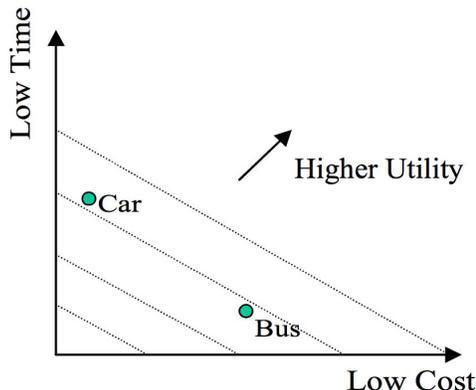
Penalties of stairs, escalators and ramps compared to level walking (taken from [2])

Stairs may have a penalty up to almost three times that of level walking.

Given the stair penalty is essentially multiplied with the transfer penalty, even small number of stairs can quickly add up. Long flights of stairs, requiring more physical effort, can quickly compound to a burdensome experience for travellers, who will perceive their trips as taking more effort.

Every passenger will make the mode choice between driving and taking transit based on many factors, involving cost, time and effort. For many travellers, the choices are fairly elastic - even relatively small changes in the costs may result in travellers favoring different modes.

Essentially, for many commuters, (especially a more suburban clientele) there's a "tight race" between favoring driving or transit, so a badly designed transfer can easily make transit "lose".



Excerpt of Figure 4.5 of [3], showing a potential mode choice mode for a user.

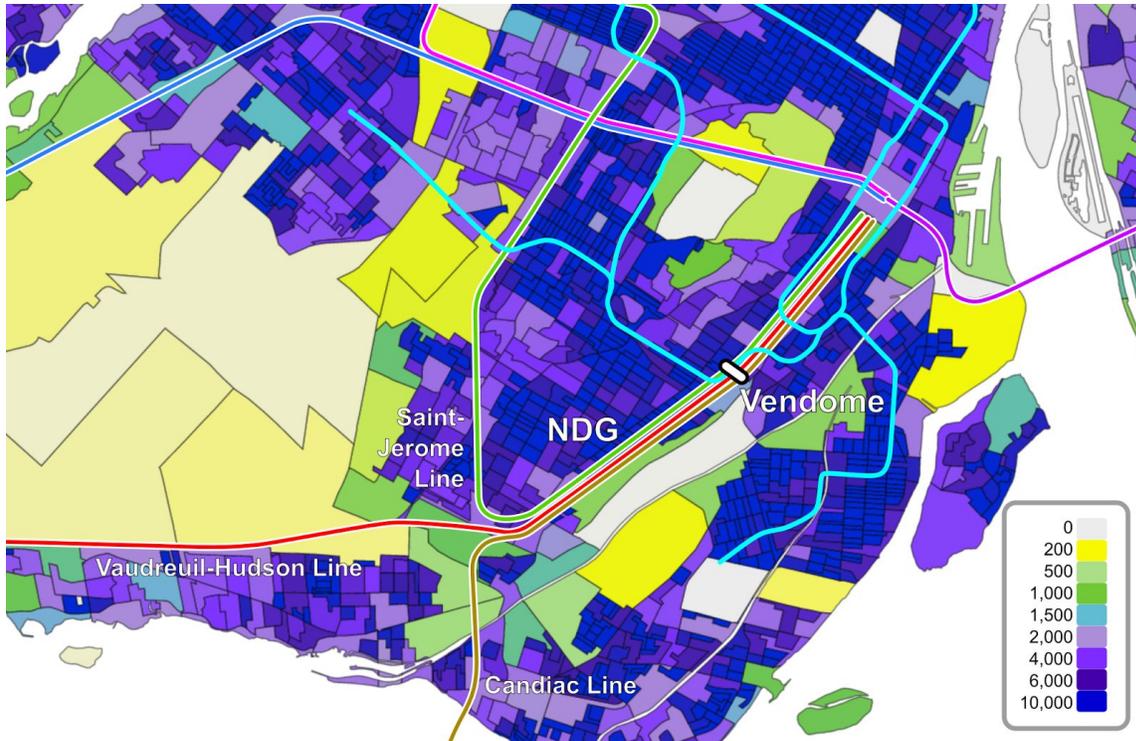
For many travellers, relatively small changes in effort and travel time can change overall mode choice.

2.2. Context B - The Importance of the Vendome as a Transfer

The Potential of the CP division of the AMT

Vendome is an important transfer point between the Orange line of the STM and the Saint-Jerome, Vaudreuil-Hudson and Candiac lines of the AMT commuter rail network. These lines form the CP division of the commuter rail network. The Vendome station itself is situated along the "Westmount Division" of the CP rail network.

While the three lines using the CP division see 33,700 passengers per day [4], the infrastructure is underutilized. This is largely because of limited number of trains, more expensive fares compared to the STM, and lack of stations in NDG (between Montreal-Ouest and Vendome). The area in NDG that the CP line passes through is one of the most densest area of Montreal that is not already served by rapid transit. The 105 bus line connecting Montreal-Ouest and Vendome has a ridership of about 15,000 trips per day alone (half of the AMT lines of the CP division).



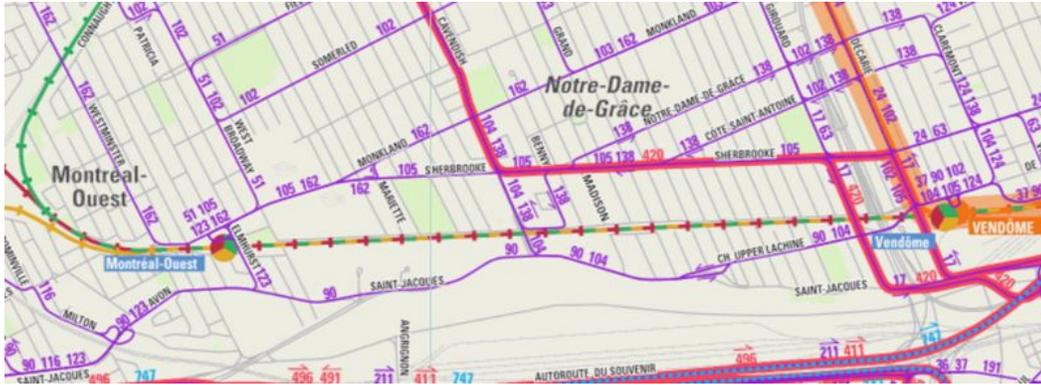
*Population density near the transit network centered around Vendome station (source: 2011 census).
The area in NDG is one of the densest areas of Montreal not already served by rapid transit.*

There have been calls and proposals to better utilize the CP division. This includes improved service along the Vaudreuil-Hudson line, adding stations and rapid-transit-like service through NDG (a “metro surface”), adding stations along the Saint-Jerome line around Cote-St-Luc, and a “tram-train” to Lachine.



The Lachine Tram-Train proposal envisioned using the CP Westmount Division to connect Lachine and downtown - with a stop at Vendome [6]

It is conceivable, just by consolidating the various nearby bus lines in Lachine and NDG onto the rail line, and with induced demand of a rail access, that the ridership along the Westmount division could potentially be tripled.



Various bus lines parallel to NDG-YUL line corridor, (STM map, 2012)

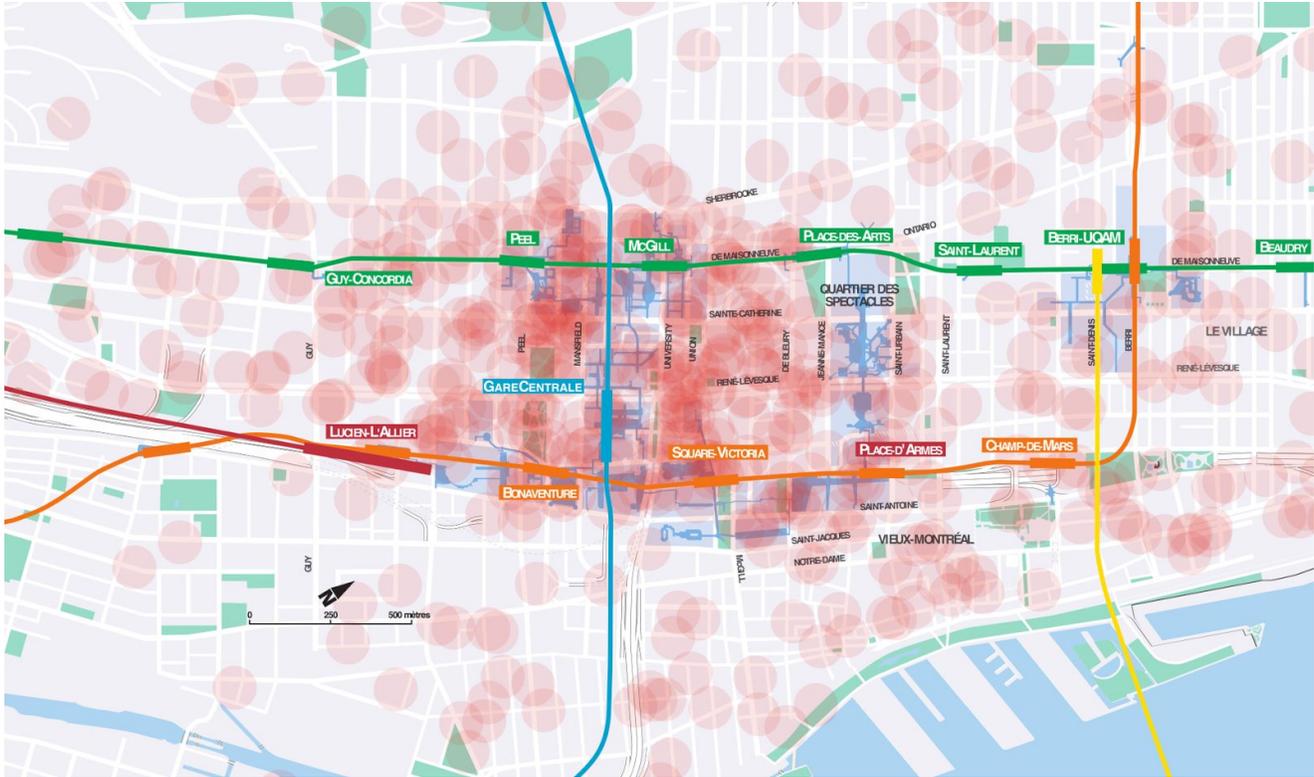
Bus Line	2011 Ridership
90	10,842
104	2,293
105	14,723
420	1,269
109	2,395
162	3,196
747	2,693
sum	37,411

Ridership of parallel bus lines (extracted from Opus card trip data), 2011

The Vendome Access project will result in infrastructure that will be utilized for many decades, so the potential of the AMT infrastructure should definitely taken into account.

The Issue of the CP division of the AMT: Downtown Access

While the AMT Westmount division has a lot of potential in terms of connecting to outlying residential areas, it has one major issue: the quality of the downtown connection. The terminal station, Lucien l’Allier (built when access to Gare Windsor was cut off by the construction of the Bell Centre) is located downtown, but the walking distance to many work places is rather long. Work places in Eastern downtown are not reasonably reachable by walking -- commuters will use the metro to reach them.



Lucien l'Allier (red, centre-left), compared to the places of work in downtown. Every red circle represents 500 workplaces (source: 2006 census).

Note that Lucien l'Allier also has a connection to the metro, but this transfer is rather long, because of the distance between the metro and AMT station locations, and the great depth of the metro station.

The result can be seen in the ridership numbers of the AMT [4]. While the Deux-Montagnes and Mont-St Hilaire lines have almost of all of their ridership going to Gare Centrale, along the Westmount division ridership is split between Lucien l'Allier and Vendome. This is despite the transfer at Vendome being not very optimized right now. (Note: the effect is less pronounced for the Saint-Jerome line, which provides the more convenient transfer to the Orange line at de la Concorde).

	Vaudreuil-Hudson	Candiac	St-Jerome
Vendome 2015 ridership	1,347,800	527,600	161,000
Lucien l'Allier 2015 ridership	1,853,100	504,000	514,500

Ridership comparison Vendome vs Gare Centrale [4]

In conclusion, the connection between the AMT CP division and the metro is extremely important for the AMT network. Since Lucien l'Allier will most likely always have a worse transfer than Vendome (largely due to large depth of the station), the Vendome station is the most important transfer between the AMT CP division.

3. Critique of the Presented Design

3.1. The Transfer Walk Distance, involving too many steps

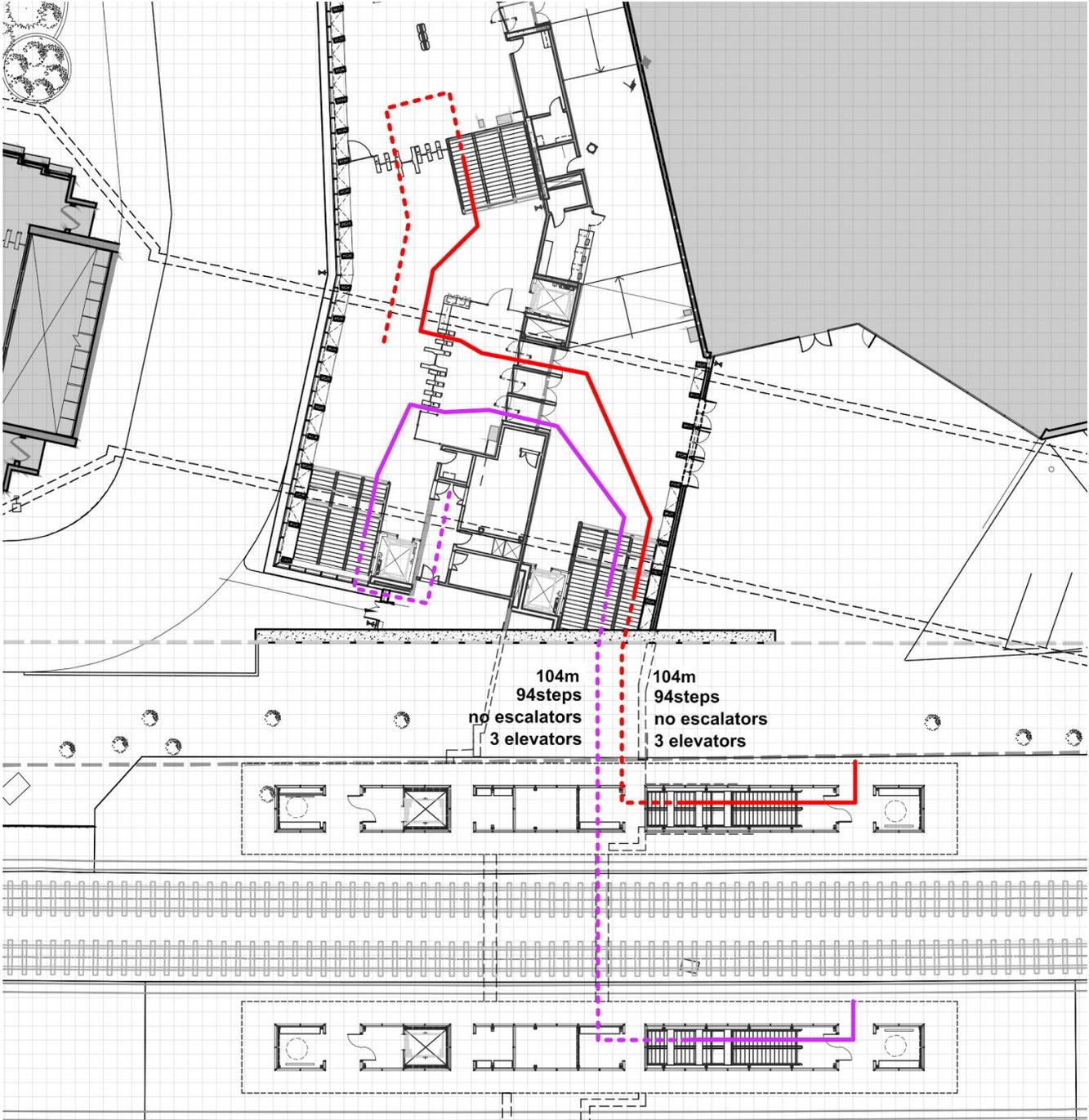
The Vendome Project is in various Media, including this Consultation, always presented with this image:



Presumably it shows a modern, airy station building, one that passengers would enjoy. While very pretty and impressive, this image is unfortunate, because it does not represent the user experience of most travellers -- most travellers in this project will want to transfer between the AMT and STM trains.

People who transfer between buses and the train or metro will continue to use the existing concourse and edicule. And the number of residents who will use this entrance to access the metro (mostly residents living east of Vendome, as well as people requiring the use of the elevator) is smaller than the number of potential transferees between the AMT and the STM.

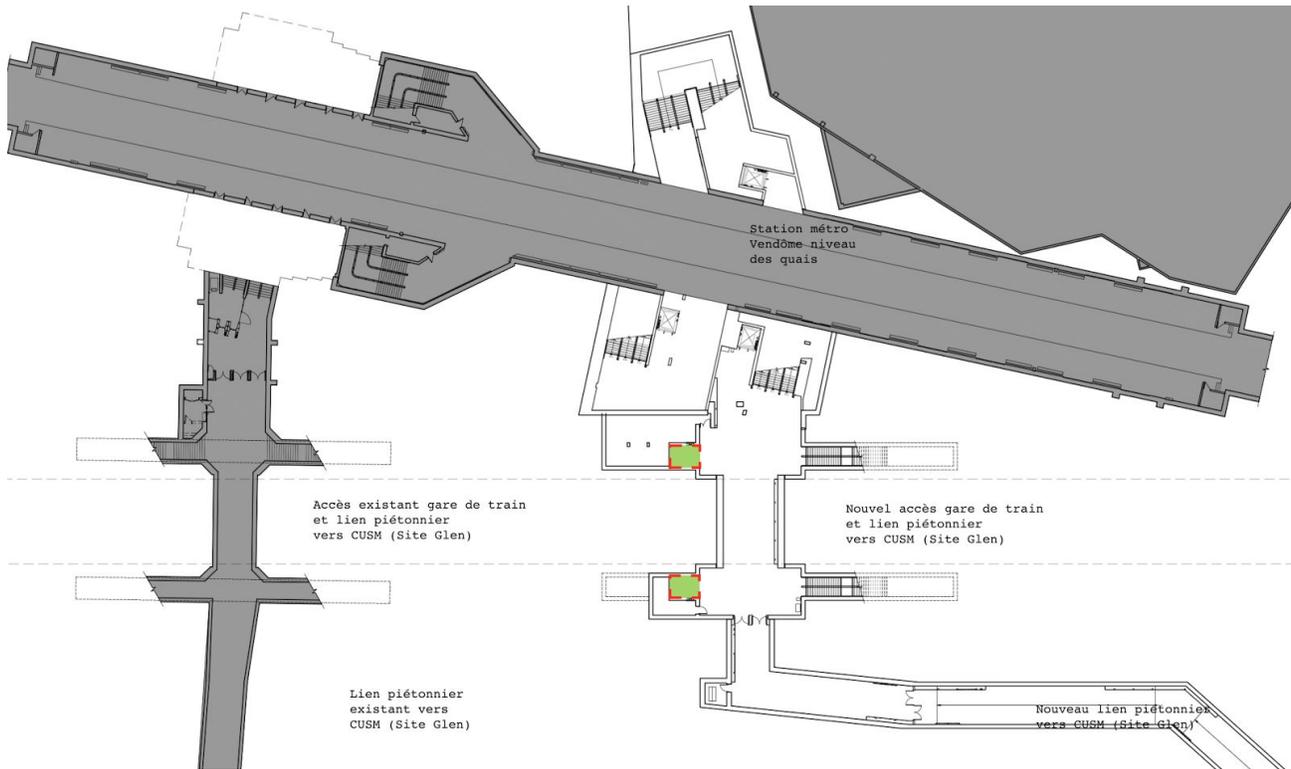
I would propose an alternative view of the project, one which is concerned more with the functional aspect, the transfer between AMT and STM (I'm mostly concerned with the transfers that are in the same geographical direction):



AMT-STM transfer: long, many steps, no escalators

For comparison, the very long transfer at Berri-UQAM between the Green line and the Yellow line is about 120m.

Also for comparison, the existing concourse at Vendome as a transfer length of 88m/105m. The total number of steps is around ~60 steps.

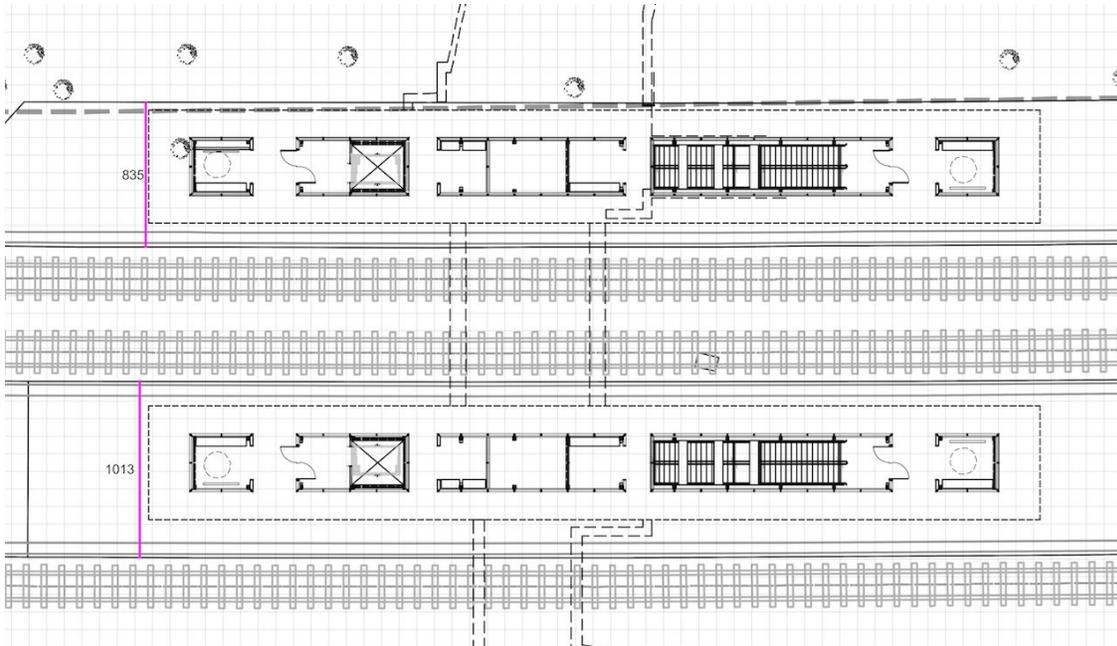


Existing vs proposed transfer concourses at Vendome Station

The existing transfers are shorter because they don't turn onto themselves. They have fewer steps both because the metro mezzanine is lower, and because the train concourse is higher. On the other hand, the existing transfer is far on the West of both the train and metro station, which is not ideal.

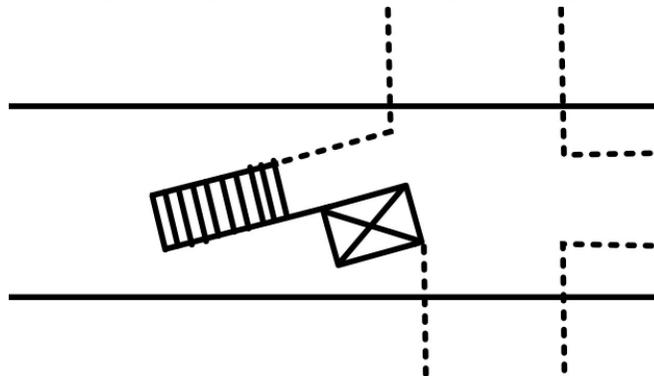
The plans for the new concourse effectively squander the opportunity given by the smaller physical separation between train and metro station, and the better position along the platforms, by providing a transfer-walk which is worse.

A related issue is that for the new AMT connection, the stairs only go up East from the tunnel. It would be preferable for stairs to go both East and West from the tunnel, just like the old concourse. This would decrease the required along-platform walk.



Proposed plan: stairs only are on the Eastern side of the tunnel. There should be One set of stairs on the Western side.

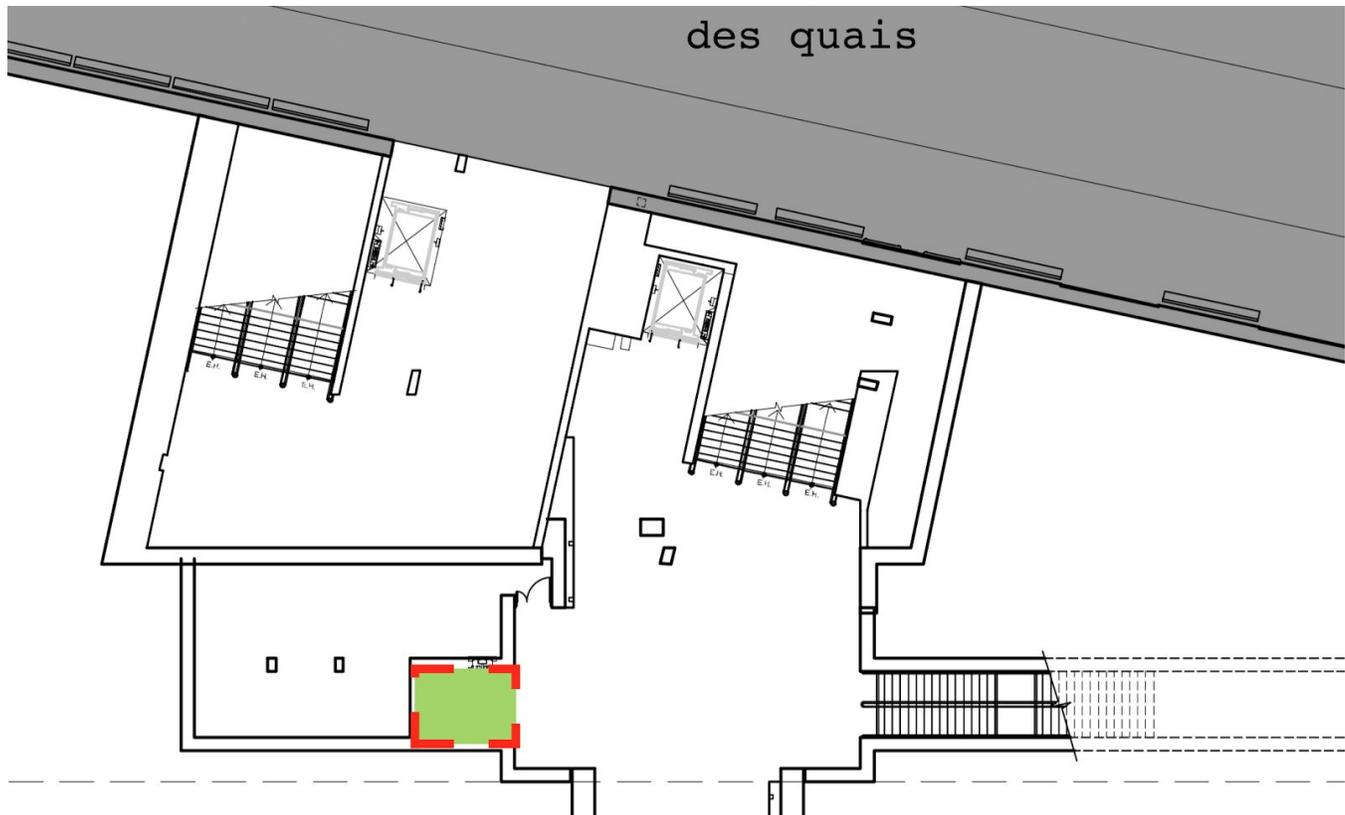
From the plans provided (which were given without scale), we can infer the platform width to be 8.35m and 10.13m, which should be sufficient for one set of stairs and an elevator side-by-side. Additionally, the stairs and elevators can be slightly angled relative to the platform, providing more space:



Aside: More even-distance access points along the platform encourage passengers to spread along the trains, rather than concentrate inside the trains at the few access points where the walking time is minimized upon arrival. Since the AMT trains are very long (10-car trains are 260m long), it is important to encourage good distribution of passengers inside trains -- if passengers concentrate, most will experience the crowded conditions, and it will cause longer dwell times, making travel times longer.

3.2. Lack of connection between Southern Metro Platform and AMT Concourse

From the documentation provided, it appears that the Southern metro platform and the AMT tunnel are on the same level. Since there is no connection, passengers have to walk up 31 stairs, walk through the doors connecting the AMT and the STM areas, and walk down 31 stairs to end up only one wall away from where they started.



STM Southern Platform area (left), AMT tunnel area (right). Note identical stair patterns.

At the consultation session on February 21, Matthew MacLauchlin asked why there is no connection between those areas. The answer was that there is a difference in level, and we were promised that the volumetric plans would be provided that would show that. The plans provided do not answer that question. They do, however, seem to indicate that the level is the same, given that the stairs in the AMT and STM areas appear identical.

The lack of a door at this point adds significantly to the transfer burden, both for abled bodied users (number of stairs and walking distance) and for people who need to use elevators (it would be possible to use 1 elevator instead of 3 to transfer).

3.3. Lack of Escalators

There is no single escalator in the design, as far as we know. In the consultations, we were informed that there is not enough vertical space, no further explanations were given. We already established that there are a lot of steps required to make this transfer (more than for the existing concourse), about three times the total vertical separation. In this context, having elevators would make a lot of sense.

A related concern is that the lack of elevators, combined with the large number of stairs, will encourage more people to take the elevators. That is, people who require escalators or elevators will be forced to take elevators. This may result in over-burdening the elevators. Note at the consultations Maha Clour said there are "standard" elevators, as if it was impossible to have different requirements based on the context in which they exist.

3.4. Too Many Elevators

Passengers who cannot walk the 94 steps (62 up) will have to take elevators (given that there are no escalators). In order to make the transfer between the STM and the AMT, they are required to take 3 elevators. Not only is that inconvenient and slow, it also increases the probability that the transfer is not possible at all. Essentially, the probability that a passenger can not make the transfer is triple the probability that any one elevator is out of service.

Also, note that *five elevators* are required in total, even though two of them connect the same physical areas: there are two elevators that connect the metro mezzanine and the AMT tunnel concourse, one within the STM paid area, and one outside it (this is assuming the Eastbound STM platform and the AMT tunnel are on the same level).

Ideally, there should be a ramp between the residential area north of the Vendome station and the MUHC hospital, so that the connection exists at all times, even when elevators break down.

4. Requests for Improvement

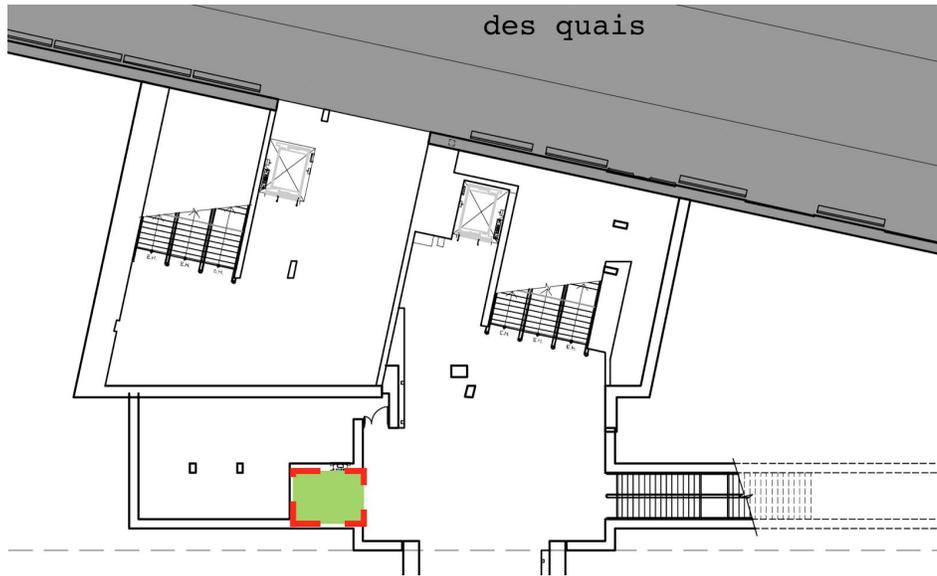
I request that the design for the Vendome Access project be rethought, in order to improve the following aspects:

- Minimize total walking distance between STM and AMT platforms, In particular:
 - create a connection between the Southern STM metro platform and the AMT tunnel concourse
 - Addition of stairs going up West from the AMT tunnel to the AMT platforms
- Minimize total number of stairs between STM and AMT platforms
- Addition of Escalators along the transfer between STM and AMT
- Study optimizing the layout and add ramps so that the connection between Vendome and the MUHC can be done without elevators

5. Suggestions for Improvement

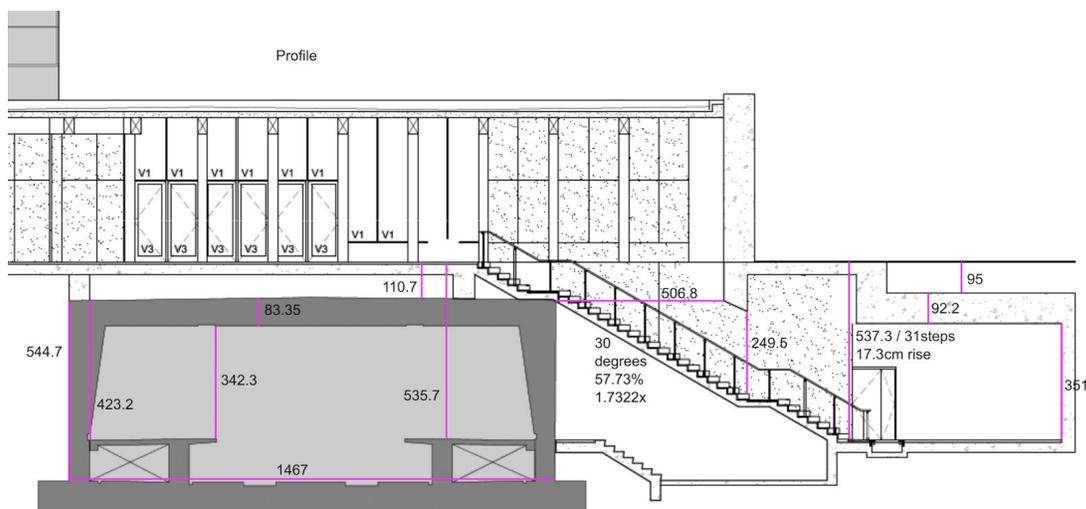
5.1. Connection Between Southern STM platform and AMT tunnel

This suggestion relates to making a connection between the STM Southern platform (Eastbound) and the AMT tunnel area.



Current Plan of the Underground Level, showing STM area (left) & AMT tunnel (right)

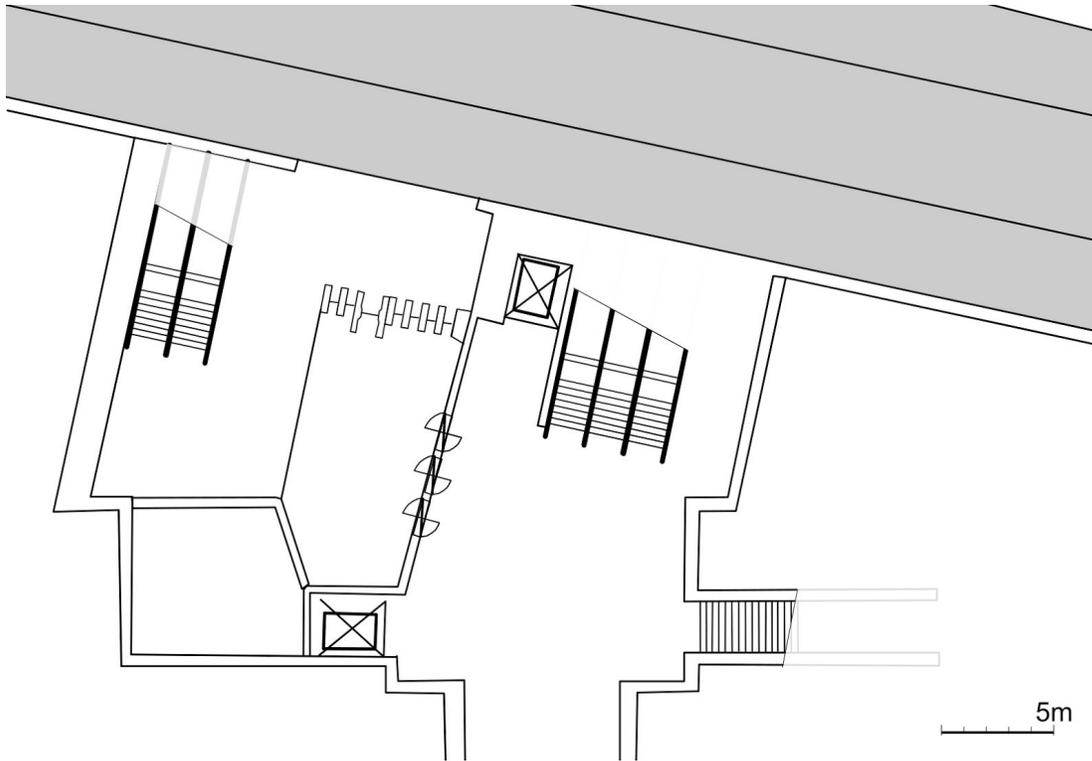
From the provided plans these appear to be at the same level. Even if they are not at the same level, it is possible to raise or lower the AMT tunnel level to match the STM level. This should be easily attainable, as there is 5.36m height difference between the STM platform level and the ground level (at which AMT trains should be), plenty of space for the tunnel and the necessary construction to hold the tracks above it. If this is not possible, refer to section 5.3 for a design allowing different levels.



Profile view, with annotated distance measurements

5.1.1. Connecting areas while maintaining separate Concourses

Assuming the STM and the AMT tunnels are on the same level, we can create a connection between them as follows:



Proposal 1.1 (underground level)

Note the following:

- The various design elements (doors, stairs, turnstiles) are merely copied from other plans, at the correct scale.
- The overall physical envelope is taken from the current design, no exterior wall was moved (although some space of the utility room in the bottom left corner was turned into a public area).
- The three sets of stairs on the left was reduced to two, because most passengers will use the shown turnstiles, and can alternatively use the other shown stairs.
- The elevator inside the paid area was removed, thus this design only has 4 elevators overall. This elevator is redundant, removing it maintains all the same accessible paths (while removing the requirement to take 3 elevators for any transfer involving the Eastbound Metro platform).
- The areas that are not shown are largely unaffected, and can use the current plan.

5.1.4. Proposing a Shared Concourse

The reason we still need turning doors between the AMT and the STM areas in the above drawing is that the STM has its own air-circulation, which is sealed relative to the outside air. The result is that this station essentially needs two concourses: a sealed one with a paid fare area for the STM and one for the AMT, which uses POP and different ventilation.

In effect, the planners of the Vendome Access Project beautifully created a large amount of space by taking it from the bus loop and the adjacent building. They then filled the space with all sorts of infrastructure, dividing it and making the space cramped and hard to use. It also means the AMT area does not benefit from the fenestration.

But it is possible to use a single shared concourse. This means the the shared concourse is a non-paid area, and the turn-stiles would be placed just before the platform (as we have done in the above design).

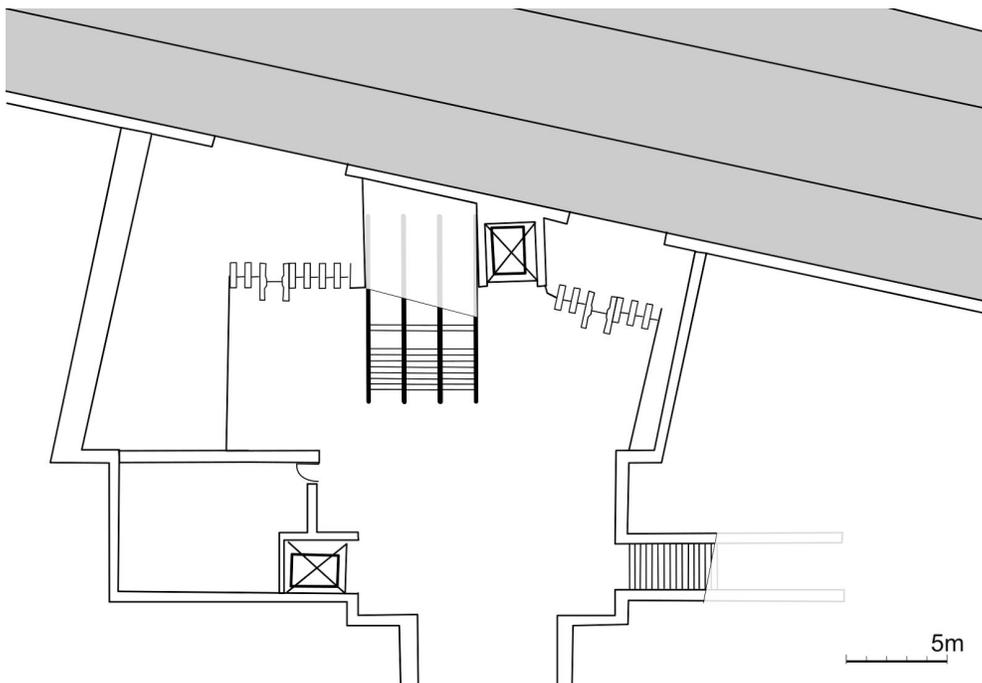
This design pattern is used in the Bonaventure Metro station, where the large concourse area through the metro station is used to connect various landmarks (bus Terminus Centre Ville, Gare Centrale, Place Bonaventure, Gare Windsor), and the turnstiles are between the concourse and the stairs.

There's also precedent to leave a "metro-air" concourse open to the public after metro hours, which is true at the Concordia station. This will have to happen here as well, in order to maintain the MUHC access to the residential areas at all times.



*Current plan vs current plan removing all the walls inside the proposed edicule.
Imagine all the space and light opened up by using a shared concourse! (1m grid)*

A single shared concourse can allow an even better connection between STM and AMT:

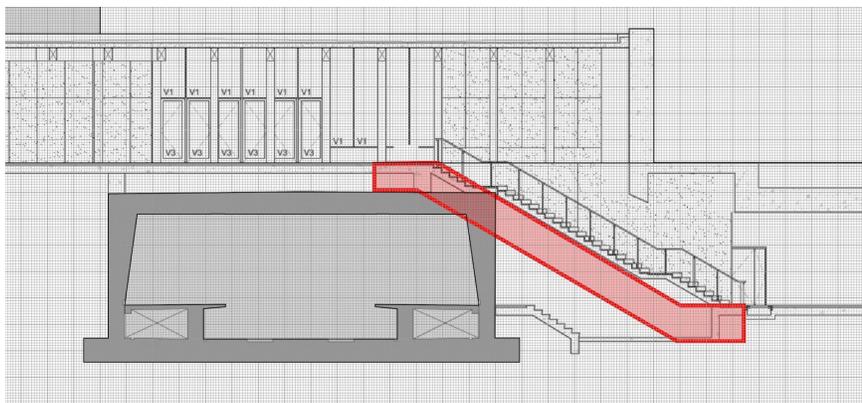


Proposal 1.2 (underground level)

Note that there are now two connections between the metro platform and the AMT tunnel, reducing walking distance from platform from tunnel for people descending the metro on the West. Again it will also encourage better distribution of passengers inside the metro trains.

5.2. Addition of Escalators

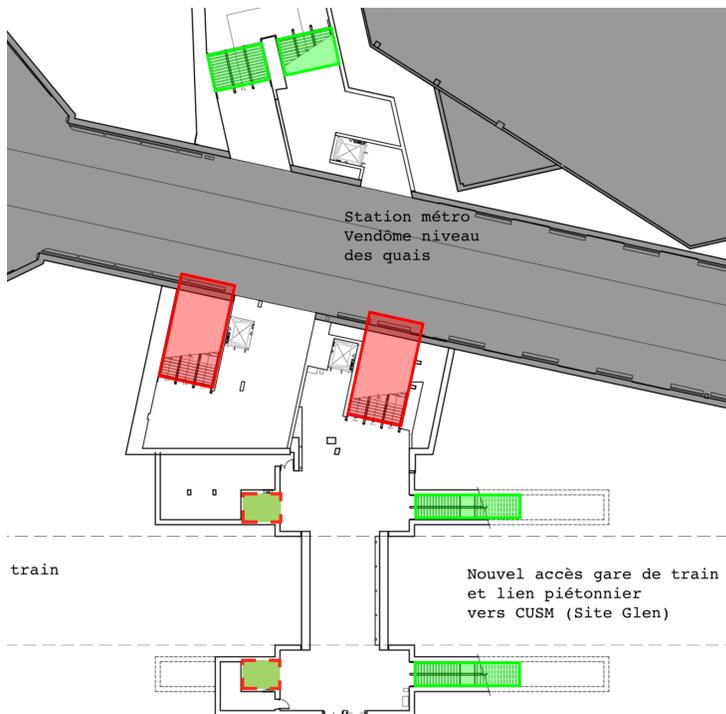
At the consultations it was claimed that there is simply not enough space to insert escalators, due to lack of “vertical space”. Indeed, if one looks at the profile, and considers the clearance requirements for elevators (about 2m at the top and bottom, about 1m down from the stairs [7]), it’s easy to see that the stairs from the level above the current metro tunnel down to the AMT tunnel/Southern STM platform will go inside the envelope of the tunnel:



Profile of current plans, with elevator envelope superimposed, showing conflict

One thing to wonder is whether it's possible to cut a "slice" of 2m width away from the tunnel, but this is likely not be possible because of statics.

However, this problem only affects the stairs shown in the following diagram in red. All the other stairs have no such clearance issues:

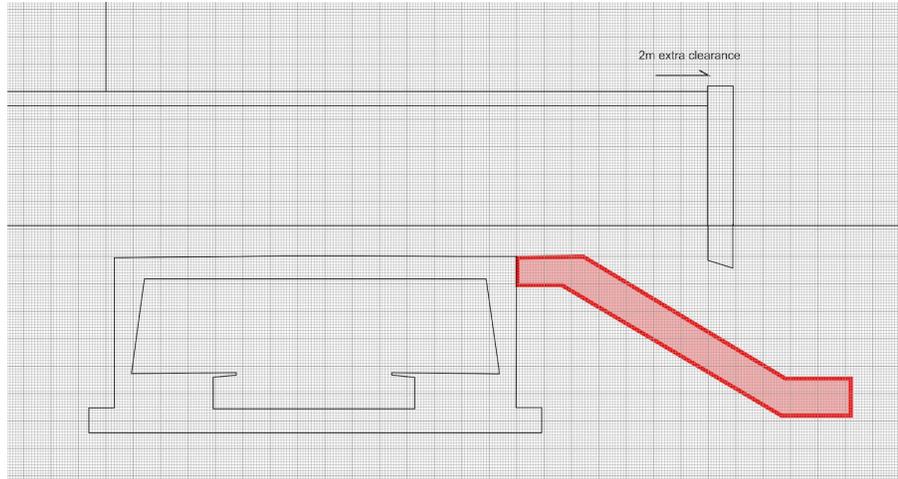


*Stairs with clearance issues shown in red,
stairs that should not have clearance issues shown in green*

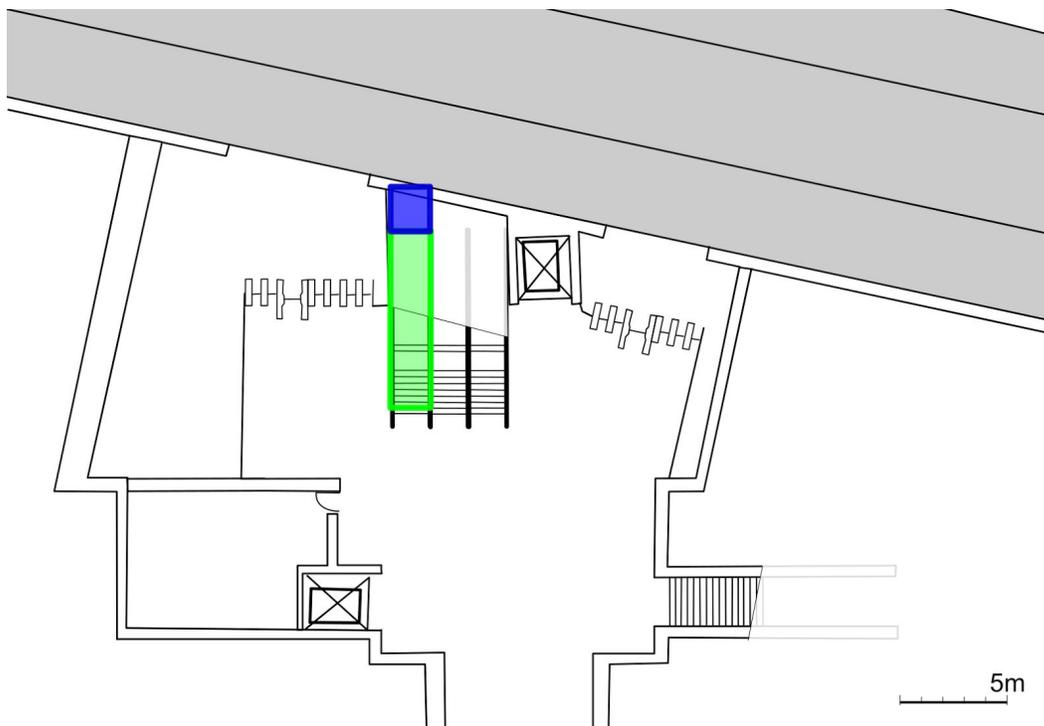
In order to resolve these, could do the following:

- Move the STM mezzanine level 1m down, so that it will be straight on top of the existing metro tunnel. This has the positive side effect as to reduce the total number of stairs to make a transfer from the North side by a total of 12 steps (6 up, 6 down).
- Refer to the Proposal 1.2, which moves the various stairs left. This provides more vertical clearance (since the "crash wall" and the Vendome metro station are at an angle relative to one another).

In combination, this should allow adding an escalator for the crucial tunnel/mezzanine connection.



Profile assuming the mezzanine is moved down to metro level, with escalator clearance shown. Note the 2m extra horizontal clearance to the crash-wall, by moving the stairs several meters West.



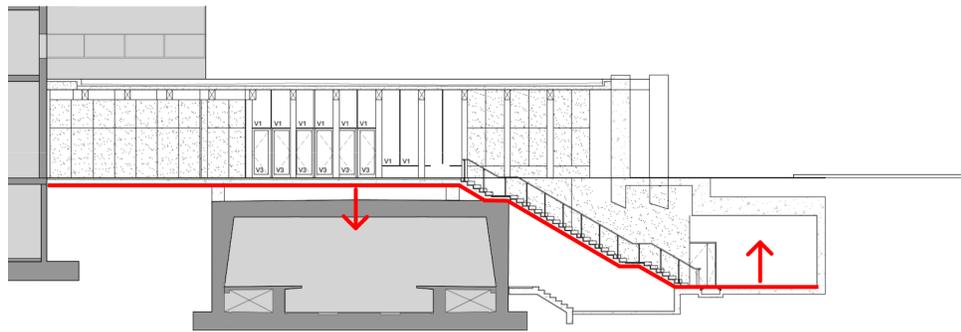
Proposal 2. Location of single upward escalator, with enough 2m clearance (shown in blue) between the Metro tunnel and the escalator

Overall, this alteration should allow adding escalators to all stairs.

5.3. Maximize Tunnel Level, minimize Mezzanine Level

The design so far has reduced the length of the transfer between the Southern metro platform and the AMT concourse from more than 100m to about 35m. To make an impact in the other direction, i.e. the transfer between the Northern (Westbound) metro platform and the AMT trains, one thing one has to attempt to do is to remove the total number of stairs.

Optimizing this transfer is essentially an exercise in raising the AMT tunnel up, and lowering the mezzanine above the metro tunnel down.



Profile view of Optimizing the Vendome Station transfers

As the the two shown levels move towards each other,

- the total number of stairs required for transfers from the Northern metro platform to the AMT goes down (at twice the rate of of moving the levels),
- The constraints due to the small horizontal space between the metro tunnel and the crash-wall will reduce,
- Long flights of stairs will be turned into several shorter flights of stairs, which require less effort,
- It may become feasible to have a ramp between the two shown levels, allowing an elevator-less access between the MUHC and the residential area to the North of Vendome,

Ideally, the two levels should be the same, or have a small difference that can be bridged with a ramp. This does not appear possible without cutting into the existing metro tunnel. Most likely this is not possible or at least not possible without large construction impacts.

Note that the current STM plans for the tunnel under the AMT station both has a lot of vertical clearance (for humans), and a lot of structural thickness. Indeed it is possible to have a tunnel clearance as little as 2.20m, and a bridge thickness as little as 1.1m. These values are extreme, but the low clearance would only occur below the tracks. This would require building the tunnel using a cut-and-cover technique, for example using pre-fabricated tunnel sections (in order to still maintain the required 72 hour construction window).

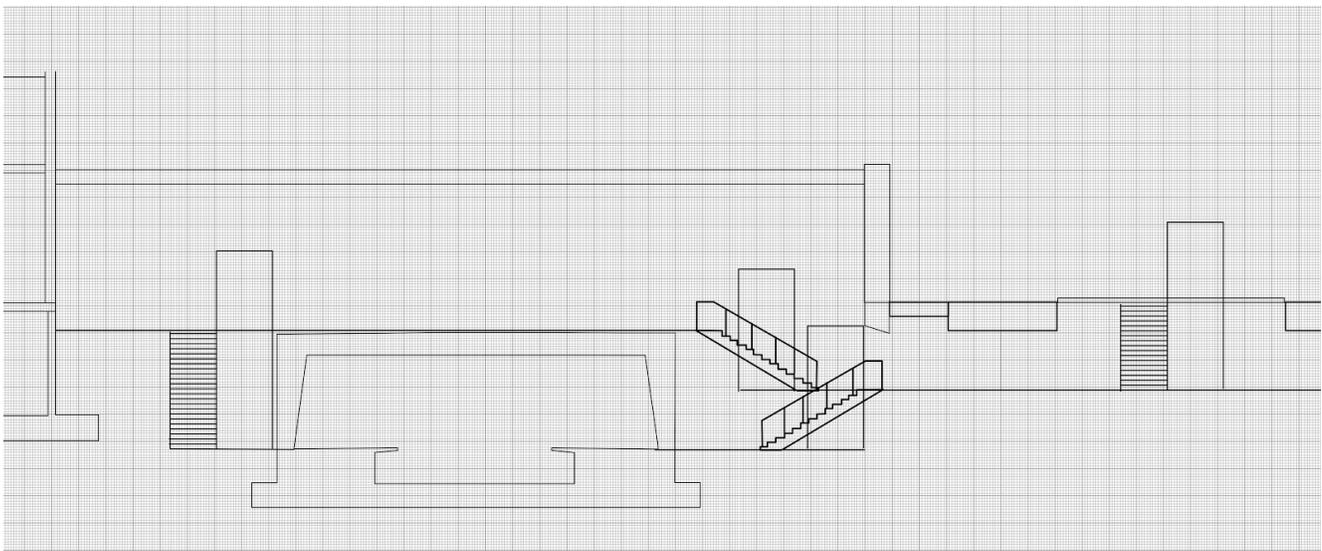


Example Brkln Bridge–City Hall/Chambers Street, NYC. The clearance is 2.15m, measured by author

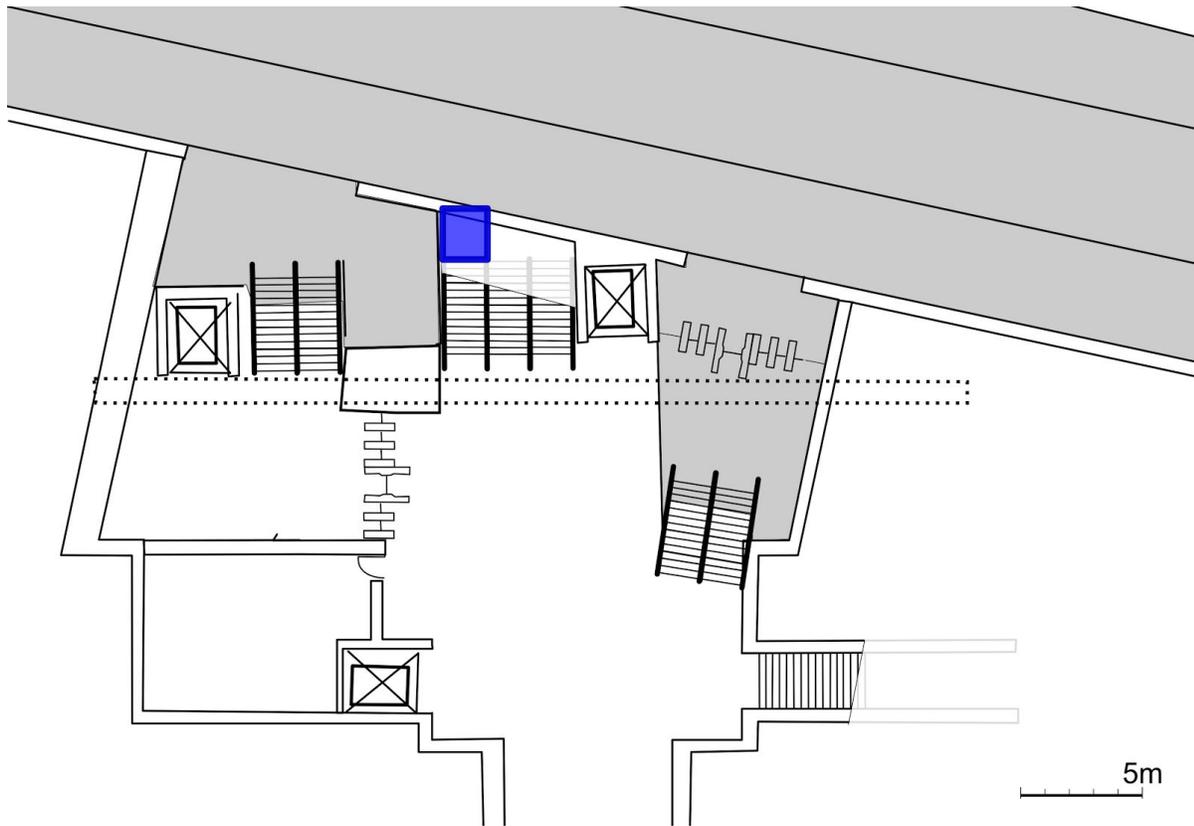


CN Bridge over Christoph-Colomb in Montreal. Length of span: ~12.3m

This “optimization” may result in a design like this:



Proposal 3, profile view. The height is meant to be to scale (using 1m grid), the horizontal features are approximate. The boxes represent elevators.



Proposal 3. (underground level). The darker area represent areas that are At the STM level. The white areas represent areas that are at the AMT level. The blue area represents the vertical clearance required for an escalator. The dotted bar is the crash wall.

The above design is an “extreme”, which split the ~4.40m distance between metro platform-level and the ground-level into two equal, 2.20m split-levels. Since the stairs are all relatively unconstrained, this design should allow any height-difference between the AMT and the STM level between 2.20m all the way down to 0m, in which case this would be equivalent to Proposal 2.

Note that we are using five elevators again. If the height difference between the AMT and STM level was small (up to ~100cm), then it would be possible to use a large L-shaped ramp along the wall on the left, instead of an elevator.

Thus this design can deal with the case where the AMT and the STM level are not exactly at the same level, as was claimed during the consultations.

Overall, we have shown possible optimizations to the station layout that will improve transfer distance and effort, and could increase the utility of the Vendome station for a positive regional transit impact.

6. Sources

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[2] W. Daamen, P. H. L. Bovy & S. P. Hoogendoorn. "Choices between stairs, escalators and ramps in stations". June 2006.

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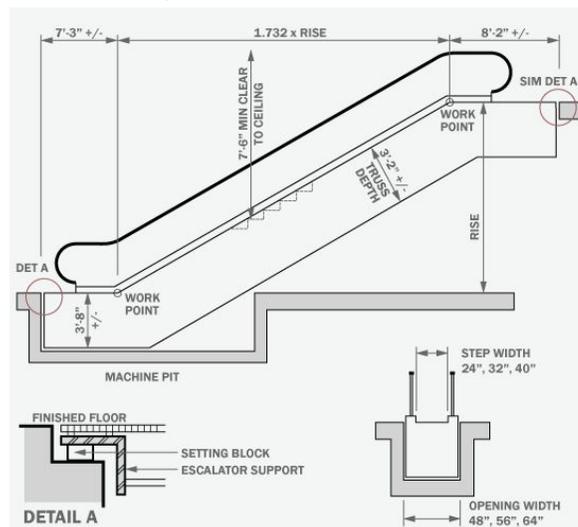
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[6] Pabeco Inc. "Projet pilote de tram- train reliant Lachine et le centre-ville de Montréal"

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[7] archtoolbox.com. "Escalator Design and Dimensions".

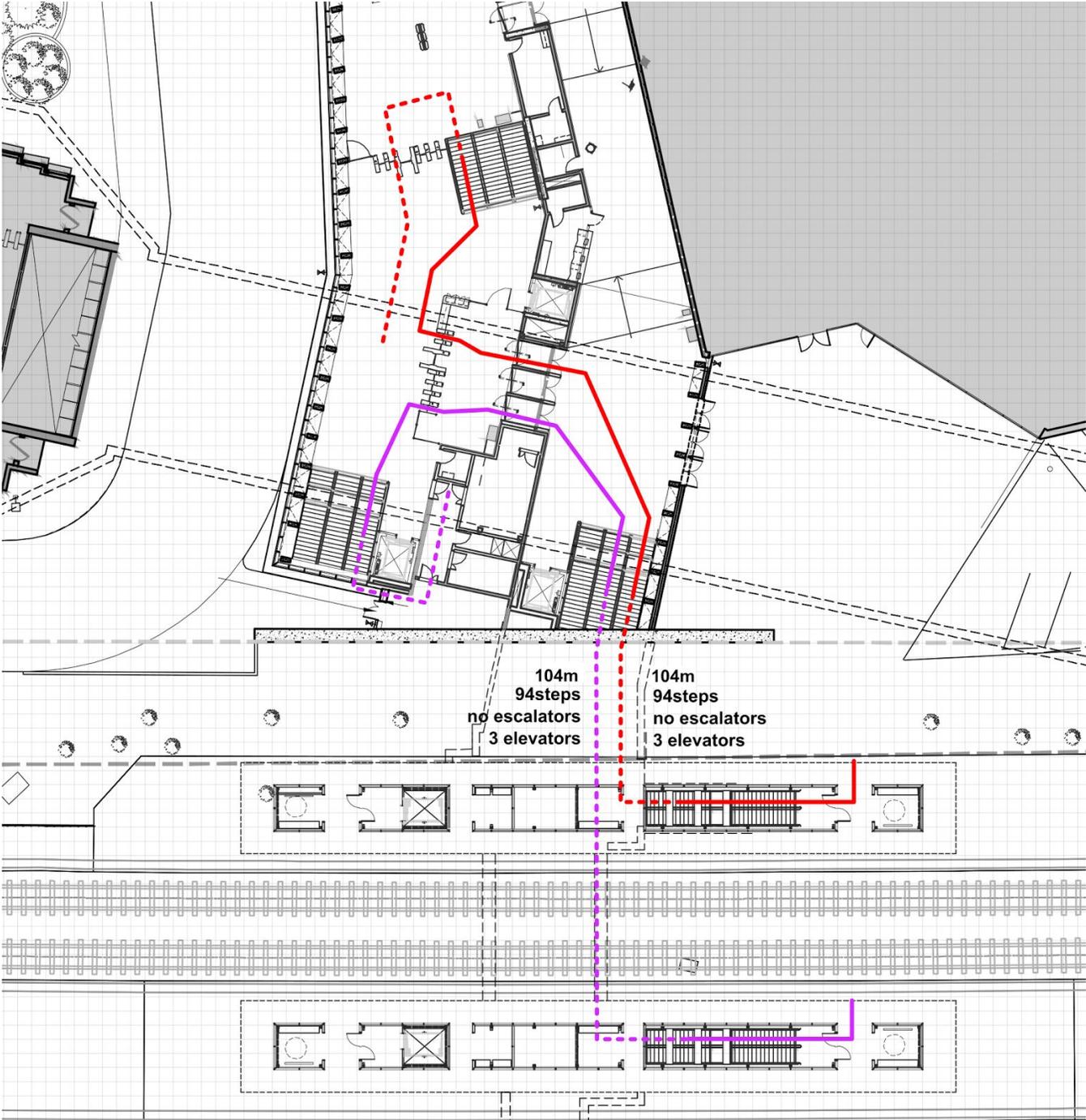
<https://www.archtoolbox.com/materials-systems/vertical-circulation/escalators.html>

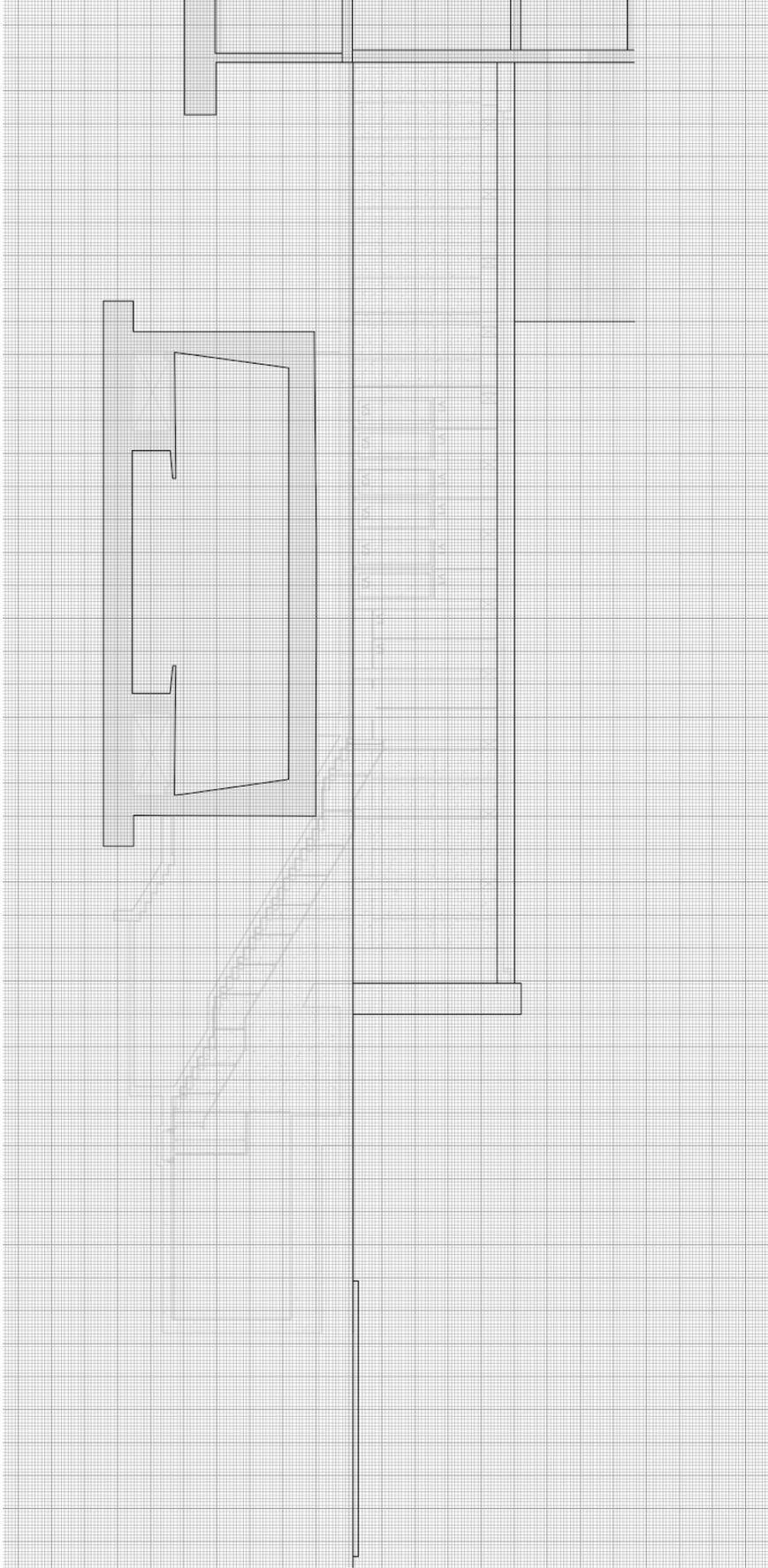


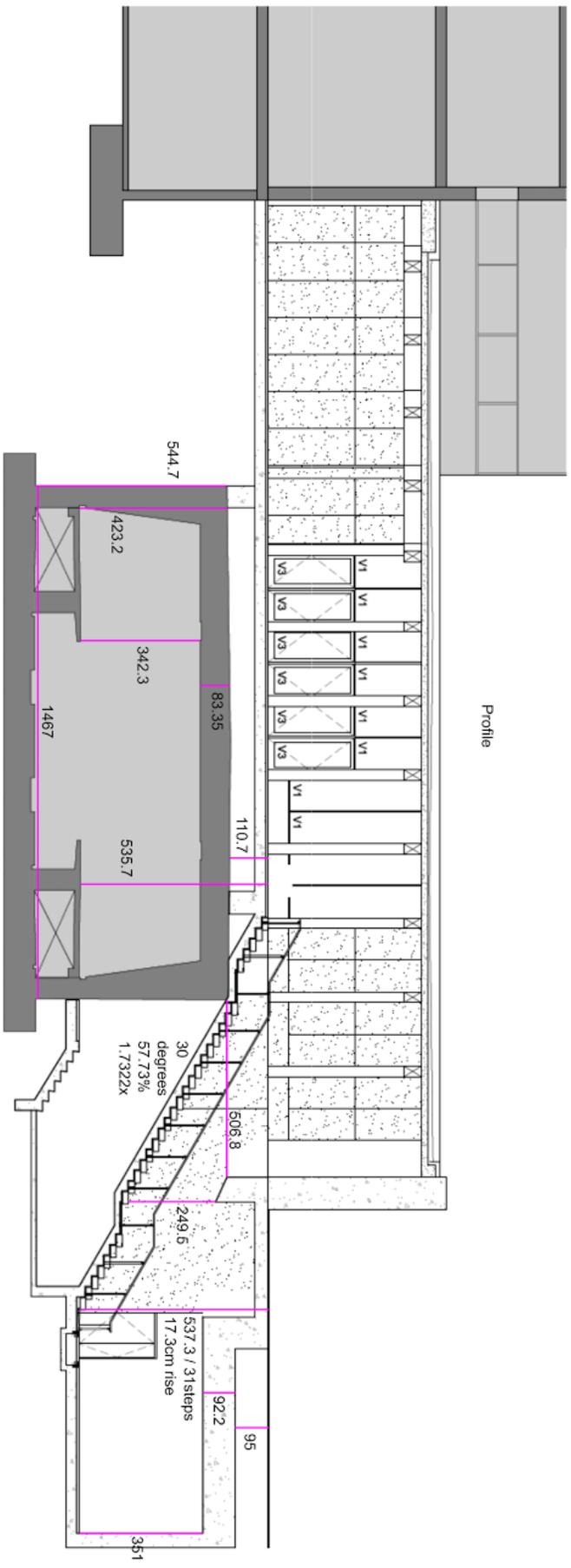
7'3"=221cm, 8'2"=249cm, 1.7323 rise factor = 30 degrees

7. Annotated Plans

A collection of the plans provided as part of the consultations, with grids or distance measurements added, or features removed. These are added here to help understand the project as currently proposed by the STM, and to sketch ideas.







Profile

544.7

423.2

83.35

342.3

1467

535.7

110.7

506.8

249.6

30
degrees
57.73%
1.7322x

537.3 / 31 steps
17.3cm rise

92.2

95

351

