



PORT of
vancouver

AECOM

Vancouver Fraser Port Authority

Centerm Expansion Project Alternative Siting Report

Prepared by:

AECOM

3292 Production Way, Floor 4
Burnaby, BC, Canada V5A 4R4

www.aecom.com

604 444 6400 tel
604 294 8597 fax

October, 2016

Project Number: 60476505

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by AECOM represent AECOM's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since AECOM has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, AECOM, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by AECOM and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

AECOM accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of AECOM to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2015-04-13
© 2009-2015 AECOM Canada Ltd. All Rights Reserved.

Signatures

Report Prepared By:



Neil Snowball, P.Eng.
Design Manager

Report Reviewed By:



Ron Byrne, P.Eng.

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Revision History

Revision #	Date	Revised By:	Revision Description
0	2016-10-28	NS	Issue for Use

Table of Contents

	page
1. Introduction	1
2. Background	1
3. Methodology	2
4. Constraints	2
5. Alternatives Appraisal.....	4
5.1 Container Ship Berths	4
5.1.1 Alternatives Considered	4
5.1.2 Comparison	5
5.1.3 Conclusion.....	6
5.2 Intermodal Yard.....	7
5.2.1 Alternatives Considered	7
5.2.2 Comparison	8
5.2.3 Conclusion.....	9
5.3 Container Yard	10
5.3.1 Alternatives Considered	10
5.3.2 Comparison	11
5.3.3 Conclusion.....	12
5.4 South Shore Access – Overpass	12
5.4.1 Alternatives Considered	12
5.4.2 Comparison	13
5.4.3 Conclusion.....	14
5.5 South Shore Access – Port Security Gates.....	15
5.5.1 Alternatives Considered	15
5.5.2 Comparison	15
5.5.3 Conclusion.....	15
6. Assessment Summary	16
7. Assessment Conclusion.....	16

List of Figures

Figure 1: Berth Alternatives	5
Figure 2: Intermodal Yard Alternatives.....	8
Figure 3: Container Yard Alternatives.....	10
Figure 4: Overpass Alternatives	13

1. Introduction

The Vancouver Fraser Port Authority (port authority) is proposing to expand the Centerm container terminal and improve transportation connections on the south shore of the Port of Vancouver's inner harbour to increase goods movement through the Port of Vancouver.

This Alternative Siting Report discusses the proposed terminal expansion, comparing key aspects of the Proposed Design to other alternatives considered during the initial planning phase, and outlines the anticipated impacts, issues and rationale for the development of the Proposed Design compared to presented alternatives.

2. Background

The Centerm Container Terminal (Centerm) on the south shore of Vancouver's inner harbour is one of three primary container terminals in the Vancouver area and handles approximately one-fifth of the container goods shipped through Vancouver. DP World Vancouver (DPWV) operates the terminal on federal lands and waters which is leased from the port authority.

Trade of containerized goods shipped through Canada's west coast is increasing; In 2015, container terminals on the west coast of Canada (including Vancouver and Prince Rupert) handled more than 3.8 million twenty-foot equivalent units (TEU), with nearly 3.1 million TEUs handled by container terminals in the Port of Vancouver. The Port of Vancouver's container terminals (Vanterm, Deltaport, Fraser Surrey Docks, and Centerm) are currently able to handle an estimated 3.9 million TEUs per year.

Independent forecasts completed for the Vancouver Fraser Port Authority (port authority) by international experts in transportation and trade indicate that container traffic through the west coast of Canada will increase by approximately 3.5 million TEUs by 2035. This growth is driven primarily by the growing demand between Canada and Asian markets for imported products such as clothing, food, electronics and manufacturing inputs, such as car parts, and exports of Canadian products such as pulp, paper, lumber and specialty grains.

The Container Capacity Improvement Program is the port authority's long-term strategy to provide container terminal capacity to meet future needs for Canadian trade.

The port authority is mandated to ensure that terminal capacity is available to meet Canada's trade needs. The Container Capacity Improvement Program was established in 2010 to examine three opportunities:

- Improvements at existing terminals to increase their capacity and efficiency
- Conversion of other existing terminals to handle containers
- Building a new terminal

As a result of the decision to close the Ballantyne Cruise Terminal at the east end of Centerm and consolidate cruise operations at Canada Place, there is an opportunity to expand Centerm to meet the near-term demand for increased container handling capacity.

The Centerm Expansion Project (CEP) is a series of proposed improvements to the Centerm Container Terminal. The proposed infrastructure improvements will increase the number of containers that can be handled at Centerm by approximately two-thirds, from a current maximum annual capacity of 900,000 TEUs to 1.5 million TEUs. During peak operations, the number of containers that can be handled at the terminal will increase from an annual sustainable capacity of 750,000 TEUs to 1.3 million TEUs. To increase the container capacity of the terminal by 67 per cent, the proposed terminal improvements include an expansion of the terminal footprint by 15 per cent and reconfiguration of the terminal.

The proposed off-terminal works, collectively referred to as the South Shore Access Project (SSAP), includes a new Centennial Road Overpass, and an extension to Waterfront Road. The proposed off-terminal works complete the port authority's long-term objective of providing a contiguous port road along the entire south shore port area to increase efficiency and access. The proposed work addresses road congestion issues for port users by effectively eliminating three at-grade rail crossings for Centerm container trucks and other port vehicles.

The CEP objectives are to deliver a project which:

- Increases the overall terminal capacity;
- Maximises the potential of the existing terminal through optimising operations;
- Minimises additional land requirements as a result of proposed expansion plans;
- Increases terminal operations efficiency by reducing unnecessary transportation movements.

These guiding principles were considered throughout the assessment of potential alternatives.

3. Methodology

This alternative siting appraisal summarizes the decision-making process undertaken by the Centerm Expansion Project team during the initial planning phase in developing the Proposed Design. It compares key components of the project and assesses each alternative against a series of assessment criteria pertinent to that component. From this assessment, the key findings are summarized.

Increasing the capacity and efficiency of existing container terminals like Centerm will ensure timely delivery of required marine and land-based infrastructure to meet the predicted growth in the container sector. Sustainable capacity is when the terminal is operating efficiently at high throughput and under ideal operating conditions. Maximum capacity is when the terminal achieves maximum throughput, however it stretches the effectiveness of operations and equipment and is generally only achieved for short periods of time. Terminal operating volumes vary widely depending on the goods moving through the terminal. Larger terminals attract larger ships, which in turn exchange larger volumes of containers.

The Project has been developed using the proposed sustainable annual capacity (considered to be 85% of maximum annual capacity), as this represents the peak operating conditions. The current sustainable container capacity at Centerm is approximately 750,000 TEU/year (maximum capacity 900,000 TEU/year) and its 646 metre (m) berth can accommodate two small- or medium-sized vessels simultaneously (i.e., two vessels of up to 6,000 TEU or a single vessel of 9,000 to 14,000 TEU with limited access to cargo in some sections of the vessel when positioned on the western berth). The proposed Project would increase Centerm's container capacity by approximately two-thirds to a sustainable capacity of 1.3 million TEU/year (maximum capacity of 1.5 million TEU/year) and continue to accommodate larger vessels of up to 14,000 TEU (with full access to vessel cargo while at the western berth).

4. Constraints

The south shore port lands are made up of a complex mix of industrial terminals and transportation networks which support them. These impose constraints on any expansion considerations and the potential impacts or restrictions that they pose are factored into the design process. These constraints are briefly outlined below.

Canada Place

Canada Place is home to the Vancouver Cruise ship terminal, with three berths for vessels. The cruise operations are mainly active from April to September each year. The manoeuvring of cruise ships is a key constraint to any development adjacent to this location.

Sea Bus

Translink's SeaBus operation has its southern terminus within the embayment between Canada Place and Centerm. Ferry services operate seven days per week, running at 15 to 30 minute intervals. The passage of ferries through the channel into the embayment is a key constraint.

HeliJet and Vancouver Harbour Heliport

The Vancouver Harbour Heliport is located to the south east of the terminal. Its primary operator is HeliJet, which operates a scheduled service to Victoria. The Final Approach and Take Off (FATO) route is over the embayment and channel between Centerm and Canada Place.

CRAB Park at Portside

Since it opened in 1987, this small urban park and beach situated to the south west of Centerm has been an important community green space in Vancouver's downtown eastside and waterfront. The City of Vancouver's Board of Parks and Recreation leases the park from the port authority on a long-term basis. It has a view scape which stretches from Canada Place to Centerm (and to the north shore mountains beyond).

Canadian Fishing Company (Canfisco)

The Canfisco facility, on Waterfront Road, includes docks for fishing vessels on its northern side, with a large building to house fish processing operations occupying the majority of the site.

CP Rail Corridor

A long-established rail corridor which serves the south shore port lands and connects to the downtown area, this corridor comprises three railway tracks, with additional sidings and train yards along its length. During peak weekday hours, the West Coast Express operates within the corridor, while freight operations occur throughout the day and night.

Ballantyne Pier

This Pier, built in the 1920's, forms the eastern limit of the existing Centerm facility. Initially operating as break bulk and pulp dock, it was renovated in the 1990's to create a cruise ship terminal (which ultimately closed in 2014). The remaining section of the 1920's warehouse which is still on the site has been designated as a heritage structure by the City of Vancouver.

Mission to Seafarers

This structure, built in 1905/6 has housed the Flying Angel Club, part of the Mission to Seafarers charitable organization which offers help and support to the welfare of merchant seaman, since 1973. The building is on the City of Vancouver heritage register due to its cultural and social significance and its history as the office and sales centre for the Hastings Mill, and Harbour Commissioners Office.

Burrard Slip

The Burrard Slip has been used for numerous industrial activities throughout its long lifespan, and is currently owned by Southern Railway of BC (SRY). SRY has a joint agreement with the port authority with regards to operations within the water lot between Ballantyne Pier and the Burrard Slip.

Port Maintenance

The port authority has a maintenance facility located between the Burrard Slip and Rogers Sugar building.

Rogers Sugar

This is a private property that houses a sugar processing plant. It is accessed from Rogers St. The site has Heritage status with the City of Vancouver, particularly the southern warehouse structure which is one of the oldest elements of the site.

Alliance Grain Terminal

This Grain terminal is situated north of Stewart St. and east of Rogers St. It includes a rail connection which crosses Stewart St as well as a tail track which crosses Rogers St. and runs along the Rogers Sugar building frontage.

Vanterm Container Terminal

Located north of Stewart St, between Clark Drive and Commercial Drive, Vanterm is an established container terminal. The terminal entrance is located off Stewart St. west of the Clark Drive Overpass. The terminal has an intermodal yard on the west side of the terminal with the connecting track crossing Stewart St.

Metro Vancouver Harbour Pump Station

This pump station is located immediately west of the Clark Drive Overpass, adjacent to the Truck Entrance to Vanterm. It has sewer interceptors connected to it from the west and east, including the Vernon Drive Relief sewer which is greater than 2m square.

Clark Drive Overpass

This existing overpass connects the port lands to City of Vancouver Streets, primarily via the Clark Drive /Knight St corridor.

5. Alternatives Appraisal

Container terminals comprise three primary components, and the overall capacity is based on the lowest capacity of any one component. These three components are:

- Container Ship Berths – the location where containers are moved to/from container ships across the wharf;
- Container Yard – the storage of containers between transportation modes;
- Transportation / Intermodal Yard – the movement of containers to/from manufacturers, producers, and consumers via land-based transportation modes (rail and trucks).

Development of any one component must be balanced by the other components, otherwise its capacity potential may not be realised. In short, productivity across the berth cannot be maintained if there is insufficient space to store containers within the yard. Similarly, container yard capacity cannot be realised if there is limited capacity to move containers out of the terminal to final destinations, thus clearing space within the yard for additional containers.

The various terminal expansion opportunities are discussed below. This includes the proposed Centerm Expansion Project (identified as the “base design”).

5.1 Container Ship Berths

Centerm has a limited two-berth wharf for handling container ships, that can accommodate up to two medium sized (less than 275m) vessels at the same time. These existing container ship berths have capacity which exceeds the terminal’s overall capacity. However, as other components of the terminal are upgraded, this capacity will become the limiting factor, and in order to remain in balance with improvements elsewhere in the terminal, berth capacity will need to be increased, in part to accommodate larger vessels. The western berth was extended in 2012 through the addition of a mooring dolphin, which allowed mooring of larger vessels. However, the berth configuration with the dolphin does not allow the quay cranes direct access to containers stacked near the stern of the vessel, limiting the efficiency of the western berth.

5.1.1 Alternatives Considered

Each of the alternatives considered for increasing berth capacity are outlined below.

5.1.1.1 Westward extension of wharf structure to the Mooring Dolphin (Proposed Design)

Increase the length of the existing wharf face from 646m to 724m by extending the wharf structure westward to the location of the existing mooring dolphin. The extension would accommodate a large container ship (New-Panamax size) and a small to medium container ship (Panamax / Post-Panamax size) simultaneously. Vessels would berth in the same positions as today with minimal change to mooring arrangements. Access to the stern of vessels by quay cranes can be achieved.

5.1.1.2 More extensive westward extension

Increase the length of the existing wharf face from 646m to 825m by extending the wharf structure westward beyond the existing mooring dolphin. This would accommodate two large container ships (New-Panamax class) at berth simultaneously. Vessels would be moored in a different arrangement, with vessels positioned further westward.

5.1.1.3 New north berth

Construct a new container ship berth on the north yard, with a new wharf constructed immediately north of the existing terminal wharf face to minimise capacity reduction within the container yard. This new berth would accommodate a single large container ship (New-Panamax class) with the existing berths combined to accommodate a single large container ship.



Figure 1: Berth Alternatives

5.1.2 Comparison

	West Extension to wharf structure to the Mooring Dolphin (Proposed Design)	More extensive westward extension	New north berth
Length / Size	78m extension (to 724m) – enough the reach containers on the stern of a vessel in the western berth.	179m extension (to 825m).	New 400m berth.
Layout Issues	Slightly more capacity than container yard or intermodal yard.	Creates a large operating berth.	Needs to be constructed north of existing berth to avoid restriction of capacity gains by impacting container yard.
Equipment	2 additional quay cranes to replace 2 existing cranes - remains at 7 cranes (based on new crane to be added in Jan 2017 by DP World Vancouver).	3 additional quay cranes to replace 2 existing cranes – increases to 8 cranes (based on new crane to be added in Jan 2017 by DP World Vancouver).	Up to 5 additional quay cranes for new berth.

	West Extension to wharf structure to the Mooring Dolphin (Proposed Design)	More extensive westward extension	New north berth
Construction	Two caissons added to west end of existing berth. Mooring dolphin removed.	Up to five additional caissons. Mooring dolphin removed.	Approximately 11 new caissons constructed north of the existing terminal, or a pile and deck structure.
Container Capacity	Increased to approx. 1.48M TEU (sustainable).	Increased to approx. 1.69M TEU (sustainable).	Increased to approx. 2.14M TEU (sustainable).
View Impacts	Some impacts to views from Crab park area. Similar to existing situation with vessel at berth.	Substantial impacts to views from Crab park area. Greater than existing situation with vessel at berth.	Limited view impacts from south shore. Already an industrial view.
Terminal Operational Considerations	Berth parallel to container and intermodal yards. Minimises transportation times for the movement of containers between berth, container yard and intermodal yard.	Berth parallel to container and intermodal yards. Minimises transportation times for the movement of containers between berth, container yard and intermodal yard.	Longer transportation times for movement of containers between berth, container yard and intermodal yard. Split operation may induce increases in terminal congestion.
Other User Impacts	Some impact to cruise ship activities at Canada Place east berth. Changes to cruise ship manoeuvring will be needed. Seabus operations may be slightly affected by channel narrowing.	Significant impact to cruise ship activities at Canada Place east berth. Likely to make berth unusable. Greatly impacts Seabus operations by restricting channel width.	Extension northward will increase manoeuvring difficulty into bight adjacent to Roger sugar. No impacts to cruise ships. No impacts to Seabus.
Environmental Impacts	Dredging and filling for marine foundations and land reclamation.	Dredging and filling for marine foundations and land reclamation.	Dredging and filling for marine foundations and land reclamation.
Available Land	Required land reclamation from Burrard Inlet (approx. 2.9ha of reclaimed land, with an estimated total impact to the seabed of 4.2ha).	Required reclamation from Burrard Inlet (approx. 5.0ha of reclaimed land, with an estimated total impact to the seabed of 6.5ha).	Required reclamation from Burrard Inlet (approx. 3.8ha of reclaimed land).
Cost Implications	Base Cost (includes replacing 2 cranes).	Additional costs for berth and marine reclamation. Extra cranes required to service full berth length. (total of 8 cranes needed). Estimated as 14% increase on base cost.	Significant additional costs to create new berth. New cranes required. Estimated as 30% increase on base cost.

5.1.3 Conclusion

While the container ship berth needs to be expanded to provide the desired container capacity, the increase does not need to be extensive to reach the 1.3M TEU target.

The more extensive western expansion of the wharf to accommodate two large vessels would provide greater capacity at the berth than could be accommodated by the rest of the terminal. Additionally, expanding extensively westward also has substantial impacts to the operations of both cruise ship and SeaBus. This expansion would narrow the channel into the embayment, reducing the ability for vessels to pass through safely, or in the case of cruise ships, make it extremely difficult to safely manoeuvre into the east berth of Canada Place.

Similarly, the introduction of a new berth at the northern section of the terminal would provide much more capacity that could be accommodated by the terminal's container yard and intermodal yard capacities. Additionally a new container ship berth in this location would be much more costly than a short extension to the existing berths.

Therefore extending the existing berth only far enough to create a berth length that can fully service a vessel at berth and provide the desired container capacity is recommended.

5.2 Intermodal Yard

Expanding the intermodal yard is critical to the success of the proposed Centerm Expansion Project. With more containers leaving the terminal each year, the increase in capacity within the intermodal yard enables an increase in the overall terminal capacity. Without increasing the intermodal yard capacity, the intermodal yard becomes a limiting factor within the terminal, increasing the volume of containers transferred by truck to local facilities for loading onto trains.

With unit-train lengths at 3650m (12,000ft), the intermodal yard needs to be sized to accommodate quarter trains on a single track within the yard. Each of these tracks would be 914m in length (3,000ft). This enables the target peak (sustainable) capacity of 1.3M TEUs to be achieved.

5.2.1 Alternatives Considered

Each of the alternatives considered for the changes to the Intermodal yard are outlined below.

5.2.1.1 Balanced Expansion (Proposed Design)

Expand the intermodal yard to both the east and the west, with approximately 150m (500ft) of track each way. Add a fifth track on the south side of the intermodal yard to gain capacity increase. Matches the expansion needed for the container berth.

5.2.1.2 Westward Expansion

Retain the Intermodal yard track connections at the east of the yard and focus expansion of the intermodal yard westward by 260m (850ft), maximising track length. Add a fifth track on the south side of the intermodal yard to gain capacity increase. Extends beyond the proposed western berth expansion; better matched to the longer berth alternative.

5.2.1.3 Eastward Expansion

Concentrate all the track expansion, adding 300m (1,000ft) to the east, crossing SRY property. Connect intermodal yard to CP rail corridor at Rogers Sugar. Add a fifth track on the south side of the intermodal yard to gain capacity increase.



Figure 2: Intermodal Yard Alternatives

5.2.2 Comparison

	Balanced Expansion (Proposed Design)	West Expansion	Eastward Expansion
Length / Size	300m (1,000ft) extension overall, split equally to 150m (500ft) east and west. Add a fifth track on the south side of the intermodal yard.	Extend westwards by 260m (850ft) to create 870m (2850ft) yard. Add a fifth track on the south side of the intermodal yard.	Extend eastwards by 300m (1,000ft) to create 914m (3,000ft) yard. Add a fifth track on the south side of the intermodal yard.
Layout Issues	No issues as extended rail yard connects to existing networks.	No issues as extended rail yard connects to existing networks.	Expansion would fail to connect to rail network at key location, limiting future access to all rail networks.
Equipment	Add up to 5 new gantry cranes to support intermodal yard.	Add up to 5 new gantry cranes to support intermodal yard. Reduced track length may limit crane productivity.	Add up to 5 new gantry cranes to support intermodal yard.
Construction	Disruptive to terminal operations during construction.	Majority of construction on reclaimed land from the marine environment.	Disruptive to terminal operations during construction. Expected to be more disruptive than balanced expansion due to more construction across terminal entrance area.
Container Capacity	Meets 1.3M TEU capacity target.	Falls short of 1.3M TEU capacity target.	Meets 1.3M TEU capacity target.
View Impacts	Impacts viewscape from Crab Park. Stretches across approximately 30% of viewscape. Similar to existing situation where 30% of viewscape is impacted by vessels at berth.	Impacts viewscape from Crab Park. Stretches across approximately 65% of viewscape. Similar to existing situation where 30% of viewscape is impacted by vessels at berth.	Expansion contained within existing industrial lands. Minimal impacts.

	Balanced Expansion (Proposed Design)	West Expansion	Eastward Expansion
Terminal Operational Considerations	Balanced position with respect to primary container storage and berths.	Position of intermodal yard is not fully balanced with regard to primary container storage and berths, leading to longer truck trips to and from the intermodal yard.	Position of intermodal yard is not fully balanced with regard to primary container storage and berths, leading to longer truck trips to and from the intermodal yard.
Other User impacts	Some marine reclamation. Channel impacts are possible to mitigate with different operating plans. Maintains connections to all adjacent rail networks.	With large reclamation and narrowing of channel into embayment, there are significant impacts to cruise ship operations, Seabus and other marine users. Maintains connections to all adjacent rail networks.	No impacts to marine users. Significant impacts to rail operators. Limited connections to adjacent rail networks – no connection to north-south railway connections.
Environmental Impacts	Impact to marine environment through land reclamation. Some restriction of channel into embayment.	Impact to marine environment through land reclamation. Greater restriction of channel into embayment.	No marine works. Severe impacts to Ballantyne Pier heritage building - would be removed to facilitate terminal layout adjustments.
Available Land	Required land reclamation from Burrard Inlet (approx. 2.9ha of reclaimed land, with an estimated total impact to the seabed of 4.2ha).	Required reclamation from Burrard Inlet (approx. 5.0ha of reclaimed land, with an estimated total impact to the seabed of 6.5ha).	No reclaimed land needed for Intermodal yard. Additional land likely required for associated container terminal. Adjacent property (Burrard Slip owned by SRY) not within port authority control. This limits opportunity to expand.
Cost Implications	Base Cost based on land reclamation of 2.9ha (4.2ha of impacted seabed).	Increased cost from additional land reclamation (estimated 6.5ha of impacted seabed).	Potential cost reduction related to land reclamation for intermodal yard. Lessened by cost increases anticipated due to potential terminal layout impacts (admin building relocation, additional land needed for associated container yard).

5.2.3 Conclusion

Expanding only to west introduces considerable impacts including limitations on cruise ship operations, greater marine infilling, and a larger impact to established view corridors. Additionally, it is unlikely to deliver the necessary rail track length within the expanded intermodal yard, limiting the capacity to the intermodal yard to less than the target sustainable capacity of 1.3 million TEU.

Eastward focused expansion limits the marine and view scape impacts at the western side of the terminal, however this limits the ability to connect to all adjacent rail networks, as well as resulting in the removal of the Ballantyne Pier heritage structure as a result. Finally, the location of existing properties, such as the Burrard Slip (owned by SRY), prevent sufficient eastward expansion such that it would remove the need for some westward expansion.

Based on these two considerations, the balanced approach takes advantage of possible expansion eastward and introduces the remaining intermodal yard length through limited westward expansion. This expanded intermodal yard is matched to the proposed expansion of the berth, squaring the end of the terminal in line with the existing mooring dolphin. This balanced approach also retains the Ballantyne Pier heritage structure.

5.3 Container Yard

The container yard acts as the middle ground for both the berth and intermodal yard operations. It stores the containers between the changes in transportation modes. As a result, its capacity needs to be matched to both the container berth and the intermodal yard.

5.3.1 Alternatives Considered

All alternatives for changes to the container yard include the removal of the old shed and pier structure at Ballantyne Pier, introduction of infilling to replace the existing pier structure, and use of this space for terminal operations activities (vehicle and equipment storage). This creates space within the centre of the terminal to introduce some additional container storage.

Each of the alternatives considered for the changes to the container yard focus on providing the additional capacity needed to reach the target 1.3M TEU capacity, and are outlined below.

5.3.1.1 West expansion to square off at mooring dolphin (Proposed Design)

This expansion provides a significant additional container yard at the western end of the terminal positioned to service the berth and intermodal yard.

5.3.1.2 West Expansion to parallel Canada Place

A very large expansion which adds significant additional container yard capacity. The expansion is positioned to service the berth and intermodal yard.

5.3.1.3 Eastern Expansion

Creation of additional container yard through land reclamation from water lot between Ballantyne Pier and Burrard Slip.



Figure 3: Container Yard Alternatives

5.3.2 Comparison

	West Expansion to square off at Mooring Dolphin (Proposed Design)	West Expansion to parallel Canada Place	Eastern Expansion
Length / Size	Approx. 2.9ha of additional terminal area (estimated 4.2ha of impacted seabed).	Approx. 5.0ha of additional terminal area (Estimated 6.5ha of impacted seabed).	Approx. 3.8ha of additional terminal area (estimated 4ha of impacted seabed).
Layout Issues	Optimal layout for interaction with berth and intermodal yard.	Skewed layout relative to berth and intermodal yard not optimal.	Segregation of container operations is less optimal with increased vehicle trips to maintain operations.
Equipment	No additional rubber-tired gantries needed to operate expanded yard.	An additional rubber-tired gantry crane may be needed to operate expanded yard.	May require additional rubber-tired gantry cranes to service this section of the container yard.
Construction	Marine reclamation, including dredging of seabed.	Marine reclamation, including dredging of seabed.	Marine reclamation, including dredging of seabed.
Container Capacity	Provides approx. 200,000 TEU. (remaining capacity increased through yard optimisation).	Provides approx. 350,000 TEU. (remaining capacity increased through yard optimisation).	Provides approx. 260,000 TEU. (remaining capacity increased through yard optimisation) Not located in an optimal location compared to remaining container yard and intermodal yard.
View Impacts	Some impacts to views from Crab park area. Stretches across approximately 30% of viewscape. Similar to existing situation where 30% of viewscape is impacted by vessels at berth.	Impacts viewscape from Crab Park. Stretches across approximately 65% of viewscape. Similar to existing situation where 30% of viewscape is impacted by vessels at berth.	Limited view impacts from south shore. Already an industrial view.
Terminal Operational Considerations	Expansion in close proximity to key terminal operations: berth and intermodal yard operations.	Expansion in close proximity to key terminal operations: berth and intermodal yard operations. Increased vehicle trips to service intermodal yard.	Container yard expansion further from intermodal yard and berth increases trips on the terminal. Location also desirable for terminal gates and support services.
Other User impacts	Some impact to cruise ship activities at Canada Place east berth. Changes to cruise ship manoeuvring will be needed. Seabus operations may be slightly affected by channel narrowing.	Significant impact to cruise ship activities at Canada Place east berth. Likely to make berth unusable. Greatly impacts Seabus operations by restricting channel width.	Expansion eastward will increase manoeuvring difficulty into bight adjacent to Roger Sugar. No impacts to cruise ships. No impacts to Seabus.
Environmental Impacts	Dredging and filling for marine foundations and land reclamation.	Dredging and filling for marine foundations and land reclamation.	Dredging and filling for marine foundations and land reclamation.
Available Land	Required land reclamation from Burrard Inlet (approx. 2.9ha of reclaimed land, with an estimated total impact to the seabed of 4.2ha).	Required reclamation from Burrard Inlet (approx. 5.0ha of reclaimed land, with an estimated total impact to the seabed of 6.5ha).	Required reclamation from Burrard Inlet (3.8ha). Adjacent property (Burrard Slip owned by SRY) not within port authority control. This limits opportunity to expand.
Cost	Costs associated with marine dredging and filling for land reclamation.	Additional costs associated with greater marine reclamation. Potential additional rubber-tired gantry cranes.	Additional costs associated with greater marine reclamation works needed.

5.3.3 Conclusion

Container yard expansion needs to be matched to the expansion of the container berth and intermodal yard. The location of the container yard should be in the vicinity of the berth and intermodal yard to limit the travel distance for the movement of containers throughout the terminal.

With the preferred design including limited westward expansions of the container ship berth and the intermodal yard, establishing the container yard's westward expansion would be in line with the extent established by these elements. This keeps the berth, container yard and intermodal yard all closely positioned, reducing vehicle trips around the terminal to move containers.

Expanding westward only does not provide enough capacity on its own to meet the target capacity of 1.3M TEU. As a result some filling to the east would be needed. This would accommodate the repositioning of terminal operations facilities (Operations buildings, vehicle storage, entrance gates) eastward to maximise the space in the centre of the terminal for container storage.

5.4 South Shore Access – Overpass

With the removal of the Heatley Ave Overpass to facilitate expansion of the terminal Intermodal Yard, one of the existing grade-separated access points to the south shore port area would be removed. Grade-separated connectivity to the surrounding city, and its truck traffic network is needed to maintain access to the south shore for both port destined traffic and emergency vehicles.

5.4.1 Alternatives Considered

Each of the alternatives considered for an overpass in the vicinity of the terminal entrance to replace the connectivity provided by the existing Heatley Ave Overpass (removed for terminal expansion) are outlined below.

5.4.1.1 New Centennial Road Overpass (Proposed Design)

Construction of a new overpass to separate road and rail interactions between Clark Drive and the Centerm terminal entrance. This overpass would be positioned along the existing corridor to maintain connectivity with the rest of the south shore port area, including Vanterm and Columbia Containers.

5.4.1.2 New Waterfront Road Overpass

A new overpass spanning the expanded Centerm Intermodal yard rail connection, and linking an extended Waterfront Road to Centennial Road and the terminal entrance area. This would provide grade-separate connectivity to port lands via Main Street.

5.4.1.3 Reconstructed Heatley Ave Overpass

Realigns the Heatley Ave overpass by removing the northern spans and constructing a different overpass route on the northern side of the rail corridor. Spans over the Centerm Intermodal Yard expansion and connects to Centennial Road at the Centerm Terminal entrance.



Figure 4: Overpass Alternatives

5.4.2 Comparison

	Centennial Road Overpass (Proposed Design)	Waterfront Road Overpass (New Overpass)	Realignment of Heatley Ave Overpass
Length / Size	500m.	160m.	200m.
Construction	Constrained construction environment.	Mainly constructed outside of the roadway.	Mainly constructed outside of roadway. Reconstruction of structure will heavily impact rail operations.
Traffic Impacts	Provides grade separation of all vehicles using the port roadway at two busy rail crossings. Reduces blockages on port roadways used by truck traffic that access Centerm. These blockages can cause congestion on City streets.	Provides grade-separated exit from port lands via Main street. No improvement to traffic on port lands, particularly at existing road-rail crossings.	Would maintain existing grade-separated exit from port lands. No improvement to traffic on port lands, particularly at existing road-rail crossings.
Emergency Vehicles	Requires different access arrangements for emergency vehicles. Response times similar to existing arrangements.	Requires different access arrangements for emergency vehicles. Response times similar to existing arrangements.	No difference in emergency access and response times compared to existing conditions.
View Impacts	Partially obscures view to Rogers Sugar building.	Partially obscures view to Ballantyne Pier building.	Partially obscures view to Ballantyne Pier building.
Business interruption	Rogers Street traffic using port roadways will need to route via Clark/Stewart to access western terminals.	Impacts terminal footprint, particularly terminal gate operations during construction.	Impacts terminal footprint, particularly terminal gate operations during construction.

	Centennial Road Overpass (Proposed Design)	Waterfront Road Overpass (New Overpass)	Realignment of Heatley Ave Overpass
Port Operational Considerations	Improves container truck movements, reducing delays and improving journey times on port lands. Separates road/rail crossing issues.	No improvement to container truck movements. Delays due to rail still present.	No improvement to container truck movements. Delays due to rail still present.
Other User impacts	No disadvantages to emergency access compared to other alternatives.	No disadvantages to emergency access compared to other alternatives.	No disadvantages to emergency access compared to other alternatives.
Environmental Impacts	Emissions from idling trucks would be lower as a result fewer delays at rail crossing.	Potentially longer journey times for vehicles leaving port lands.	No significant improvements to current environment, particularly for emissions from vehicle idling.
Available Land	Along existing road corridor.	Impacts Centerm footprint.	Impacts Centerm footprint.
Cost	Highest cost due to longer structure compared to alternatives.	Lowest cost.	Increased cost compared to Waterfront Road due to longer structure.

5.4.3 Conclusion

With the removal of the northern end of Heatley Ave Overpass, grade-separated access to the south shore port area, primarily to the Centerm terminal entrance area, and connections to the east, will be removed. A replacement overpass needs to re-establish this grade-separated connectivity, while maximising the benefits to the traffic using the south shore.

Neither a Waterfront Road Overpass, or a realigned Heatley Ave Overpass improve journey times for truck traffic (the main vehicle type that makes up the traffic flow), as the rail crossings on Centennial Road and Stewart Street remain on the primary route to Centerm for truck traffic.

The introduction of the Centennial Road Overpass will improve traffic flow on the port roadway for vehicles accessing Centerm by separating road and rail interactions. This reduces delays to vehicles on port roadways as a result of rail blockages. It also reduces congestion on adjacent city streets which can occur when vehicles accessing port lands cannot enter due to blockages. These vehicles are often diverted to the Commissioner St entrance to the port lands, introducing additional truck trips on city streets.

Construction of the Centennial Road Overpass will be disruptive to traffic movements during the construction period, however, the resulting benefits from eliminating delays associated with rail crossings provides a major benefit to journey time reliability and the movement of goods.

With the benefits to truck traffic through the separation of road and rail movements, the Centennial Road Overpass is the preferred overpass arrangement.

5.5 South Shore Access – Port Security Gates

Most of the existing industrial facilities and terminal on the south shore of Burrard Inlet are within the current security perimeter. With the proposed extension of Waterfront Road within the south shore port area, forming a contiguous roadway through the south shore, a western security perimeter access point will be needed to maintain the perimeter..

5.5.1 Alternatives Considered

Each of the alternatives considered for the position of the port security gates are outlined below.

5.5.1.1 Under Main St Overpass (Proposed Design)

Located directly under the Main St Overpass on Waterfront Road, this would establish a new port security gate, and control equipment to secure port lands east of this location. This will include Main St Docks, Canfisco, and the southern entrance to Centerm.

5.5.1.2 Waterfront Road Extension (east of Dunlevy Ave)

Introduction of a new security gate on the proposed Waterfront Road extension. This would be located immediately east of Dunlevy Ave near to the Mission to Seafarers building. Establishes a new port security gate, and control equipment to secure port lands east of this location. This keeps Main Street Docks, Canfisco, and the southern entrance to Centerm outside of the security cordon.

5.5.2 Comparison

	Under Main St Overpass (Proposed Design)	Waterfront Road Extension (east of Dunlevy)
Location	At limit of port lands. Existing roadway.	East of Dunlevy Ave alignment in port lands.
Traffic Impacts	Sufficient road space to accommodate any queuing.	Sufficient road space to accommodate any queuing.
View Impacts	Limited impact as the alternative is positioned under an existing overpass, and with an industrial backdrop.	Potential impact to views to Mission to Seafarers building due to close proximity.
Port Operational Considerations	Secures port perimeter with existing port tenants within boundary.	Security perimeter within port lands with some existing port tenants not contained within boundary.
Other User impacts	No loss of access to CRAB Park at Portside.	No loss of access to CRAB Park at Portside.
Available Land	Contained within existing roadway.	Part of new construction for Waterfront Road extension.
Cost	No significant difference to other alternatives.	No significant difference to other alternatives.

5.5.3 Conclusion

Either location is suitable for the placement of a VACS security system; however positioning the security cordon under Main Street Overpass encompasses all industrial tenants in this area while keeping CRAB Park at Portside available to the public.

6. Assessment Summary

Based on the alternative appraisal in the section above, the following key findings are identified.

- Wharf extension is needed to serve existing vessels moored at the terminal;
- Berth capacity expansion does not require a significant increase to meet overall capacity objectives;
- Eastward only expansion of the intermodal yard is limited by adjacent property boundaries and fails to connect to a key location on the rail network which provides access to all rail connections;
- Westward expansion is constrained by potential impacts to cruise ship and Seabus operations;
- Westward expansion will impact the embayment, decreasing the width of the channel into the embayment;
- Westward expansion will impact views from CRAB Park at Portside;
- Eastward only expansion of the intermodal yard will severely impact the Ballantyne Pier heritage building;
- Container yard expansion should be aligned with berth and intermodal yard to limit unnecessary on-terminal vehicle trips.
- The Centennial Road Overpass provides journey time benefits for a significant volume of truck traffic serving the port.
- The introduction of VACS at the western extent of the south shore port lands provides a security perimeter encompassing all terminal facilities east of Main Street.
- The cost of implementing alternatives is a consideration in determining the preferred arrangements. The capacity increases / benefits to traffic relative to the associated costs are also factored into decision-making.

The results of these findings guided the development of the project design. The existing constraints to the east of the terminal limit the potential for expansion in this direction. The proposed terminal expansion utilises as much of the eastern expansion potential as possible. While there are some impacts as a result of westward expansion, to enable key expansion components to be achieved, there will still be a need for some expansion in this direction.

7. Assessment Conclusion

The following conclusions have been identified from the assessment and its findings:

- The wharf only needs to be extended far enough to enable cranes to reach the containers at the stern of vessels moored at the berth. This would be limited to the extent of the existing mooring dolphin to minimise impacts to existing marine traffic using the embayment and the view impacts from CRAB Park. Container vessels would continue to be berthed in the same position as today, with the same associated view impact.
 - Extending the berth length to encompass the existing mooring dolphin meets this need.
- To reach the target length of 914m (3,000ft) within the intermodal yard, the existing yard needs to be extended. Extending eastward can provide at least 50% of the desired expansion, however, the layout of the rail connections in this area limit the extent of the extension of the intermodal yard eastwards. The remaining intermodal yard expansion needs to be provided at the west end. The length of track required to meet the 914m intermodal yard length is in line with the extent of the wharf extension, resulting in a balanced expansion which squares off the end of the terminal in line with the existing mooring dolphin, without encroaching further into the channel into the embayment.
 - The balanced expansion of the Intermodal Yard provides the desired intermodal yard track length and connection to all available rail networks.
- The container yard must be balanced to the berth capacity and the intermodal yard capacity. Additional ground space is needed to create the matching capacity. This would be through eastern expansion (to limits imposed by property boundaries), and some westward expansion.
 - With the westward expansion of the wharf and intermodal yard, the expansion of the container yard to the limits imposed by these elements is sufficient to provide the capacity requirements.
 - Some eastward expansion, and associated infilling will still be required to provide the necessary terminal space for terminal operations facilities. This would be through the partial filling of the water lot between Ballantyne Pier and Burrard Slip.

- The proposed Centennial Road Overpass allows truck movements to be separated from existing rail crossings, improving the movement of goods vehicles on the port lands and reducing instances of vehicle idling while delayed by trains.
- The position of the proposed security gate is driven by its location relative to port activities. Placement on the perimeter of port lands secures all adjacent port terminals and properties.

About AECOM

AECOM (NYSE: ACM) is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries.

As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges.

From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM companies had revenue of approximately US \$19 billion during the 12 months ended June 30, 2015.

See how we deliver what others can only imagine at aecom.com and [@AECOM](https://twitter.com/AECOM).

Contact
Neil Snowball
Design Manager
T 604 444 6592
E neil.snowball@aecom.com