COMBINED SEWAGE STORAGE TUNNEL (CSST)

Category | Water Resources

HERRENKNECH

From:	2022 Canadian Consulting Engineering Awards
To:	Maloney, Patty
Subject:	Notice of Intention to Enter: 2022 Canadian Consulting Engineering Awards
Date:	Wednesday, April 13, 2022 9:13:18 AM

2022 Canadian Consulting Engineering Awards

Thank you, your entry form has been successfully submitted.

Project Name: Ottawa Combined Sewage Storage Tunnel
Project Category: C. Water Resources
Firm Name: Stantec

Important: Consent Forms

Please download these forms.
You will need to sign the Firm Consent Form and have the project owner sign the Project Owner Consent Form. (If the client is different from the project owner, you will also need to have the client sign the Client Consent Form.)
Later, you will need to upload the signed documents when you complete your project entry form.

2022 Canadian Consulting Engineering Awards Consent Form

For a project entry to the 2022 Canadian Consulting Engineering Awards to be considered complete, the following documents must be included with the submission:

- This form, completed and signed by an individual on behalf of the entering consulting engineering firm(s).
- A completed and signed project owner consent form.
- A completed and signed client consent form (if not the same as the project owner).

TO BE COMPLETED BY AN INDIVIDUAL SIGNING ON BEHALF OF THE ENTERING COMPANY (COMPANIES).

I (We) confirm that this entry complies with the contest rules and that the information submitted is accurate.

I (We) also agree to accept as final the decision of the panel of jurors.

I (We) consent to having the entire project entry archived on the *Canadian Consulting Engineer* website, whether it is selected as a winning project or not.

Name: Adrien Comeau

Position: Vice President, NA Discipline Leader - Urban Water Resources

Company: Stantec Consulting Ltd.

Address: 300 - 1331 Clyde Avenue

City: Ottawa Province: ON

Postal Code: K2C 3G4 Tel.: (613) 298-0454

E-mail: Adrien.Comeau@stantec.com

Signed [signature]

Date April 13, 2022

CANADIAN CONSULTING
Engineer
For professional engineers in private practice

2022 Canadian Consulting Engineering Awards Project Owner Form

I am authorized, on behalf of (INSERT ORGANIZATION NAME) City of Ottawa,
to confirm and consent to the following relating to (INSERT PROJECT NAME) Combined Sewage Storage Tunnel,
being submitted to the 2022 Canadian Consulting Engineering Awards by (INSERT SUBMITTING FIRM'S NAME)
Stantec Consulting Ltd.:

- The project was completed to our satisfaction;
- The submitting firm(s) performed duties as described in their submission;
- We are not, and do not expect to be, in litigation with the submitting firm(s) regarding the project being submitted

I also acknowledge and agree to the following:

- Submitted projects will be evaluated by a panel of jurors who are engineering experts and/or have expertise relevant to the judging criteria;
- The decision of the panel will be accepted as final;
- The submitting firm(s) whose projects are selected for an award by the jury will be notified in Q2 of 2022
- Winning projects will be announced publicly in Q4 during an awards gala hosted by the Association of Consulting Engineering Companies – Canada (ACEC)
- Videos and descriptions of the winning projects will be produced for the awards gala by ACEC and will be available to the submitting firms, owners and clients upon request following the gala.
- Following the awards gala, winning projects will be publicized through, but not limited to, the following:
    - *Canadian Consulting Engineer* magazine and website
    - ACEC publications and website
    - ACEC #20DaysofExcellence social media campaign
    - Press releases issued by ACEC
- Submitting firms may also publicize the winning projects
- The entire project entry will be archived on the *Canadian Consulting Engineer* website, whether it was selected as a winning project or not.

Name: Steven Courtland

Position: Program Manager, Municipal Design & Construction

Company: City of Ottawa

Address: 110 Laurier Avenue West

City: Ottawa Province: Ontario Postal Code: K1P 1J1

Tel. 613-580-2424x16207 E-mail: Steven.Courtland@ottawa.ca

Signature: Steven Courtland Digitally signed by Steven Courtland Date: 2022.03.21 14:15:24 -04'00' Date:

75 Word Description

Reducing the volume and frequency of combined sewer overflows to the Ottawa River is one of the key objectives of the Combined Sewage Storage Tunnel (CSST), which consists of two 3m diameter interconnected tunnels that provide over 43,000 m3 of storage volume. The CSST will improve the health of the Ottawa River, benefiting the City of Ottawa, the environment and the people who live, work, visit, and play in our nation's capital.

Q1
INNOVATION

Background

The control of combined sewer overflows (CSOs) to the Ottawa River is one of the key objectives of the City of Ottawa's "Ottawa River Action Plan (ORAP) – a plan for enhancing the health of the Ottawa River and protecting Ottawa's water environment for future generations". The implementation of Real Time Control (RTC) for the operation of the City's central interceptor system, along with the Combined Sewage Storage Tunnel (CSST), are two marquee projects in the ORAP that are designed to meet the City's CSO control objectives. RTC implementation was completed in 2011 and the project received the Canadian Consulting Engineers Environment Award in 2012. This award submission focuses on the implementation of the multi-purpose CSST facility, which builds on the success of RTC.

The Ontario Ministry of Environment, Conservation and Parks' (MECPs) CSO control guidelines (Procedure F-5-5) outline the following targets:

1. CSO volumetric target: In an average design year, 90% of wet-weather flow (WWF) volume generated by the combined sewer system is captured and sent to the wastewater treatment plant (WWTP).
2. CSO frequency target (for downstream swimming and bathing beaches): no more than two overflows lasting less than 48 hours in an average design year (over the designated swimming period of June to September).

Once the implementation of RTC on the interceptor system was fully commissioned in 2011, it reduced the previously measured CSO volumes to the river by over 60–70%. This has resulted in an overall wet weather flow volumetric capture rate of over 95% on a consistent basis, thus meeting and even exceeding the Procedure F-5-5 volumetric target.

The CSST fully integrates with the RTC system to successfully achieve an overflow frequency target of one to two CSOs per year, on average. Figure 2 depicts how much overflow would have occurred annually between 2010 and 2019 if the CSST had been in place. This level of CSO control would have been accomplished through storing sewage volumes within the CSST tunnel system that would otherwise overflow to the Ottawa River, where the sewage is released after the rainfall event to the WWTP. The ten-year average is currently 1.6 overflow events per year.

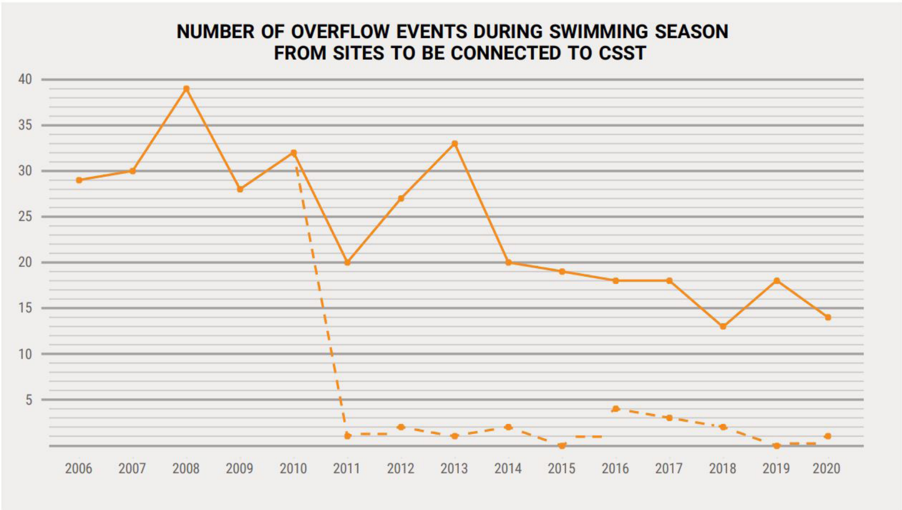
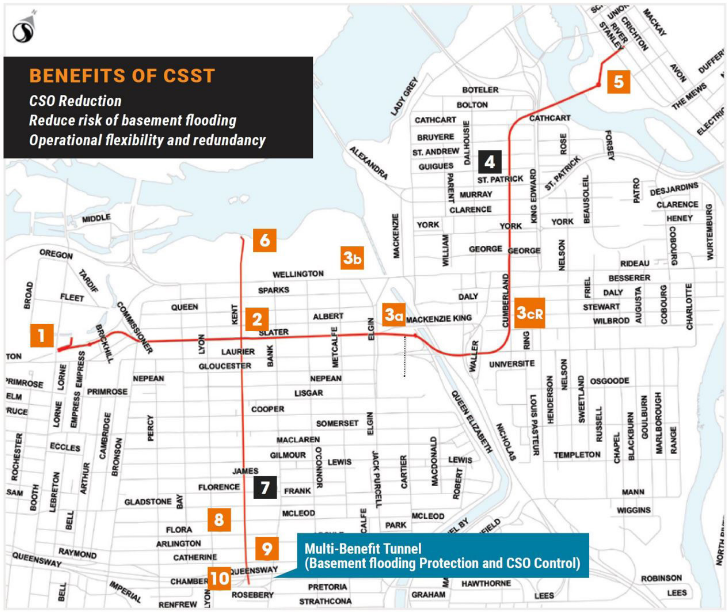


Figure 1
Overflow Events During Swimming Season from Sites to be connected to CSST

Project Objective

While the CSST's primary goal is to target one to two overflows per year, the innovative design of the system provides several other benefits for the City, making it truly a multi-purpose system.



Site 1	West End Shaft – LeBreton Flats
Site 2	EWT/NST Intersection – Kent and Slater Streets
Site 3a	Rideau Canal Interceptor Diversion/Drop – Confederation Park
Site 3b	Rideau Canal Regulator – Rideau Canal
Site 3cR	Wilbrod Shaft–Wilbrod and Cumberland Streets
Site 4	(Eliminated)
Site 5	EWT Outlet / RRC Diversion – New Edinburgh Park
Site 6	NST Overflow and Kent Street Outfall – Ottawa River Pathway
Site 7	(Eliminated)
Site 8	McLeod Street Drop – Kent and McLeod Streets
Site 9	Catherine Street Drop – Kent and Catherine Streets
Site 10	Chamberlain Shaft – Kent and Chamberlain Streets

Figure 2
The CSST (EWT - Sites 1 to 5, NST - Sites 6 to 10)

As illustrated in Figure 3, the CSST consists of two 3m diameter interconnected tunnels that provide over 43,000 m3 of additional storage volume. The East–West Tunnel (EWT) is 4,100 m long, interconnected with a 1,900-m-long North–South Tunnel (NST). This innovative gravity-based tunnel design:

1. Increases the CSO storage volume to target one to two overflows per year, on average.
2. Maximizes the resiliency of the collection system, therefore reducing the potential for basement flooding in the downtown core.
3. Maximizes the functionality of the collection system by twinning a significant portion of the aging interceptor system. This helps increase operational reliability and sustainability (e.g., temporary dry weather flow storage in CSST permits maintenance at the primary pumping station at the WWTP).

Innovative Solutions and Achievements

Combined Sewage Overflow Frequency Target

The City Council's mandated objective was to design the CSST to capture and treat all WWF during the swimming season of the defined design basis average year (i.e., no overflow in the designated average design year during the swimming season), while accepting more than two overflows outside of the swimming season and during years with more severe wet weather than the defined average year, and/or during very large rain events. The CSST project provides a storage capacity of 43,000 m3 to meet the City Council's CSO control objectives for the Ottawa River, and has the potential to perform better than the MECP guidelines.

The tunnel sizing also considered the impacts of planned intensification development, based on 2031 projections from the City's Wastewater Infrastructure Master Plan, and possible impacts of climate change by considering a 15% increase in rainfall volume. Based on performance testing using rainfall records from recent years, the average frequency of overflows is predicted to be less than two overflows per year during the CSO control period (April 15 to November 15); this is better than the MECP's requirements under Procedure F-5-5, even when factoring in the potential effects of climate change.

Basement Flooding Risk Reduction

While the tunnel storage volume is designed to meet the City's CSO control objectives, the CSST's configuration is specifically designed to provide added benefits and operate as a multi-purpose facility. The innovative interconnected tunnel design reduces the risk of basement flooding in the downtown core by providing a highlevel relief outlet to the river during extreme events. During such events, excess inflows to the NST are directed northward to the Ottawa River via an overflow structure located at Site 6 (NST Overflow/Kent Street Outfall).

An investment of $120M in basement flooding risk reduction measures was previously defined for the downtown core. With its configuration as two interconnected tunnels, the NST provides both CSO control and flood risk reduction and has allowed for the optimization of the higher-level basement flooding measures. With an investment of $55M in the NST, the original investment of $120M in flood reduction measures was thus reduced to $65M. Investment in the NST also eliminated a significant amount of disruptive local flood control measures and improved the level of service for the community.

Added Collection System Functionality (Critical Interceptor Sewer Redundancy)

Evaluation of alternative design solutions from a holistic system needs perspective directly led to the development of an innovative and multi-benefit functional design solution. Originally conceived to be a single, deep tunnel storage facility dewatered by pumping (as is common for most such CSO tunnel storage solutions), the innovative tunnel design evolved into the interconnected tunnel solution that acts as both a tunnel flow conveyance and storage tunnel that drains by gravity, avoiding a costly and expensive dewatering pumping station.

Since the CSST is a gravity-based system, the alignment was carefully selected to effectively parallel the main Interceptor Outfall Sewer (IOS) through the downtown core between Lebreton Flats and the east side of the Rideau River. The flow control structures at Site 1 (West End shaft) allow temporary diversion of most wet- and dry-weather flows from the IOS to the EWT. The EWT thus "twins" the IOS and, in doing so, provides both system reliability and operational flexibility.

Since most of the IOS flow can be diverted into the EWT, the City can now conduct a full structural inspection and condition assessment (or repair) of the IOS, where this was not possible in the past. This is particularly important because the IOS is a critical sewer that serves over 300,000 people, has been active for over 60 years, and is approximately 30m underground. The NST also allows some dry-weather flows to be redirected away from the Rideau Canal Interceptor (RCI). This greatly helps reduce the amount of dry-weather flow being managed during future inspection or maintenance work on the RCI, which is more than 90 years old.

In addition, the City can now also temporarily shut off the majority of flow from the IOS entering the Raw Sewage Pumping Station (RSPS) located at the City's only WWTP by leveraging the CSST for storing dry-weather flow. The City tested this functionality and observed that flow can be significantly reduced for 6–8 hours for emergency inspections or repairs, such as pump suction piping in the wet well of the RSPS.

Operational Integration into RTC System

The CSST is integrated into the existing RTC system, where the system is controlled by the City's central wastewater Supervisory Control and Data Acquisition (SCADA) system. The CSST and its associated infrastructure use static controls where possible to protect the IOS from surcharge. A number of active RTC flow controls (isolation and modulation gates) are nevertheless required to divert and/or limit flows to and from the CSST under various modes of operation. Although the system largely operates using autonomous reactive controls based on locally observed flow conditions, some of the automated control logic relies on SCADA communications between CSST control sites.

The RTC system maximizes the IOS capacity, which is achieved by modulation and isolation gates, as well as local level monitoring of the IOS and collector sewers at each RTC site. Prior to the CSST integration, once the IOS and local sewer reached their maximum capacity, excess wet weather flow was diverted to the Ottawa River as overflow. Now that the CSST is integrated into the RTC system, excess flow is diverted to the CSST for storage until the IOS can accept more flow. Once the IOS regains capacity for incoming wastewater, the CSST is dewatered using modulation gates to slowly release the stored wastewater to the IOS by gravity.

For the infrequent and more severe events where the CSST reaches capacity before the IOS levels recede, further excess flow is then diverted to the Ottawa River as overflow. Compared to the original RTC system, this integration allows for approximately 43,000 m3 of additional wastewater storage before an overflow occurs. The integration of the CSST within the existing RTC system resulted in little change in the operation of the existing RTC system for the City operators. The controls at the existing RTC sites effectively maintained their original operation and SCADA system upgrades were minimal, thus facilitating the commissioning of the system as a whole and its on-going operation. The operator can now also utilize the CSST system's flow diversion and storage functions when performing maintenance and troubleshooting works on the RTC sites, while also minimizing the risk of an overflow.

Odour Risk Mitigation

When air moves in sewer tunnels, odorous air may be released. Many mechanisms can cause these air movements, including convection, displacement, and air entrainment in drop structures. Given the location of the shafts within the downtown core, design features were proactively developed to control the emanation of potential odourous air from the tunnel and mitigate the impact to communities in the most sensitive locations. Odour Control Facilities (OCFs) were built at three strategic locations, including the one shown on Figure 4, which is located on the west bank of the UNESCO-classified Rideau Canal. Air that is displaced while filling the tunnel is treated with granulated activated carbon adsorption systems at the high points in the system. A fourth facility was constructed at the downstream end of the system, in the popular Stanley Park (Figure 6), replacing an existing facility designed to treat air from the existing system.

The design of the CSST and OCFs also considered that convective air currents represent the largest air movements within the CSST—if allowed to form. These mostly occur during cold winter months when the tunnels are empty, and the ground is warmer than the outside air. Convective air movements in the CSST are controlled using air curtains at strategically placed locations that prevent all but very extreme air movement out of the tunnel at sensitive locations. By installing these curtains, it was possible to reduce the size and design capacity of the OCFs, ultimately saving the City capital and long-term operations costs.

Additionally, drop structures were designed to minimize air entrainment into the tunnel through strategies such as vortex and baffle drop structures. Blow-off structures were installed in the tunnel shafts to reduce the risk of air entrapment and prevent the shafts from being pressurized in a severe event.

Sediment and Grit Control

The risk of accumulation of sediment materials in the CSST system is reduced through the design configuration of the tunnels and the flow diversion structures. Flow diversion structures are configured such that the flow diverted to the CSST consists largely of the upper and less sediment laden portion of the flow stream, where flow is decanted from the collector into the CSST. The tunnel design is such that the CSST is dewatered by gravity, thus providing the ability to individually flush each tunnel after each storage event. Wet- or dry-weather flow can be diverted from three major collectors into the EWT, which can provide significant scouring velocity. Storing and quick release flushing of the NST can be initiated at Site 10 using potable water to scour residual sedimentation within the tunnels.

Q2
COMPLEXITY

Background

Construction of the CSST began with the excavation of the 25-m-deep shaft located at Site 10, adjacent to the main transportation hub through the City of Ottawa - Highway 417. Tunneling of the 1,900-m-long NST proceeded from Site 10 to Site 6 using a single- pass Tunnel Boring Machine (TBM) with a precast concrete tunnel lining system under the City's downtown core. This leg of the CSST involved crossing several important structures including a bridge structure under Highway 417, tunneling below sensitive marine clays susceptible to consolidation, crossing under the newly constructed Ottawa Light Rail Transit (LRT) Tunnel and over the City's most critical sewer, the IOS.

The TBM exited the NST excavation from an at-grade portal in the rock face of the slope at the edge of the Ottawa River and located adjacent to the Supreme Court of Canada, which overlooks the Ottawa River from above the rock escarpment.

Tunnelling of the EWT proceeded westward from Site 5 (Stanley Park) across the downtown core to Site 1 (Lebreton Flats), with several key crossings requiring careful consideration of risks and development of mitigation measures in both design and in construction specifications:

- Under the Rideau River, into the historic lower town neighbourhood
- Underneath several heritage-designated homes
- Underneath the newly constructed Ottawa LRT tunnel
- Below a buried valley with low rock cover over the tunnel (<1m), and risk of heavy groundwater infiltration and mixed-face conditions
- Underneath the historic Rideau Canal (a UNESCO World Heritage Site)
- Through the City's downtown core and passing through the previously constructed NST (invert to invert)
- Exit at Site 1 in LeBreton Flats adjacent to the Ottawa LRT tunnel and Pimisi station with minimal rock cover above the tunnel

Tunneling Above the Existing Interceptor Outfall Sewer (IOS)

The IOS was constructed by drill and blast tunneling in the early 1960s and is the most critical sewer in the City of Ottawa, conveying the flow from the entire combined sewer area and serving over one third of the city's total population of 1 million people. The NST leg of the CSST needed to cross over the IOS (approximately 30m deep) on Wellington Street in front of the Supreme Court of Canada and through the Parliamentary Precinct.

Due to the design features of the CSST that allow it to act as a gravity sewer when draining, the slope of the NST had to be minimized while still maintaining adequate flow velocities and the correct control elevation at the Site 6 outfall to the Ottawa River. This resulted in a separation distance of only 900 mm between the bottom of the NST excavation and the top of the existing IOS excavation. In addition to the small separation distance, the design and construction means and methods considered that the existing IOS was constructed by means of drilling and blasting, with installation of rock anchors where deemed required (up to 4 m in length), followed by a cast-in-place concrete tunnel liner.

Given the sensitivity of this critical sewer, it was vital that the elevation of the IOS be confirmed in the field during the design phase of the project. This was done by accessing a maintenance hole vortex drop structure along the IOS alignment close to the proposed crossing and conducting a survey of the invert elevations and coordinates to get an accurate position of the IOS. During construction, the contractor was required to reconfirm the elevation and position of the IOS in advance of the arrival of the TBM by advancing pilot holes into the IOS for further physical verification.

To further mitigate risks during active mining above the IOS, an Emergency Response Plan (ERP) was developed and implemented to address concerns regarding the potential for rock anchors placed during the original construction of the IOS; and more significantly, it addressed the potential for a worst-case scenario (i.e. collapse of the IOS during the crossing). This included a real-time monitoring program conducted in close coordination with the constructor, which included a constant visual of the inside of the IOS during the tunnel crossing operation using CCTV. Damage to the older tunnel was averted as the TBM crossed above the IOS without any impact.

Tunneling Through an Existing Underground Cavern

During the construction of the IOS in the 1960s, an offshoot tunnel approximately 1.8 m x 1.8 m and 200-m long was mined perpendicular to the IOS to intercept an existing outfall to the Ottawa River. This offshoot tunnel was also used as a means of access to supply concrete during original construction, but was ultimately abandoned in place at the completion of the IOS project. The NST alignment crosses through this cavern and runs on a skew, resulting in a 120-m length of potential conflict between the NST and the cavern.

From the IOS as-built drawings, it could not be determined whether this rock tunnel was backfilled at the time of original construction or left empty. If empty, the large void could potentially alter the TBM alignment causing it to dive; thus creating a sump in the NST and introducing issues with PCTL installation and grouting, or potentially jam the TBM in place requiring a rescue shaft to be excavated adjacent to the Supreme Court of Canada.

To mitigate this risk, an extensive exploration of the cavern was conducted as part of the CSST works by drilling and CCTV, and it was confirmed that the cavern had not been backfilled and was left as an underground void. Upon confirmation, the cavern was grouted in place in advance of the TBM arriving in the area. This was completed by pumping over 500 m3 of flowable concrete into the cavern from boreholes drilled from the portal cliff face at Site 6 and vertically near the IOS crossing location.

The cavern risk was averted as the TBM successfully bored through the length of the pre-grouted cavern with minimal impact to the TBM’s production rate, grade, and alignment, and without causing damage to the machine.

Subsurface Conditions and Sensitive Clays

Sensitive marine clays that overlie the till and bedrock along some areas of the NST alignment are susceptible to consolidation resulting from dewatering/depressurization of the bedrock. Mitigation against excessive or prolonged dewatering/depressurization of the bedrock, and in turn the overburden clays, was a key consideration in the design and construction of the CSST project to mitigate the risk of utility and/or surface structure settlements.

As part of the development of the geotechnical monitoring program, consideration was made to address the concerns for potential dewatering of the overburden clays. Piezometers and settlement monitoring instruments were installed along the alignment, and on critical buildings and sensitive infrastructure.

This risk of dewatering the overburden clays was averted by implementing a “line as you go” tunneling methodology that used segmental precast concrete liner installed behind the TBM, in addition to the geotechnical monitoring program and sealed shaft excavations in susceptible areas. This methodology reduced the amount of time a section of tunnel was permitted to drain into the excavated area before it was lined, thus reducing the amount of groundwater infiltration during construction.

Ground Condition Investigation Under the Rideau River

At the onset of mining the EWT from Site 5a, the first significant crossing was underneath a 200-m-wide section under the Rideau River. This crossing was anticipated to require pre-excavation probing, and potentially grouting of the rock to condition it in advance of TBM mining. This was anticipated to be required to mitigate the risk of increased or uncontrolled groundwater, or a direct hydraulic connection to the river, during the crossing.

Probing and grouting ahead of the TBM would have resulted in a slower mining rate, increasing the amount of time spent underneath the river, thereby increasing the likelihood and volume of groundwater infiltration if encountered. An exploratory borehole was drilled via horizontal directional drilling above the tunnel obvert, along the full length of the river crossing. This was done to determine whether significant groundwater was expected during the mining of the tunnel.

The findings of the borehole were that little groundwater was expected to infiltrate into the excavation, and the contractor was able to proceed with mining without the need for probing and grouting ahead of the TBM. The TBM was able to cross the river section more quickly, reducing the risk of extended periods being needed to manage increased amounts of groundwater. The crossing was a success and no significant increases in groundwater were observed.

Q3
SOCIAL AND/OR ECONOMIC BENEFIT

Protecting the Ottawa River

The Ottawa River is a significant natural resource that is enjoyed by residents of Ottawa and surrounding communities along its entire reach. The river provides municipal water supplies for many municipalities upstream and downstream of Ottawa, and provides recreational opportunities such as fishing, boating, canoeing, and swimming for area residents and tourists alike.

The CSST will help to reduce the amount of CSOs that discharge to the Ottawa River and is designed to achieve an overflow frequency target of one to two CSOs per year, on average. The analysis conducted during the design and sizing of the tunnels showed that the ten-year average is currently projected to be 1.6 overflow events per year. The facility is thus designed to exceed the minimum requirements of the MECPs CSO Control Policy document, Procedure F-5-5.

By significantly reducing pollutant loadings and frequency to the Ottawa River as a result of CSOs, the CSST Project will lead to direct recreational and environmental health benefits for residents of the City of Ottawa and downstream communities. It will also lead to economic benefits given that the Ottawa River is such an integral and important part of the City's history, character, and tourist industry. The CSST Project showcases the City of Ottawa's efforts and innovativeness as a leader in environmental protection among municipalities across Canada.

Project Support

The Federal and Provincial Governments provided support and funding for the project. Major press conferences were held for the project kickoff and following substantial completion of the work, with speakers such as Mayor Jim Watson of Ottawa, the former Environment Minister Catherine McKenna, local member representatives of both the Federal and Provincial Parliaments, and local city councilors. These press conferences provided publicity for the project and emphasized the environmental benefits to the Ottawa River.

Festivals and Events

Canada celebrated its 150th Anniversary in 2017 and there were large-scale festivities that occurred throughout Ottawa; particularly in the downtown core where the project was being implemented. A number of CSST sites had considerable restrictions on what work, if any, could be performed during all or parts of 2017. Construction also accommodated other key community events and festivals at Stanley Park, Confederation Park, LeBreton Flats, and Parliament Hill (e.g. the Ottawa Race Weekend Marathon, Ottawa Bluesfest, Jazz Fest, Winterlude, and Remembrance Day ceremonies).

Communication and coordination with stakeholders and festival organizers was spearheaded by the City and Stantec's Community Relations Team. Ongoing communication with the contractor and community representatives was vital to ensure that individual events' special requirements could be accommodated during construction.

Guided Tours

The CSST project was made possible by the various stakeholders. To keep the stakeholders involved during the construction phase of the project, many guided tours were held at CSST sites for Public Services and Procurement Canada (PSPC), the NCC, the media, city councilors, and various levels of City of Ottawa senior management. Special accommodations and safety orientation and precautions were made by the contractor during each stage of construction for these guided tours.

Field Ambassador

Stantec deployed a Field Ambassador at highly sensitive communities in proximity to construction. This person was both an in-person representative of the City and an advocate for the community to whom residents could express their concerns and pose questions regarding ongoing or upcoming work face-to-face. This proved to be a successful and proactive approach for the City to listen to community concerns and complaints, and provided a more personal means of communication between residents and the City. Working alongside the Field Ambassador was a public communications team dedicated to the project giving weekly updates customized to different communities and working hand in hand with the project management and construction team to mitigate impacts on the public.

Q4
ENVIRONMENTAL BENEFITS

The CSST project represents an investment in a highly sustainable and resilient wet weather flow management solution that provides multiple and long-term benefits. It is one of the most important projects of the Ottawa River Action Plan, which is the City of Ottawa's overall control plan for protecting the health and vitality of the Ottawa River for present and future generations.

Sustainability in Design

The CSST is configured such that it extends through the City's core and twins a 4 km long segment of the main interceptor sewer that convey flows for approximately one third of the City's population. A further feature of its design is that it is adaptable in that it can be extended all the way to the downstream wastewater treatment facility in the future, thus allowing the twinning of the entire length of the 60+ year old interceptor sewer, and in the process, providing added resiliency, performance capability, and additional capacity to further adapt to changing conditions.

In meeting all these objectives and providing this functionality, the CSST project represents an investment in critical infrastructure that provides for added robustness and resiliency within the City's core collection system, protects the health and ecology of both the City's citizens and the Ottawa River, as well as supports growth and economic development for the region. With this commitment to the sustainability of the City's infrastructure, its economic growth, as well as the health of the environment, the Government of Canada and the Province of Ontario partnered with the City of Ottawa to collectively provide more than $232 million in funding to the CSST project. This has demonstrated a vote of confidence in the City of Ottawa's commitment to its citizens and the environment, including one of its most precious resources, the Ottawa River.

Flow Management and Emergency Response Plans

The key principle of the RTC/CSST system is to maximize the efficiency of the combined sewer system and leverage the CSST for storage of excess flows to reduce the volume and frequency of CSOs to the Ottawa River during rainfall events. The reduced volume and frequency of CSOs significantly reduces pollutant loadings to the Ottawa River and leads to direct recreational and environmental health benefits for residents of the City of Ottawa and downstream communities.

Special measures for environmental protection were carried through from the design phase of the project into construction. Construction of the CSST system required physical tie-in to five large diameter sewers (>2100mm diameter) under live flow conditions. Incoming wet- and dry-weather flows at each tie-in had to be maintained operational during construction while still allowing work to proceed without increasing risk of environmental spills or CSOs to the Ottawa River.

The City and Stantec developed detailed flow management plans and constraints at the design and tender stage for each tie-in so that each site could be constructed under live flow conditions. During construction, the contractor worked closely with Stantec and City staff to further refine the flow management plan for each site prior to implementation. This included the development of emergency response and escalation plans. During all phases of the construction, the City Operations staff were directly involved with monitoring and supervising the work to prevent unwarranted CSOs or environmental spills.

Close coordination and detailed planning between Stantec, the City of Ottawa, and DTJV was crucial in mitigating the risk of construction-related overflows to the Ottawa River and/or sewer back-ups that could lead to basement flooding. Implementation of the flow management plans was successful and did not cause any issues relating to unwarranted CSOs/spills, flooding, or damage to the infrastructure.

Mitigation of Community Impacts

Significant effort was made during construction to minimize the impact of construction activities on the community. Given the number of heritage-designated structures in proximity to the CSST project along the entire project alignment, the implementation of a robust vibration monitoring and geotechnical monitoring plan was a requirement of the City. The requirements ensured that risk of damage to sensitive heritage buildings and structures was mitigated.

A secondary driver to implement a vibration monitoring program was to monitor and assess the level of disruption on the surrounding communities. In addition to vibrations generated from underground or above-ground construction activities, mitigation of noise generated from construction sites was also a concern for the City. Given the long-term duration of work at some of the CSST sites, the City deemed it vital that the contractor be held to reasonable noise and vibration limits to mitigate the impacts to surrounding communities, particularly during overnight work which is common on tunneling projects. Noise mitigation devices were also employed in highly sensitive areas to benefit the residents closest to the work sites.

Q5
MEETING CLIENT'S NEEDS

The Ottawa River Action Plan (ORAP) has been the main driver for the implementation of RTC on the existing central interceptor system and the subsequent integration of the CSST facilities, which both contribute to the main objective of controlling combined sewer overflows (CSOs). With the RTC system alone being able to reduce the volume of CSOs to the river by over 60-70%, simply by making more effective use of existing infrastructure, the opportunity to cost-effectively achieve an elevated level of CSO control was available.

With the CSST fully integrated with the RTC system, the City is now projecting that the frequency of overflows will now be reduced to between one to two CSO events per year during the swimming season, on average; thus meeting and even exceeding the MECPs CSO control guidelines (Procedure F-5-5). This is accomplished by storing sewage volumes within the CSST tunnel system then releasing them after the rainfall event to the WWTP. With the implementation of this project, the City of Ottawa has achieved a level of CSO control that meets and even exceeds minimum control objectives as outlined in Provincial guidelines and has met the City Council's mandated targets as outlined in the ORAP.

While the CSST's primary goal was to target one to two overflows per year, the innovative design of the system provides several other benefits for the City, making it truly a multi-purpose and multi-benefit system. The CSST consists of two 3m diameter interconnected tunnels that integrate into the overall system and provide over 43,000 m3 of additional storage volume. This innovative gravity-based tunnel design:

1. Increases the CSO storage volume to meet a target of one to two overflows per year, on average.
2. Maximizes the resiliency of the collection system by providing a high level relief outlet during rarer and major storm events, therefore reducing the potential for basement flooding in the downtown core.
3. Maximizes the functionality and long-term reliability of the collection system by twinning a significant portion of the aging interceptor outfall sewer (IOS) system. This helps increase operational flexibility and sustainability of the system by providing operators with the flexibility to operate the CSST as both a conveyance and storage facility as well as the ability to divert flows from the IOS to properly inspect and rehabilitate this critical piece of infrastructure that serves over a third of the population of the City of Ottawa.

In implementing the project with funding partners at the Government of Canada and the Province of Ontario, one of the City's key goals and success factors was to maintain costs within defined funding and affordability limits. As the CSST project inherently had numerous implementation challenges and risks that need to be addressed, a holistic approach to risk management from concept through to commissioning played a key role in the successful delivery of the project. The risk management tools and procedures adopted for the CSST are used throughout the industry, where appropriate. What is unique about this project is the holistic approach to risk management and the planning process leading to their adoption, the degree to which the design and planning process focused on mitigating the key project challenges and risks with these tools, as well as the development and application of an innovative procurement process that provided opportunity to receive feedback and value-added proposals from the bidders during the "in-market" period via a confidential white paper process incorporated within a traditional design-bid-build procurement model. A focus was placed on the use of procurement practices and contractual risk management tools to mitigate the risks to the City of Ottawa – both during design and carried forward through construction in managing project delivery risks in collaboration with both the City and the Contractor.