2014 CANADIAN CONSULTING ENGINEERING AWARDS

PORT OF MONTREAL - VIAU SECTOR REDEVELOPMENT

Montreal, Quebec

CATEGORY “ENVIRONMENTAL REMEDIATION”

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PROJECT ENTRY

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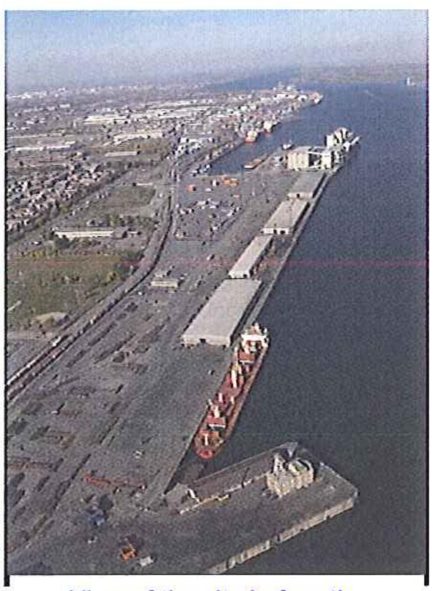
PROJECT OVERVIEW

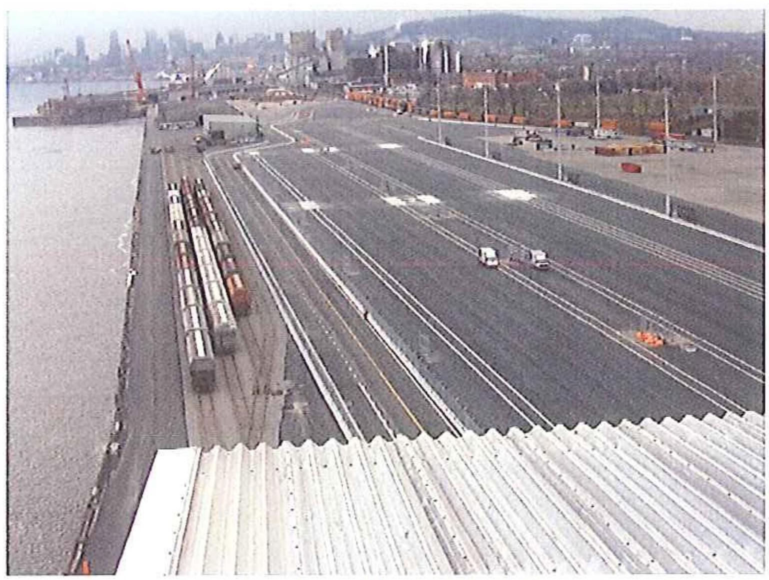
The Montreal Port Authority (MPA, i.e. *Administration portuaire de Montréal*) decided to redevelop the port's Viau sector into a container storage and transshipment area to improve the productivity and competitiveness of its marine facilities. This initiative increased the Port of Montreal's capacity by 150,000 twenty-foot containers and has thereby made the port more competitive on the international scale.

Valued at $30.6M, the project included: dynamic soil compaction, relocation of rail tracks and rail car storage, construction of sewage, water supply, electrical and lighting infrastructure, and the design and construction of the container terminal pavements.

One of the primary challenges of the project was how to manage contaminated soil. During the redevelopment studies, it was determined that managing contaminated soil excavated on site during the project would have a significant financial impact on the viability of the project. Furthermore, it would affect the MPA's ability to complete all of the works or just a portion of them, depending on the total available budget. Thus, SNC-Lavalin implemented an innovative and sustainable soil management solution, which in this case involved applying a solidification/stabilization (S/S) treatment to contaminated soil so that it could be safely reused in the pavement sub-base.



View of the site before the redevelopment



View of completed Terminal

PROJECT HIGHLIGHTS

Q1. INNOVATION

Following various development analyses for optimizing the design of the new terminal, SNC-Lavalin determined the project constraints.

These constraints were:

- Thick, heterogeneous layers of backfill behind the docks with contaminated soil at the surface;
- Existing pavement and heterogeneous backfill requiring upgrades in order to withstand the very heavy loads resulting from stacked containers and handling equipment;
- The level of the terminal could not be changed due to surrounding existing structures.

These constraints translated into challenges, which led the project team to:

- Reduce the quantity of contaminated soil to manage;
- Design a thin durable pavement, able to withstand heavy loads, including those from handling equipment.

In order to address these challenges, SNC-Lavalin produced a design that would optimize soil management with three major elements.

Improving the Soil through Dynamic Compaction

In order to upgrade the geotechnical properties of the existing backfill, dynamic compaction was used on the heterogeneous backfill. The increase in density ensured adequate stability of the soil used as a subgrade for the new port pavement, which is largely used for storing heavy containers and handling equipment.

This technique also lowers the ground level thus reducing the volume of contaminated soil that would need to be managed when the new pavement is built.

Soil improvement by dynamic compaction

Optimizing the Pavement with a Sub-Base Made from Contaminated Soil Treated by Solidification and Stabilization (S/S)

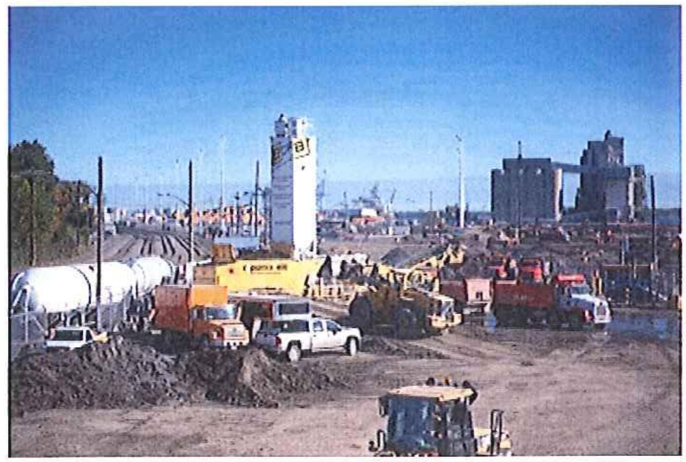
During the study phase, a conventional port pavement measuring 975 mm in thickness was selected which carried a construction cost of approximately $5M (including excavations, off-site disposal of material, the sub-base and the granular foundation of the pavement).

As an alternative to managing contaminated soil off-site and importing new aggregates, SNC-Lavalin recommended safely reusing the contaminated soil by using the S/S treatment process directly on site. During the optimized design phase, a pavement measuring 810 mm in thickness was selected. Since the sub-base structure is made from solidified soil, the thickness of the port pavement could be optimized and reduced by 165 mm.

S/S Treatment for Reusing Contaminated Soil

Currently, the S/S process is the only recognized and proven treatment for inorganic contamination throughout the site. However, it is still seldom used in Quebec and elsewhere in Canada.

The soil treatability study conducted previously by SNC-Lavalin showed that the soil could be treated by S/S. The specifications developed by SNC-Lavalin described the mix formulas for soil treatment as well as the related physical and chemical performance objectives. Under constant supervision by SNC-Lavalin, the contaminated soil was treated with the chosen formula (cement, additives, etc.) using a portable mixing plant or "pugmill." As a result of the S/S treatment, nearly 35,000 metric tonnes of contaminated soil were reused directly in the pavement.



Pugmill

Q2. COMPLEXITY

To facilitate inter-provincial and international trade, the MPA wished to improve the productivity and competitiveness of its marine facilities. From a geographic standpoint, the Port of Montreal is strategically located (shortest direct route to Europe and the Mediterranean), thanks to its proximity to key markets in central Canada and the United States and its connections to North American rail systems. Redeveloping the Viau Sector as a storage and container facility site aimed to increase the capacity of the Port of Montreal by 150,000 twenty-foot units, thus making the port more competitive on the international scale.

One of the main challenges in this project was to manage the contaminated soil removed during excavation works. By studying the various development scenarios, it was determined that managing the excavated soil would have a significant financial impact on the viability of the project. Furthermore, it would affect the MPA's ability to complete all of the works or just a portion of them, depending on the total available budget. As a result, the project required innovative and sustainable solutions for the environmental management of the soil.

The Viau sector dry bulk terminal site was initially built on thick, heterogeneous layers of backfill. The geotechnical properties of the backfill had to be upgraded in order for the new container terminal to adequately withstand the very heavy loads resulting from the stacked containers and handling equipment.

Heterogeneous backfill is often characterized by strong physical and chemical heterogeneity, thus rendering the environmental management complex. When managing contaminated soil is highly complex, there may be additional costs and significant delays.

Furthermore, this project involved repurposing the existing terminal, whose ground level at the site was relatively inflexible due to surrounding existing structures (quays, traffic lanes, railways, etc.). Given the circumstances and in order to reduce the quantity of contaminated soil to manage, the design team had to take into account the need for the new pavement to be as thin as possible despite the fact that the weight of the handling equipment required the pavement thickness to be greater than the existing thickness at the bulk terminal.


Sampling sub-base of the port pavement

Q3. SOCIAL AND ECONOMIC BENEFITS

The solution chosen by SNC-Lavalin—to use the contaminated soil treated by S/S as the sub-base of the pavement—enabled the project to meet its budgetary objective. In addition to the contaminated soil being safely reused directly on site, the solidified material allowed for the construction of a thinner and more durable pavement. These S/S feasibility studies showed savings of $2.1M (compared to the initial costs estimated at $5M), based on the reuse of contaminated soils (instead of sending them to a landfill), the total reduction of pavement thickness and the reduced amounts of aggregates imported to the site. This estimate was verified by the client at the end of the works and enabled the construction budget of $30.6M to be met.

The fact that the pavement would have to bear very heavy loads made this project challenging in unique ways. The S/S treatment process had to be adapted, on the one hand, to the specificities of the contaminated soil located on the site (for example, particle size, humidity and contamination of the soil), and on the other hand it had ultimately resulted in the creation of a product (solidified soil) that would respond to the very high mechanical resistance requirements.

Moreover, since the pavement sub-base was made from solidified soil, the life cycle of the pavement increased considerably. In fact, according to the structural analysis of the chosen pavement, the number of crossings (or allowable load applications) increased by more than 60% specifically for the front loaders used for handling containers.

Q4. ENVIRONMENTAL BENEFITS

The project conducted in the Port of Montreal's Viau sector is not only an example of sustainable development with regard to environmental, social and economic aspects, since the solutions found for this project can be used again in similar initiatives, it can be considered doubly "sustainable."

Minimizing the environmental impact of transportation

The terminal redevelopment project will make it possible for larger quantities of merchandise to arrive by ship to the Port of Montreal. This in turn will promote and enhance maritime transport, which compared to highway and railway shipping, maritime transportation, is less damaging on the environment (based on greenhouse gas emissions or GHG emissions). Thus, the redevelopment of the Viau sector supports a broader effort to reduce the environmental impact of transportation.

Reducing the environmental footprint related to the environmental remediation of contaminated sites

In general, the S/S treatment method results in lower levels of GHG emissions, particles and other highway pollutants.

Not only was contaminated soil safely reused thanks to the S/S treatment, other initiatives included in the project also directly reduced GHG emissions by limiting the amount of materials transported to and from the site:

- Dynamic soil compaction considerably reduced the volume of material that needed to be excavated and managed off-site;
- Contaminated soil was treated in situ then reused on the site, compared to dumping it as waste at a landfill;
- The thickness of the pavement was reduced and therefore less material needed to be excavated;
- Significantly less aggregate material needed to be brought in to the site.

The fact that less material needed to be excavated is directly related to the reduced activity of heavy equipment, such as excavators and especially the trucks for transporting contaminated soil to a landfill. Moreover, fewer trucks were needed to bring in new aggregates from quarries because contaminated soil treated by S/S was used instead of a granular sub-base. In reusing contaminated soil on site, the number of crossings to and from the landfill site was extremely limited. In all, an estimated 5,200 crossings to and from the landfill site were prevented, which is equivalent to 400 tonnes of carbon dioxide (CO_2).

Fewer crossings to the landfill also had an effect on particulate matter. Since 5,200 semi-trailers did not need to be loaded and unloaded, an estimated 23 tonnes of particulate emissions were prevented. Further benefits include reduced airborne dust and vehicle emissions resulting from semi-trailer traffic. Particulate matter emitted when soil and granular material are shipped has an effect on the environment and human health. Thus, reducing particulate matter from the redevelopment works has a direct, positive impact on neighbouring communities.

Finally, taking 5,200 semi-trailers off the road positively affects noise levels for communities adjacent to the highways leading to the landfill and quarry. This in turn contributes to improved quality of life for these communities.

Improving the durability of structures (port pavement)

Pavement built over contaminated soil treated by S/S is more durable than conventionally built pavement. Over the medium and long term, this results in fewer container handling and repair operations. To give an indication, conventional pavement can withstand approximately 200,000 crossings of container handling front-loaders. Meanwhile, pavement built with contaminated soil treated by S/S can withstand more than 320,000 crossings of this nature. This represents a significant increase in the useful life of the pavement and therefore translates into reduced environmental impact, thanks to reduced maintenance and repair.

Preservation of groundwater quality

Water and soil contamination are among the most serious environmental issues we face. Chemical soil stabilization and encapsulating contaminated soil in a solid cover prevents pollutants from leaching or at least limits this effect. Even though landfills are subject to several control measures and careful monitoring, concentrations of untreated contaminated soil in a single location or landfill site can result in environmental problems for future generations and may even affect groundwater quality. Solidification/stabilization treatment is a proactive method of addressing contaminated soil as it reduces the solubility of contaminants and confines them within a durable and nearly impervious cement matrix. In this way, the S/S process supports sustainable development by protecting groundwater quality.

Preservation of resources

It is also worth noting that the S/S approach used during this project also helped reduce the amounts of two types of resources needed. These include less aggregate material from the quarry and less space required at an authorized site to store contaminated soil. The reduced need for resources had environmental, economic and social benefits. Reusing soil minimized the need to extract natural resources and the need for landfill space, and thereby supports society's "zero landfill" objective.

Innovative contaminated soil treatment solutions

Using the S/S treatment in Quebec has led to the development of new skills and contributed to innovation within environmental management and sustainable management of contaminated soil. This new know-how will facilitate the environmental remediation of several contaminated sites across the province, where other treatment techniques may not be applicable or viable. Moreover, people now recognize that remediating contaminated sites presents numerous advantages at the economic, social and environmental levels. These recognized advantages include: increased tax base for different levels of government, job creation and maintenance, removal of threats to public health and safety, improvement in the quality of life of citizens living or working near the sites, improvement of air quality and reduction of urban sprawl.

Reduction of light pollution with innovating lighting

Light fixtures featuring light-emitting diode (LED) technology was used on the site, resulting in several environmental advantages. First, the directional flux of LED fixtures makes it possible to direct light toward a specific portion of the ground, thereby reducing light pollution in the sky. Given the amount of lighting required for the Port of Montreal, LED fixtures resulted in 60% energy savings compared to high-pressure sodium lighting. Since they have a longer useful life, LED fixtures also help reduce waste caused by bulb replacements and associated maintenance costs. And since LED lamps offer better diffusion of light, lamp posts do not need to be as tall and thus less material is required for their production.

Q5. Meeting Client's Needs

The objective of the Viau sector redevelopment project was to repurpose the Port of Montreal's Viau sector into a container storage facility, which was previously used for storing bulk goods. The Viau sector covers approximately 180,000 square metres and is located on the St-Lawrence River in Montreal. It is bordered by Notre-Dame Street, Viau Street and Pie-IX Boulevard.

Initially, the MPA contracted SNC-Lavalin to conduct an overall project planning study for the site. This study aimed to identify any major constraints and determine whether prerequisite studies would be required, as well as proposing and analyzing various development options, and recommending innovative and sustainable solutions to optimize the site for its new purposes.

In order to plan the works and estimate all associated costs, it was very important to call on a multidisciplinary team with experience in this type of redevelopment initiative. Thus, SNC-Lavalin brought together a team of experts to create preliminary plans for the different scenarios and to assess the corresponding costs.

Before selecting the best redevelopment scenario, SNC-Lavalin first performed a comparative analysis of various scenarios by using multiple criteria analysis. These criteria were developed in conjunction with the MPA and various experts during work sessions.

The discussions and ideas tabled during these workshops ultimately helped guide the study toward variations on the initial solutions. The goal was to improve the scenarios that had been developed and determine their strengths, weaknesses, and any impacts on work budgets and schedules.

Subsequently, SNC-Lavalin was tasked with producing the plans and specifications for all the facilities required for the site redevelopment project.

Valued at $30.6M, this project included:

- Dynamic soil compaction;
- Relocation of railway tracks and rail car storage areas;
- Construction of sewage, water supply, electrical and lighting infrastructure;
- Safe reuse of contaminated soil on the site following S/S treatment;
- Design and construction of port pavement.

Initially, the scope of the project was not clearly defined, as there were various redevelopment options for the terminal (each varying in size and purpose) being studied. By that point, however, an important challenge had been identified: the project could not exceed the budgeted amount of $30.6M. Moreover, the MPA hoped to complete the preparatory works (soil compaction and water mains) in 2012, prior to the onset of winter. This meant that there were just three months to conduct the feasibility study and complete the plans and specifications for the preparatory works. The site redevelopment works would then begin the following spring and be completed in 2013, again requiring the production of plans and specifications within a short timeframe.

The MPA set December 2013 as the target for commissioning the new terminal facilities. Project phasing and activities were planned in accordance with this target, and thus work was commenced on many fronts, including overlapping soil compacting and railway track relocation works. In addition, facility design had to take into account the progress of works on the site and the changes in order to combine upcoming work packages. Since the SNC-Lavalin team was involved from the start of the planning phase, it was able to anticipate challenges and make adjustments to suit the MPA's needs. The team was also able to provide the client with assistance in this very dynamic and complex project environment.

SNC-Lavalin supervised the dynamic soil compaction works, ensuring compliance with the performance criteria set out in the specifications. Additionally, SNC-Lavalin performed quality control and inspection throughout the duration of the project. A tremendous effort was made to verify the performance of the sub-base of soil treated using the S/S process, from both physical and chemical standpoints and taking into account that this was a one-of-a-kind S/S treatment project.

ANNEXES

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