

**Hawkesbury Hydro 115kV
Substation Budget and
Construction Review**



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1.0 INTRODUCTION

Hawkesbury Hydro hired BPR (Tetra Tech) in May 2012 to provide project management, electrical and civil/structural engineering design and construction supervision services for the upgrades to their 115kV existing substation. Most of the major substation equipment was then pre-purchased over the 2 years that followed, and some construction activities were carried out, including the installation of a new control building within the substation.

In January, 2015, Stantec Ottawa was approached by Hawkesbury Hydro to provide a technical review of the 115kV substation design documents that had been prepared by Tetra Tech and to satisfy Infrastructure Ontario's Independent Engineer reporting requirements.

In April, 2016, after discussion with Infrastructure Ontario, Stantec Ottawa introduced Hawkesbury Hydro to the Stantec Montreal power systems group. Stantec Montreal was hired to act as Hawkesbury Hydro's construction management consultant, providing review and project administration services to help assemble a complete package for tendering the outstanding construction work and overseeing the project through completion. Stantec Montreal and Tetra Tech began working collaboratively, managed to secure the two remaining approvals required for the substation project to go forward, from the Ministry of the Environment, and Hydro One, and tendered the remaining construction work to a list of qualified contractors.

The project was awarded to the lowest bidder, Eptcon Ltd. and construction began on September 26, 2016. Much of the civil and foundations work for the new substation equipment was subsequently completed and the project was on track for completion by its target date of December 15, 2016. In mid-November, the decision was made by Hawkesbury Hydro to delay the remainder of the construction until the spring to reduce the risk of an outage in December, during peak loading conditions. The project is now scheduled to be completed at the end of May, 2017. As per the Eptcon and the engineering team, there is not expected to be any additional costs or delays above and beyond what has been reported to date.

The budget for this project has increased by more than 100% from Tetra Tech's original 2012 estimate. The current budget, based on costs spent to date and contracts in place, is reviewed in the sections that follow, as are the recent cost escalations. The risks and their potential to result in additional costs is then reviewed, and finally, recommendations to prevent further cost escalations are provided.

2.0 PROJECT COST ESCALATIONS

Tetra Tech's original (Rough Order of Magnitude) estimate for this project was \$1.599M. Their explanation is that this estimate was prepared prior to any detailed engineering being done. Once approvals were sought out from various authorities, Tetra Tech realized that additional equipment would be required, including a new control building, loadbreak switches, and ground grid. In April 2015, Tetra Tech submitted revised a cost estimate of \$2.83M, citing these reasons for the \$1.2M budget escalation.

In Stantec's initial project review report submitted to Infrastructure Ontario in November 2015, Tetra Tech's budget was adjusted to allow for re-testing of pre-purchased substation equipment, construction administration and our Independent Engineer reporting fees to reach a budget of \$3,030,800. The subsequent funding provided by the April 2016 financing agreement that followed was based on this estimate. A total of \$3.03M was allocated, between the original 2012 and the 2016 Infrastructure Ontario loans, to fund Hawkesbury Hydro's 115kV substation project.

In June 2016, following Hawkesbury Hydro hiring Stantec Montreal, a meeting was held in Hawkesbury with Infrastructure Ontario, Tetra Tech, Hawkesbury Hydro and the Stantec Ottawa and Montreal personnel, as Tetra Tech was resuming design activities. During that meeting, it was understood that Tetra Tech would be reviewing and submitting a revised budget prior to issuing the final tender package. When Stantec later followed up with Tetra Tech to provide this revised budget, they insisted that the latest estimate that they had presented over a year earlier was still accurate and needed no revisions.

Prior to tendering, \$1,466,816 of the total available funding of \$3.03M had already been spent, and the remaining funds left to support completion efforts were \$1,563,984, with \$945K allocated for construction, \$377K for indirect costs, and a \$275K contingency. When the tender closed and the contract was awarded to Eptcon for **\$1,540,799.00** in September, Hawkesbury Hydro, Tetra Tech and Stantec Montreal did not realize that Eptcon's bid was about \$500K more than the \$945K left in the budget for construction/direct costs. This was partially offset by the contingency and the savings in some of the budget indirect costs but still amounted to a net overrun of \$189K, with the budget increasing from \$3,030,800.00 to \$3,219,623.75. Stantec Ottawa reported this overrun when we became aware of it, as part of the November, 2016 Drawdown and Certification report.

This increase in budget was due to the accelerated construction period and associated overtime costs that were not accounted for because the 2015 budget was not revisited by Tetra Tech prior to going to tender. The other major reason for the increase was that Tetra Tech had not considered the funds already spent on construction in the 2015 budget. For example, Tetra Tech's 2015 budget allocates \$607K for civil and structural works, while Eptcon's reported cost for the civil works alone is \$609K. Eptcon's civil costs would be greater than reported in the budget because some of the labor would be charged at a premium in order to complete the project quickly, and during the fall/winter months. To compound this, the budget failed to account for

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the \$200K already spent on civil works in 2014.

As per the January 31, 2017 letter from Tetra Tech, attached as Appendix A, they confirm that the condensed schedule was not accounted for in their budget and claim that they just recently became aware that some of the budget had already been consumed in previous project phases. While they have had a number of personnel changes throughout the course of the project, Tetra Tech, as a company, has been the engineering consultant since the preliminary design phase of the substation upgrade. Prior to Stantec's involvement, all previous drawdown requests were prepared and certified by Tetra Tech personnel. As part of this exercise, Tetra Tech was sent all of the invoices from 2013-2014 and had to review them; they were fully aware of the costs spent to date on the project.

Tetra Tech finally revisited the budget in January 2017, and arrived at a figure of \$3.36M, which was \$140K more than the latest budget submitted as part of Stantec's November 2016 Drawdown and Certification Report, based on contracts in place. The reasons for this overrun are summarized as follows:

- Tetra Tech informed Hawkesbury Hydro in December, 2016 that they would be billing them for up to an additional \$25K in fees for construction supervision services
- Hawkesbury Hydro was invoiced directly by Mindcore for \$69K for the loadbreak switches; we were unaware that there were any further construction costs owed outside of Eptcon's contract when compiling the November report
- The construction documents had to be resubmitted to the Electrical Safety Authority (estimated \$5K in review fees)
- Due to the decision made in late November to defer completion of construction until the Spring of 2017, Stantec Ottawa required \$12K extra fees to cover additional site visits, and to provide additional reports to I.O. and ongoing support to Hawkesbury Hydro.

2.1 CONSULTING ENGINEERING FEES

Hawkesbury Hydro accepted an engineering services proposal for **\$100,000.00** (plus expenses) from BPR (Tetra Tech) in May 2012 to provide project management, electrical and civil/structural engineering design and construction supervision services for the upgrades to their 115kV existing substation. The agreed upon scope of work, deliverables and fees are outlined in BPR's proposal, attached as Appendix B. As indicated, Tetra Tech's mandate was to carry the project from preliminary design all the way through until the end of the construction period.

Tetra Tech invoiced Hawkesbury Hydro in full for their \$100,000.00 fee, but did not perform all of the services outlined in their fee proposal, including:

- Production of a complete and thorough design package that could be used to solicit bids for a Fixed Price Contract to complete the substation upgrades.

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- Performance of project management services: Hawkesbury Hydro had to direct much of the work, including letting contracts to sub-contractors, scheduling construction, and otherwise organizing the on-going completion of the project; Hawkesbury Hydro does not have the appropriate capabilities, insurance, or capacity to act as the constructor. They enlisted outside assistance from other firms, including Sproule and General Electric, incurring additional costs, until Stantec Montreal was eventually hired in April, 2016.
- Construction supervision services: Tetra Tech's original proposal included 12 site visits during the construction period, which should have been sufficient to carry the project through to completion. It is not known how many times Tetra Tech actually visited the substation during the construction activities that took place in 2013-2014.

Tetra Tech sent Hawkesbury Hydro an additional proposal in January, 2015 to complete their design, update their cost estimate, and provide construction support remotely, from their Montreal office. This fee proposal was for **\$62,000**, but specifically excluded any site visits during construction and management of the Hydro One mandate COVER process/testing. In December, Tetra Tech sent an additional fee proposal to Hawkesbury Hydro for **\$25,669** for construction site visits and management of the COVER process. By the time the project is completed, Hawkesbury Hydro will have paid Tetra Tech up to **\$313,593** for engineering services.

Tetra Tech's fees amount to nearly **10%** of the overall project cost for the upgrades to Hawkesbury Hydro's 115kV substation (based on the latest **\$3.36M** estimate). At the beginning of the project, Tetra Tech's \$100K fee amounted to 6.25% of the estimated project cost, based on the \$1.599M first estimate. While the budget was initially underestimated and has increased a number of times and by more than 200% overall, the increase in Tetra Tech's fees has been disproportionate.

3.0 CURRENT BUDGET REVIEW

The total project budget is now estimated at **\$3.36M**, based on the amount spent to date, plus the balance of contracts with Eptcon, Tetra Tech, and Stantec. This estimate was prepared by Tetra Tech in January 2017 and is attached as Appendix C. We have been assured that there are no other parties owed payment for work previously completed nor is there any work left to be completed not covered by these contracts. Tetra Tech's January 31st letter reaffirms their confidence in the estimate presented a few weeks ago, and states that they've accounted for all foreseeable costs to complete their mandate.

Email correspondence from Eptcon, attached as Appendix D confirms that they've covered all potential costs associated with the completion of the construction, provided all of their required work has been laid out in the tender documents. The drawings and specifications were reviewed by Stantec's Power Systems group in Montreal, who specialize in substation engineering. Their comments and revisions were incorporated into the documents before they were issued for tender. It is unlikely that there is any required work that has not been captured within the tender documents. If any apparent gaps in work scope or inconsistencies remained in the tender documents after they were reviewed by Stantec, revised by Tetra Tech and issued, they should have been noticed by Eptcon and addressed by the team prior to this late stage of construction.

3.1 MAJOR EQUIPMENT

All of the major substation equipment required for construction completion has been delivered and is either being stored within the substation or the adjacent lot, which has been rented by the contractor. Eptcon cites that there could be unforeseeable costs as a result of problems with pre-purchased equipment that has been stored on site since 2014, but that such problems are unlikely because equipment has been stored in accordance with manufacturers' recommendations for long term storage. The pre-purchased equipment currently being stored on site or in the adjacent lot is depicted in the photos below, taken by Stantec on February 3, 2017:



Figure 1: 115kV 3-pole circuit switcher



Figure 2: 110kV/12.48kV 15/20/25 MVA oil-filled transformer

The circuit switchers, manufactured by Siemens, were delivered to the substation in 2014. Siemens has since revisited the substation to re-examine the circuit switchers to determine if any action was required since they'd been stored long-term and never energized. Siemens had recommended replacement of one of the spare part kits, and the cost of this work has been covered within Eptcon's contract.

The transformer was tested in the factory the manufacturer, Pennsylvania Transformer, and again by General Electric (GE) in September, 2014, when it arrived on site. Transformer test reports from Pennsylvania and GE are included as Appendices E and F, respectively. As per the recommendation on page 2 of the GE report, the transformer's control cabinet has been supplied with a 240V circuit from a panel in the control building to power the heater while the transformer has been out of service. The decision was made by the team to defer further transformer testing on the new T3 until it has been moved to its final location, in April. It is possible, but not likely, that moisture has infiltrated the transformer's insulating oil over the previous 2.5 years. Once the transformer is relocated to its concrete pad, an oil sample will be taken and tested to determine if this is the case. In the unlikely event that the oil has been compromised, the transformer would have to be drained and refilled in advance of energization.

At an additional cost, an oil sample could be taken in advance of moving the transformer so the integrity of the oil could be determined ahead of time. If the results indicate that the transformer oil needs to be replaced, however, there will be no significant benefit or cost savings achieved by determining this in advance of the transformer's relocation. Other than moisture content in the oil, it is very unlikely that the integrity of the transformer or its components has been compromised

as a result of it sitting idle in the substation since 2014. It is not uncommon for substation transformers to be stored outdoors, de-energized for long periods of time.

3.2 REMAINING CONSTRUCTION ACTIVITIES

The project was awarded to the successful bidder, Eptcon Ltd. for **\$1,540,799.00** (taxes excluded) and construction began on September 26, 2016. Much of the civil and foundations work for the new substation equipment was subsequently completed and the project was on track for completion by its target date of December 15, 2016. In mid-November, the decision was made by Hawkesbury Hydro to delay the remainder of the construction until the spring to reduce the risk of an outage in December, during peak loading conditions.

During the changeover, the Hawkesbury Hydro customers are required to be supported by a single transformer for a significant period of time. Hawkesbury Hydro is able to divert some customers to its 44kV substation through switching, but there is still a higher risk associated with having only one transformer in service in the 115kV station, instead of two. This condition is much less risky in the spring, when the loading levels on Hawkesbury power system are substantially lower. The decision to delay the remainder of the construction did not result in additional costs from the contractor, Eptcon, because their costs for remobilization, additional labor, etc. were offset by the overtime costs built into their original bid price, due to the accelerated schedule that was originally mandated by the tender documents.

Hawkesbury Hydro's two original 115kV/12.47kV transformers T1 and T2, shown in the photo below, are currently energized, supplying power to the town until construction resumes in the Spring, while the new Transformer T3 is idle, sitting in the substation next to the control building.



Figure 3: Existing (Original) Substation Transformers

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As per Eptcon's most recent construction schedule, attached hereto as Appendix G, they are planning to re-mobilize at the end of March, and Transformer T1 (shown on the right in Figure 3) will be taken offline and moved to its new concrete pad. The system will be supplied only by Transformer T2 (left) for the month of April, while the structures, cabling, and protection work are completed for new Transformer T3, circuit switcher and loadbreak switch and the equipment is moved into place and tested. It is estimated that Transformer T3 will be energized during the last week of April. Subsequently, Transformer T2 will be taken offline and the entire system will be supplied by the new Transformer T3 for the first few weeks of May, while the circuit switcher, loadbreak switch, and additional work is completed to reconnect Transformer T1 into the system.

The contractor's remobilization and resumption of the civil work could be delayed in the event of significant snowfall at the end of March and/or beginning of April. It appears that Eptcon has some buffer built into the schedule and another short delay due to weather would therefore be unlikely to impact the schedule or cost, however; the remaining construction work was originally scheduled to be completed within a 4-5 week period at the end of 2016 and now the same work has been spread over a 2 month period.

The factor that has the most significant impact on the Hawkesbury Hydro system's electrical loading is the weather, with the colder weather bringing the heaviest loading conditions. Historically, the period during which the peak electrical loading on the system has been the lowest is between April and mid-June. During the approximately 6 weeks when only one transformer in the 115kV substation will be connected and operating at a time, Hawkesbury Hydro will be monitoring the loading levels on a daily basis. They will perform switching if and as required to alleviate the loading on the 115kV substation, transferring customers to their 44kV substation. This process will be much more manageable during this period of low demand, as compared to November and December. Operating only one 115kV station transformer during winter, as originally planned, would have increased the risk of an outage, and a failure during peak loading conditions likely would have led to an unavoidable construction delay, and additional costs.

Delaying the rest of the construction and the changeover to the Spring has reduced the likelihood of an outage, and the lighter system loading conditions will provide Hawkesbury Hydro with more flexibility to supply their customers and respond to changes in loading, and minimize the impact on the construction activities in the event that there is an unexpected outage or failure.

4.0 RISKS OF FURTHER COST ESCALATION

As discussed in the previous section, the decision to delay the remainder of the construction work has reduced the risk of further cost escalation by allowing two of the 115kV substation transformers to continue to operate until April, when lighter electrical loading conditions are expected. Weather could still be a factor, as it has an impact on the system loading and could delay resumption of civil work, but Hawkesbury Hydro will be monitoring the system loading daily and Eptcon's schedule appears conservative and so should not be impacted overall by delays due to weather.

Transformer T3 has been stored in the substation since 2014. At an additional cost, an oil sample may be taken and analyzed before construction is resumed at the end of March. Should the testing indicate that the oil needs to be replaced, knowing this upfront will only result in minor cost savings as compared to finding out when full testing is done in April after the transformer has been moved to its final location.

Additional risks that could potentially result in cost escalations are that equipment could be damaged during transport, there could be an electrical outage/failure or incident or construction accident, but none of these situations are likely or preventable at this stage, beyond taking reasonable care and exercising appropriate safety measures.

Until construction activities are completed, there is always a risk that unforeseeable conditions could arise that may impact the schedule and/or costs. Typically, there is a 5-10% contingency built into the project's budget and it is in place for the duration of the construction period to allow for such issues.

Risks discussed in this report are summarized in Table 1, below, complete with their potential impacts, probabilities, estimated costs and mitigation strategies. In most cases, the likelihood that the identified risks will occur and lead to additional cost escalations is unlikely, and the contractor, Hawkesbury Hydro and rest of the team have done or are already taking steps to mitigate these risks.

Table 1: Risk Summary

RISK	IMPACT	PROBABILITY	ESTIMATED COST	MITIGATION STRATEGY
Errors/Omissions in Construction Documents	Additional contractor costs	Unlikely	Varies depending on error/omission (\$10K - \$25K)	Documents have been thoroughly reviewed; issues detected earlier in construction period

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RISK	IMPACT	PROBABILITY	ESTIMATED COST	MITIGATION STRATEGY
Issues with Circuit Switcher after long-term storage in substation	Additional contractor costs	Very Unlikely	Cost would vary depending on specific issue (\$10K- \$25K)	Circuit switcher has already been re-examined by manufacturer, and spare parts kit replaced
Moisture content in Transformer T3 oil after long term storage in the substation	Additional contractor costs to drain and replace oil	Unlikely	\$25K - \$35K	Oil sample could be taken in advance of transformer relocation, but early detection would not result in significant cost savings for replacement of oil.
Other issues with Transformer T3 after long term storage in the substation	Component repair, or replacement costs (warranty period has expired)	Very Unlikely	Cost would vary depending on specific issue (\$15K - \$40K)	Transformer has been stored in accordance with manufacturer's recommendations for long-term storage.
Electrical outage/failure	Construction delay, possibly impacting cost	Very Unlikely	A minor outage unlikely to affect cost; a catastrophic failure cost variable	Changeover delayed until period of lighter loading conditions, reducing likelihood of outage; daily monitoring of system loading
Unforeseeable site conditions	Delays and/or additional costs	Unlikely	Variable (5-10% contingency is typical)	N/A

4.1 RECOMMENDATIONS

It is our opinion that no additional action can reasonably be taken to reduce the likelihood of further cost escalations; any investigative work that can be done prior to resumption of construction activities, such as transformer oil sampling and testing, will be subject to additional fees and only result in early detection of issues that have a low probability of occurrence, and minor cost savings.

Similarly, closer project oversight by Stantec can only ensure that any potential issues that may lead to additional costs or delays are detected earlier and reported to Infrastructure Ontario immediately, but we are unable to take or recommend any further preventative action at this point.

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It is unusual to operate with a project budget that has no contingency included to deal with the financial impact of potential issues that cannot reasonably be predicted. Until construction is completed, there is always the possibility that unexpected issues could arise and lead to cost increases and/or delays.