



Calgary

City Auditor's Office

Bonnybrook Plant D Expansion Audit

November 12, 2018

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Table of Contents

Executive Summary	5
1.0 Background	6
2.0 Audit Objectives, Scope and Approach	8
2.1 Audit Objective	8
2.2 Audit Scope	8
2.3 Audit Approach	8
3.0 Results	9
3.1 Schedule	9
3.2 Safety.....	10
3.3 Quality.....	10
3.4 Environmental Risks	12
4.0 Observations and Recommendations	13
4.1 Work Package Schedule Status Reporting.....	13
4.2 Safety Training Verification.....	14
4.3 Materials Quality Documentation	15
4.4 ECO/ESC Plan Checklist Inspections.....	16

The City Auditor's Office completes all projects in conformance with the *International Standards for the Professional Practice of Internal Auditing*.

Executive Summary

The Bonnybrook Wastewater Treatment Plant's (WWTP) Plant D Expansion Project (the Project) will increase the Plant's treatment capacity by 30% to service projected population growth in Calgary and the surrounding communities, with a projected cost of \$636M. The Project will upgrade existing facilities and equipment, expand treatment capacity, and improve Bonnybrook WWTP resiliency and environmental performance. The Project comprises 14 Work Packages; planning began in 2013, construction in 2016, and completion is expected in 2025. The Project is part of a larger program of work at Bonnybrook WWTP that encompasses capacity upgrades to existing infrastructure, enhanced energy efficiency, electrical upgrades and the construction of a new Dewatering Building that supplies biosolids to the City's new composting facility.

The objective of the audit was to assess the effectiveness of The City's project management of the Project. The objective was achieved by evaluating the design and operation of Project controls that mitigate schedule, safety, quality, and environmental risks.

The audit approach focused on the design and operation of selected Project controls in operation during the time period June 2017 – June 2018. Where the operation of controls were reviewed, the sample selected related to Work Package 13A (refurbishment of Digester 5, and three additional Digesters); which was under construction during the time period audited.

We concluded that overall schedule, safety, quality, and environmental risks to the Project are appropriately mitigated. Project Work Package schedules are monitored, and a process is in place to provide verification of Construction Manager progress prior to payment authorization. To mitigate the risk of injuries on the Project site, safety controls include physical WWTP site security, Project work site access, Project safety training, and safety monitoring and reporting. Testing and commissioning of materials and inspections of installation are designed to support quality requirements. Weekly inspections support the Environmental Construction Operation (ECO) Framework which mitigates environmental risk to the Project and WWTP site.

We identified four opportunities to improve efficiency of controls through improvements in oversight, monitoring and reporting. We recommended:

- Improving transparency in progress reporting to reflect actual Work Package schedule information;
- Enhancing safety training verification checks;
- Incorporating quality into Work Package progress meeting agendas; and
- Monitoring fulfilment of Environmental Construction Operations (ECO)/ Erosion & Sediment Control (ESC) Checklist Inspection requirements.

While our observations arose from our review of the operation of controls related to Work Package 13A, our recommendations are expected to apply to and enhance the management of risk on all current and future Work Packages which make up the Project. The Project team have agreed with our recommendations, and have set action plan implementation dates no later than December 31, 2018. The City Auditor's Office will follow up on all commitments as part of our on-going recommendation follow up process.

1.0 Background

In 2014, The City approved expansion of Bonnybrook Wastewater Treatment Plant's (WWTP) Plant D to increase wastewater treatment capacity. Bonnybrook is the largest of The City's three wastewater treatment plants and it handles approximately 70% of Calgary's wastewater (Figure 1).

The Plant D Expansion Project (the Project) will increase Bonnybrook's treatment capacity by 30%, or 325,000 equivalent population (EP) to service projected population growth in Calgary and surrounding communities. The Project includes upgrades and enhancements to improve the long-term environmental performance which will help protect the Bow River for future generations.

The Project, a major work of Utilities and Environmental Protection, is comprised of 14 individual Work Packages managed by the Water Resources department at the Bonnybrook WWTP; each Work Package is managed as a project. As shown in Figure 2, the Project comprises of upgrades to current infrastructure, and installation of new infrastructure to enhance capacity. Figure 2 also shows additional projects that are being undertaken as part of the larger program of work on site which encompasses capacity upgrades to existing infrastructure, enhanced energy efficiency, electrical upgrades and the construction of a new Dewatering Building that supplies biosolids to the City's new composting facility.

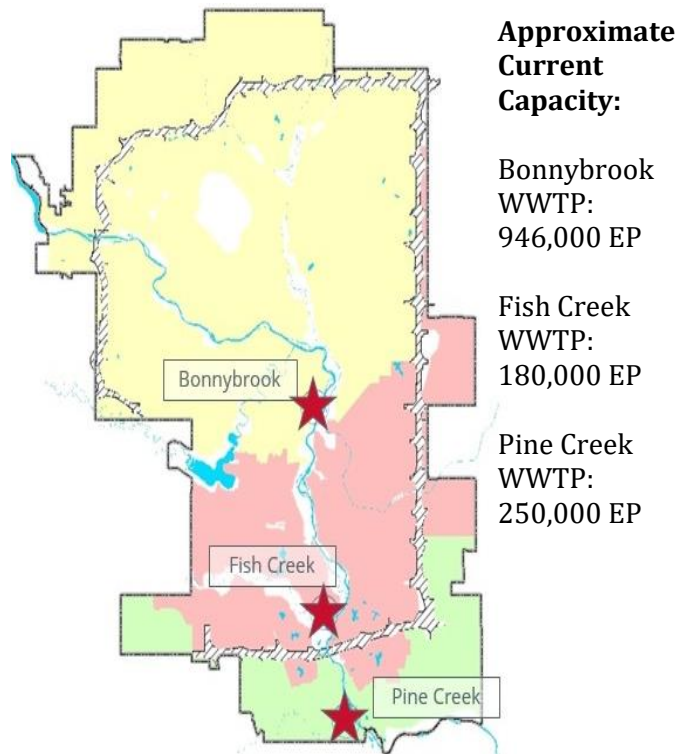


Figure 1: The City's wastewater treatments plants



Figure 2: Annotated Map of Plant D Expansion Project

The Project's cost projection is \$636M, and is expected to be completed by 2025. The expansion work began with planning in 2013 and construction work commenced in 2016. \$71.55M had been spent as of March 2018. The allocated budget for 2018 was \$69.84M.

The Bonnybrook Projects Steering Committee, as shown in Figure 3, is comprised of the Project's key stakeholders, and oversees the Expansion Project as well as the other Bonnybrook WWTP projects. The Committee reviews a standardized package from each Project that includes the Progress Reports, Risk Register, Safety Summary, Issues Log and other identified matters to guide and support the project management teams.

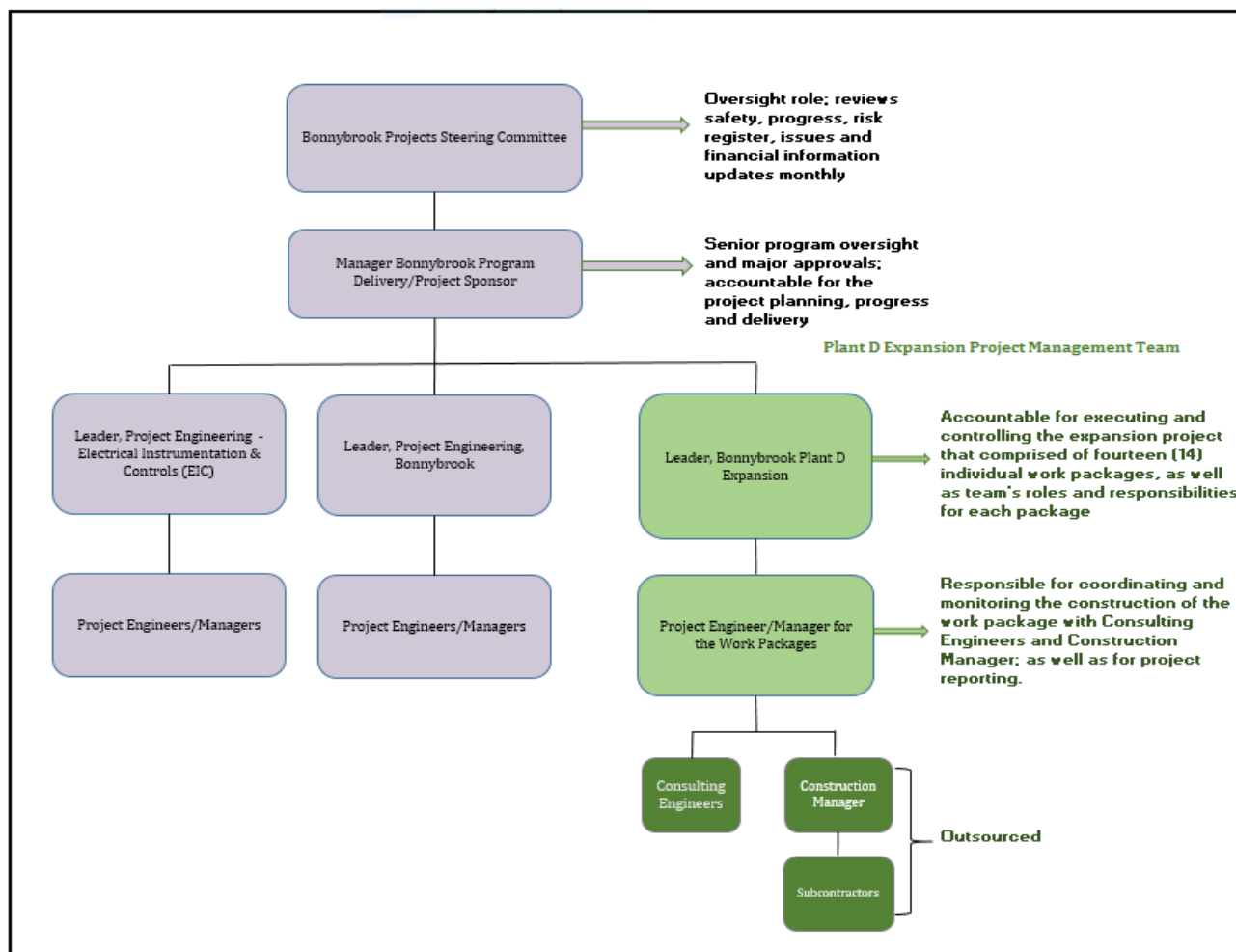


Figure 3: Bonnybrook Project Governance Structure

2.0 Audit Objectives, Scope and Approach

2.1 Audit Objective

The objective of this audit was to assess the effectiveness of The City's project management of the Bonnybrook Plant D Expansion Project. The objective was achieved by evaluating the design and operation of selected project controls that mitigate schedule, safety, quality, and environmental risks identified in our risk assessment.

2.2 Audit Scope

The audit focused on the design and operation of selected Project controls in operation during the time period June 2017 – June 2018. Where the operational effectiveness of controls were assessed, the sample selected related to the Work Package 13A (refurbishment of Digester 5 in progress at the time of fieldwork, and the additional refurbishment of a further three Digesters), as this was under construction during the time period of the audit. Work Package 13A occurs in the Solids Handling area of Bonnybrook WWTP (see Figure 2: Annotated Map - Plant D Expansion Project). The Work Package has an estimated cost of \$38.1M, approximately 6% of the total Project, and it is expected to be completed by March 25, 2021.

The audit did not focus on the design phase of the Project, nor on budget related funding decisions. In addition, as the Project's Work Packages have committed contracts at Guaranteed Maximum Price, risk to Project cost was not a focus of this audit.

2.3 Audit Approach

We conducted interviews with Project team staff, assessed the design of control documentation, and evaluated the operation of selected Project controls.

3.0 Results

We concluded that schedule, safety, quality, and environmental risks to the Project are appropriately mitigated. Project Work Package schedules are monitored, and a process is in place to provide verification of Construction Manager progress prior to payment authorization. To mitigate the risk of injuries on the Project site, safety controls include physical WWTP site security, Project work site access, Project safety training, and safety monitoring and reporting. Testing and commissioning of materials and inspections of installation are designed to support quality requirements. Weekly inspections support the Environmental Construction Operation (ECO) Framework which mitigates environmental risk to the Project and WWTP site.

Although some of the selected controls assessed had design or operating effectiveness issues, we noted other compensating processes that mitigated these risks to an appropriate level. Recommendations to strengthen these selected controls will improve effective Project oversight, monitoring and reporting.

3.1 Schedule

The Project has controls designed appropriately to mitigate the risk of delays to the Project either through the contractor (Construction Manager) experiencing delays, or through the City not being ready for the contractor to start construction. We identified one area where schedule reporting does not provide full information to support Project decision making.

We observed that weekly scrum meetings between the City Project team and Construction Manager confirm where the workers will be working, and what equipment they are working, in order to avoid safety mishaps, equipment assignment overlap, and work site conflict with day to day operational activities, which support Project site readiness and mitigates risks to schedule.

The City Project team, Consulting Engineers and Construction Manager meet bi-weekly to discuss a standardized Work Package review list. The review list includes a project schedule update based on the Construction Manager's actual Work Package progress status. This review of schedule also includes discussion of site readiness to mitigate the risk of the City not being ready for the Construction Manager to start construction.

Monthly, the Project Engineer for the Work Packages provides a Project schedule status (Normal/Concern) to the Bonnybrook Projects Steering Committee meeting based on information in the Project Reporting Tool Manager Report (PRT). We reviewed a sample of three PRT Reports and noted that schedule information (dates) aligned to progress information from the Construction Manager, and verbal information provided by the Manager, Bonnybrook Program Delivery, giving assurance that schedule information is closely monitored and accurately recorded. We identified in reviewing the sample reports that the schedule status for the Expansion Project was shown as "normal" in June 2018 despite the forecast completion dates for Work Package 13A being eight months behind originally planned schedule (see Section 4.1 for further schedule information), as the delay was not impacting the Project's critical path. The supporting PRT showed the schedule status of the Work Package as "normal". We recommended (Recommendation 1) that to enhance the accuracy, completeness and clarity of reported schedule information, the schedule status reported to the Steering Committee should reflect actual Work Package schedule information.

Two controls that mitigate the risk to the Project schedule are related to Project payments. Firstly, we confirmed that the Construction Manager will pay a daily penalty if Project completion is delayed beyond dates agreed to through City-approved change orders. At the time of the audit fieldwork no payments had been made or were expected to be paid. Secondly, a process of validation and approval of invoices submitted by the Construction Manager is required before payment is made. This process includes verification of project progress by the Consulting Engineers, and inspection of the Project site by the Project Engineer/Manager of the Work Packages, who recommends payment be made to the Leader, Plant D Expansion Program. This segregation of duties and independent verification of progress provides assurance that processes and controls are in place to support payments made based on actual project progress rather than planned schedule.

3.2 Safety

To mitigate the risk of injuries on the Project site, safety controls include physical WWTP site security, Project work site access, Project safety training, and safety monitoring and reporting. Project construction activities take place within designated areas of the WWTP, and on-going daily operations must also be maintained elsewhere in the WWTP.

Bonnybrook WWTP has physical controls to prevent unauthorized site access. We observed fencing around the WWTP, and observed that during the day, access to the site is only by access card (for designated City employees and contractors) or by visitor sign in at the main entrance (barrier controlled). At night, electronic gates only permit designated employee and contractor access, and security patrols are in place to monitor any unauthorized access. Safety training is required to be completed before authorized employees, contractors and visitors access the Project site. As part of weekly Project site safety inspections, spot checks are made that individuals on the Project site have completed the required training. However, this verification has not been designed as an effective control (Section 4.2) and requires adjustment (Recommendation 2) to give assurance to the Leader, Bonnybrook Plant D Expansion, that individuals accessing the site have taken appropriate safety training.

In addition to safety training, we observed that information regarding risks in the immediate Project work area is posted up on a podium positioned at the entrance to a Project work area. Workers accessing the Project work area are required to sign in and are able to read the Field Level Risk Assessment, which provides information on risks and hazards in the specific Project site. This acts as an additional control should an employee, worker or visitor access the work area without having completed required safety training.

The Expansion Project Safety Advisor prepares a monthly safety summary which is reviewed by the Steering Committee. We reviewed a sample of three monthly summaries from 2018, and re-performed the Total Recordable Incident Frequency calculation to confirm accuracy of the calculation. We were able to confirm that appropriate follow up action had been taken where a safety incident was reported in one of the three monthly summaries reviewed.

3.3 Quality

The Project team have designed controls to mitigate the risks that Project materials do not meet quality specifications, and that installation is not completed to the quality and specifications of the contract. We identified one instance where a materials quality control

was not operating in Work Package 13A as designed, which was mitigated by additional quality controls designed to capture materials defects following installation.

The Project's Technical Specifications establish the materials quality requirements for the Digester upgrades, including Work Package 13A (Digester 5). Per the Technical Specifications two materials quality tests are required: Factory Acceptance Testing (FAT) of significant components before leaving the factory; and Guaranteed Performance Acceptance Testing (GPAT). FAT are required for Digester Pump House and Motor Control Centre, key components of the Digester Work Package. Approved shop drawings specify that GPAT should be completed for two of the six Digesters once in operation.

We reviewed documentation that confirmed FAT was completed for Digester 5's Digester Pump House. However, we identified that FAT for the Motor Control Centre was not performed; Factory Testing was performed by the manufacturer, but it was not witnessed by City representatives. This change to Technical Specifications was an agreed decision by the Project team based on a risk discussion (Section 4.3), and, while this change did not increase the risk of materials failing to meet quality specifications, and the Project team had appropriate authority to make this change, we raised a recommendation (Recommendation 3) that Work Package progress meeting agendas should incorporate quality as a standard item to capture changes from planned quality processes.

Should a materials quality issue not be identified through FAT, additional material quality processes and controls which could identify an issue include the Substantial Performance Certificate upon successful completion of the Digester commissioning testing, and associated warranty period provided by the Construction Manager.

GPAT is completed once a Digester is back in operation. We confirmed that the GPAT for Digester 6 (recently brought back into operation after refurbishment) was scheduled for completion during Q4 2018, which provides assurance that GPAT is operating as a part of the designed Expansion Project quality controls.

As construction on a Digester progresses, the Construction Manager completes quality inspections of their installation based on their Quality Plan. The Leader, Plant D Expansion Project, and Project Engineer/Manager of the Work Packages, conduct walk-through inspections of the Project site. A key control mitigating the risk of poor quality installation is the regime of independent quality inspection reviews completed by the Consulting Engineers. The Consulting Engineers' Services During Construction agreement with The City states that they coordinate and review quality reports from 3rd party inspection & testing agencies, and review and comment on 3rd party testing and inspection approach and reports.

During the time period audited, two 3rd party installation inspections were completed on Digester 5 (Work Package 13A). We confirmed through reviewing documentation that each inspection was responded to by the Consulting Engineers within 24 hours, and deficiencies were appropriately reviewed and addressed which gives assurance that on Work Package 13A, this control is operating as designed, and provides independent assurance to the Project team regarding installation quality.

3.4 Environmental Risks

The Environmental Construction Operation (ECO) Framework was formally established and agreed upon (2014) by The City of Calgary, The City of Edmonton and the Province of Alberta. Within this Framework, the Project Construction Manager prepared (June 2017) an ECO Plan for the Digester Upgrades (including Work Package 13A) which documents the specific environmental protection and mitigation measures that the Construction Manager and any subcontractors will implement over the course of the Project to mitigate environmental risks to the Project and/or Bonnybrook WWTP.

ECO/ESC (Erosion and Sediment Control) Plan Checklist Inspections are operating to provide confirmation to the Project team that the Plan is being enacted, and environmental risks are being identified should they materialize. The Checklist Inspections follow a set template, which covers key aspects of the ECO Plan. During the time period June 2017 – June 2018, we observed that 58 ECO/ESC Plan Checklist Inspections were completed by the Construction Manager. We reviewed a sample of three Checklist Inspection reports; two of the three reports identified deficiencies and we were able to confirm that deficiencies identified had subsequently been corrected.

While our review indicated that the Checklist Inspections were operating as an effective control to mitigate environmental risk, as deficiencies were identified and corrected, we also identified that the Checklist Inspections were not operating as a control as designed and defined by the Project team. The frequency of Checklist Inspections during the time period reviewed did not align to the written expectations in the ECO Plan, and the expectations regarding communication of deficiencies were not being completely fulfilled (Section 4.4). To further enhance the operation of this control, we recommended (Recommendation 4) that the expectations as to the operation of this control be clarified and monitored to provide the project team with assurance that this control operates as designed.

We would like to thank staff from the Bonnybrook Plant D Expansion Project team for their assistance and support throughout this audit.

4.0 Observations and Recommendations

4.1 Work Package Schedule Status Reporting

Schedule information communicated to the Bonnybrook Projects Steering Committee does not give a complete, accurate and transparent picture of individual Work Package schedule status, which may limit the ability of the Steering Committee to make informed and timely decisions.

The Bonnybrook Projects Steering Committee receive a status summary progress report, supported by a verbal update on the status of all Work Packages in the Plant D Expansion Project at monthly meetings. The status summary progress report is supported by a Project Reporting Tool Manager Report (PRT Report) provided to the Project Sponsor which provides a status for each Work Package (Normal/Concern) for Schedule, as well as for Quality, Budget, Land, Resources, and Stakeholders.

Plant D Expansion Project practice has been to report Work Package schedule status in the PRT Report as “Normal” unless the slippage in the schedule is impacting a critical path item and will impact the overall Plant D Expansion Project end date and/or increase Project costs. Information about the actual current schedule compared to planned schedule for Work Packages or the Project is not provided alongside the status to the Steering Committee.

The June 2018 PRT Report shows a schedule status of “Normal” for Digester 5 (Work Package 13A). However, supporting project information indicated that the Work Package was, at that point in time, estimated to be approximately eight months behind original planned schedule, with an anticipated completion of March 2021 versus an original planned completion of July 2020. The Manager, Bonnybrook Program Delivery, indicated that this delay in completion of this Work Package would not affect the overall Plant D Expansion Project end date, as (due to a slow-down in the rate of population growth caused by the economic downturn, and a resulting optimization of the Water Infrastructure Investment Plan) the start date of subsequent Work Package (9 -THP) had been postponed to December 2023 from its original start date of September 2020. As a result, Work Package 13A was shown as “Normal” in the PRT Report despite anticipated delayed completion, as the delay will not affect the schedule of other Work Packages nor will result in an increased construction cost. The status summary progress report presented to the Steering Committee showed an Expansion Project schedule status of “normal”. Additional written commentary to clarify the Work Package schedule status was not communicated to the Steering Committee.

Recommendation 1

Manager, Bonnybrook Program Delivery, to adjust progress reporting format to the Bonnybrook Projects Steering Committee to communicate actual Work Package schedule status in addition to an overall Project schedule status, and to incorporate supporting commentary to explain inter-relationships between Work Package and Project schedules.

Management Response

Agreed.

Action Plan	Responsibility
<p>Manager, Bonnybrook Program Delivery, will re-format the progress report presented to the Steering Committee to include individual Work Package schedule status for the Plant D project. This will include any required narrative to highlight links between the Work Packages and overall Expansion Project schedule status.</p>	<p><u>Lead:</u> Manager, Bonnybrook Program Delivery</p> <p><u>Support:</u> Leader, Plant D Expansion Project</p> <p><u>Commitment Date:</u> December 31, 2018</p>

4.2 Safety Training Verification

Verification of completion of required safety training is not currently designed as an effective control to mitigate the risk of contractors, City employees or visitors accessing the Project site without relevant safety information. If workers and visitors have not completed safety training, the risk of avoidable incidences and safety hazards will increase.

The City's Water Services provides online Wastewater Treatment Orientation for all site workers and visitors. The Construction Manager also provides safety training for all site workers and visitors, including a safety orientation and video, which must be completed annually. On completion of each of the two types of training, a sticker is issued which must be applied to the individual's hard hat as evidence the training has been completed.

To mitigate the risk that workers or visitors access the Project site without the relevant safety training, the weekly site safety inspections conducted by the Project Safety Advisor and Project Engineer/Manager include spot checks that hard hats worn by site workers/visitors have two stickers, indicating both types of safety training have been completed. The spot checks do not include tracing named individuals back to training records held by either the City or the Construction Manager. As the hard hats and associated stickers do not identify an individual (hats can be swapped or borrowed), the spot checks do not provide the Plant D Expansion Project Team with adequate assurance that safety training has been completed by individuals on the Project site.

Recommendation 2

Leader, Plant D Expansion Project, to work with the Construction Manager to review and redesign safety training verification checks to provide on-going assurance that workers on site have completed the relevant safety training.

Management Response

Agreed.

Action Plan	Responsibility
<p>Leader, Plant D Expansion Project, will require the Construction Manager to forward a list of all workers who have completed the Construction Manager’s Safety Orientation. During the weekly Joint Safety Inspections, the inspectors will ask a sample of workers to provide their names, and cross reference the names to the list of workers who have completed the Safety Orientation. If a worker’s name is not on the list, they will be immediately escorted off the site.</p>	<p><u>Lead:</u> Leader, Plant D Expansion Project</p> <p><u>Support:</u> Plant D Construction Manager; Plant D Consulting Team; Water Resources Safety Advisor</p> <p><u>Commitment Date:</u> September 28, 2018</p>

4.3 Materials Quality Documentation

Changes to the materials quality plan for Work Package 13A were not documented as part of bi-weekly progress meetings. The standardized template for Work Package progress meeting agenda items did not include quality. Fully documenting decisions regarding project quality supports on-going project knowledge and future lessons learned and supports risk management and associated informed and timely decision making.

The Project Team are using the project’s Technical Specifications framework as a key part of the documented materials quality plan. The Technical Specifications states that for Digester Pump House and Motor Control Centers (MCCs), which are key components of the Digester Work Package, “Construction Manager to include all costs associated with factory testing, Factory Acceptance Testing (FAT) witnessed by a City representative, and qualified manufacturer’s representative onsite for device programming, configuration, set-up, commissioning and certification of installation.”

Witnessing of the FAT for the MCC was not performed by a City representative. Factory Testing was performed by the manufacturer, and the FAT testing documentation was provided by the manufacturer to the City and to the Construction Manager. This deviation from the Technical Specifications was agreed to by the Project team, based on an informal risk assessment, which concluded that the risk of a poor quality product was low given that previously purchased MCCs for other Digesters from the same supplier did not have quality defects; that City representatives would witness a subsequent FAT test of MCCs at the same factory a few weeks later, and mitigating project quality processes in place, including commissioning testing and associated warranty period. The decision to deviate from the Technical Specifications was discussed and agreed to by the Project team at a Work Package progress meeting but was not documented.

While the deviation from the planned quality practices was supported by an informal risk assessment at the Project team level, undocumented decisions to deviate from the Technical Specifications increase the risk of gaps in project knowledge, and associated lack of understanding of why decisions were made, linked to appropriate project risk management.

Recommendation 3

Leader, Plant D Expansion Project, to incorporate quality as an agenda item into the standardized Work Package progress meeting template.

Management Response

Agreed.

Action Plan	Responsibility
<p>Leader, Plant D Expansion Project, will update the standard Work Package progress meeting template to incorporate quality as a specific item.</p>	<p><u>Lead:</u> Leader, Plant D Expansion Project</p> <p><u>Support:</u> Plant D Project Team; Plant D Construction Manager; Plant D Consulting Team.</p> <p><u>Commitment Date:</u> September 28, 2018</p>

4.4 ECO/ESC Plan Checklist Inspections

The ECO/ESC Plan Checklist Inspection expectations (frequency of inspection, communication and resolution of deficiencies) have not been actively monitored by the Project Team to ensure that expectations have been fulfilled. Active monitoring of the operation of the Inspection regime increases the likelihood that the control operates as designed by the Project Team, and acts as an effective control to support timely identification and resolution of environmental concerns.

The ECO Plan (prepared by the Construction Manager and Consulting Engineers) states that Construction Manager is to complete an ECO/ESC Plan Checklist Inspection every seven days, and within 24 hours of a significant weather event (rainfall or snowmelt). Deficiencies are to be “corrected appropriately based on severity” (ECO Plan p20).

The Consulting Engineers’ Services During Construction agreement with The City states that “periodic reviews” of ECO Plan compliance will be completed by the Consulting Engineers, and that “summary reports” will be produced as deliverables.

The Leader, Plant D Expansion Project’s expectation is that the Consulting Engineers review completed ECO/ESC Plan Checklist Inspections, communicate deficiencies to the Construction Manager’s Site Superintendent for correction, and provide a written summary report to the Plant D Project Team.

The Consulting Engineers have not completely fulfilled expectations during the time period audited. During the time period June 2017 to June 2018, 58 ECO/ESC Plan Checklist Inspections were completed, and interviews indicated that the Construction Manager was, when a weather event occurred, completing an Inspection and counting that Inspection as the weekly Inspection and weather event Inspection combined, rather than completing an additional weekly Inspection. While the Consulting Engineers were monitoring the Inspection completion through active participation in the Inspection process, they were not ensuring

that the desired frequency of Inspections was occurring. In addition, two of a sample of three Inspections reviewed in detail contained deficiencies that were not communicated by the Consulting Engineers to the Project Team, although we were able to confirm that subsequently the deficiencies identified in the Inspections have been rectified.

Recommendation 4

Leader, Plant D Expansion Project, re-communicate The City’s ECO/ESC Plan Checklist Inspection expectations (frequency of inspection, communication and resolution of deficiencies) to the Construction Manager and Consulting Engineers, and monitor fulfillment of these expectations.

Management Response

Agreed.

Action Plan	Responsibility
<p>Leader, Plant D Expansion Project, will re-communicate The City’s ECO/ESC Plan Checklist Inspection expectations via written communication with the Construction Manager and Consulting Engineers. The Consulting Engineers will be required to submit weekly summary reports to the Plant D Project Team, and report on the ECO/ESC Inspections during the bi-weekly progress meetings. The reports will be attached to the meeting minutes of the individual Work Packages.</p>	<p><u>Lead:</u> Leader, Plant D Expansion Project</p> <p><u>Support:</u> Plant D Project Team; Plant D Consulting Team; Plant D Construction Manager</p> <p><u>Commitment Date:</u> September 28, 2018</p>