Project Risk & Opportunity Register

System			Program Information about the Risk Event											
Risk ID; Sequential ID (system)	**Last Reviewed Date (System)**	**Status Change Date (system)**	**Identification Date**	**Project**	**Phase**	**Task Group**	**Contract (Bid Op)**	**Operational or Capital**	**Facility**	**Process Area (optional)**	**Discipline (Optional)**	**Risk Type; Program or Project Level Risk**	**Category of Risk; Design, Construction, HR, Procurement etc**	**Risk or Opportunity (R / O)**
			6-Jun-13	*NEWPCC Expansion*				*Capital*	*Control System*		*Automation*	*Project*	Construction	R
			6-Jun-13	*NEWPCC Expansion*				*Capital*	*Control System*		*Automation*	*Project*	Construction	R
			6-Jun-13	*NEWPCC Expansion*				*Operational*	*Control System*		*Automation*	*Project*	Operation	R
			6-Jun-13	*NEWPCC Expansion*				*Capital*	*Control System*		*Automation*	*Project*	Operation	R
			6-Jun-13	*NEWPCC Expansion*				*Capital*	*Control System*		*Automation*	*Project*	Construction	R
			6-Jun-13	*NEWPCC Expansion*				*Capital*	*Control System*		*Automation*	*Project*	Construction	R
														R
														R
														R

Risk Event Identification							Risk Event Assessment			
Due to (Cause Event)	**this could occur (Result Event)**	**Resulting in (this Effect)**	**Risk / Opp Owner (per Agreement); CofW or Shared**	**Risk / Opp owner (Individual responsible)**	**Status (Identified / In Development / Defined / Closed)**		**Magnitude of Risk Event(1-5)**	**Likelihood (1-5)**	**Assessed Score C X L**	**Risk Response Type (Avoidance, Transferance, Mitigation, Acceptance)**
ABB is sole supplier of S+ software / migration.	Non-competitive bid.	Price increase, delays, and contractual issues.	CoW		Identified		2	3	6	Acceptance
Selection of a poor Systems Integrator	Project delays, process upset, additional resource requirements	Additional costs for remediation of issues.	CoW		Identified		4	4	16	Mitigation
Two HMI Systems in parallel	Operator Error due to confusion	Potential equipment mis-operation or process upset.	CoW		Identified		2	3	6	Acceptance
Inadequate City Operations Resources	Poor operation support for control system tie-ins	Delay in the work, plant conformance issues	CoW		Identified		4	3	12	Mitigation
Installation delays due to phasing requirements, coordination and overall complexity	Project delays	Additional costs due to contractor / consultant delays.	CoW		Identified		2	4	8	Acceptance
Modifications to the DCS Network	DCS Network Issues	Loss of partial or whole plant monitoring and some control implications.	CoW		Identified		2	2	4	Mitigation
DCS and PLC must communicate.	Communication Errors between DCS and PLC	Operational upset.	CoW		Identified		2	2	4	Acceptance
DCS Cabinet rework	Inability to install new PLC controls after DCS has been removed.	Delays, operational issues, extended manual control period, non-compliance.	CoW		Identified		3	2	6	Transferance
Installation of new controls into an existing environment.	Hidden issues.	Delays, operational issues, extended manual control period, non-compliance.	CoW		Identified		2	4	8	Acceptance
									0	
									0	
									0	
									0	
									0	
									0	
									0	
									0	
									0	

Risk Response Assessment (based on an Implemented Risk Management Plan - future state)							
Risk Response Plan - Actions	**Residual Magnitude occur (1-5)**	**Residual Likelihood (1-5)**	**Assessed Residual Score**	**Cost of Mitigation ($,000)**	**Adopted**	**Financial risk after mitigation**	**Trigger date (mandatory review date)**
	2	3	6				
Ensure Systems Integrator selection process is based upon qualifications and demonstrated quality.	2	2	4				
	2	3	6				
Resource management plan to address capacity and skills.	2	2	4				
	2	4	8				
Review network segments in detail during detailed design.	2	1	2				
	2	2	4				
Transfer to Contractor - penalty clauses in contract.	2	2	4				
	2	4	8				
			0				
			0				
			0				
			0				
			0				
			0				
			0				
			0				
			0				

Risk Response Plan - Execution Log				Contingency Plan
Date for each action	**Mitigation Evaluation**	**Action Log Reference**	**Comments**	**Contingency plan**

Prepared By:	Curtis Reimer		
	Name	**Signature**	**Date**
Checked By:			
	Name	**Signature**	**Date**
Approved By:			

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APEGM
Certificate of Authorization
SNC-Lavalin Inc.
No. 4489

REVISION REGISTER

Rev.	Description	Date	By	Checked	Approved
PA	Issued for Review	2013-06-11	C. Reimer	E. Ryczkowski	-
PB	Issued for Review	2013-07-03	C. Reimer	E. Ryczkowski	-
PC	Issued for Review	2013-07-25	C. Reimer	-	-

NOTICE

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Table of Contents

1.0 INTRODUCTION

The City of Winnipeg has initiated a program to perform upgrades to the NEWPCC facility. Replacement of the existing control system with a new control system is required as part of the work, and the scope of this technical memorandum is to discuss the required work associated with tie-in of the existing DCS based controls into new control system. A high level overview of the control system tie-ins, including expected scope of work, constructability, schedule, constraints and risks are presented. The work in this document is based upon the City of Winnipeg/Veolia NEWPCC Process Selection Report, Phase 2 Rev. 0.

1.1 Definitions

CIU	Computer Interface Unit (DCS Interface to HMI)
DCS	Distributed Control System
E&I	Electrical and Instrumentation
FAT	Factory Acceptance Test
FRS	Functional Requirements Specification
HMI	Human Machine Interface
I/O	Input / Output
NEWPCC	North End Water Pollution Control Centre
PCU	Process Control Unit
PCV	Process Control View (Existing HMI software)
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
UPS	Uninterruptible Power Supply
VLAN	Virtual Local Area Network
WAN	Wide Area Network

2.0 SCOPE OF WORK

2.1 Existing Configuration

The existing control system at the NEWPCC facility is based upon Infi90 DCS hardware and associated PCV HMI software. Generally, the facility is configured such that one or more DCS Process Control Units (PCUs) control the process in each area. Each DCS PCU has redundant processors and centralized local I/O. The PCUs are typically located in a conditioned control room, with media filtration for corrosive gasses. The DCS PCU's are connected together on a dual ring proprietary network. Remote DCS I/O is typically not utilized, except for the UV disinfection facility. A typical configuration of the existing DCS is shown in Figure 2-1. This DCS is currently nearing the end of its effective service life.

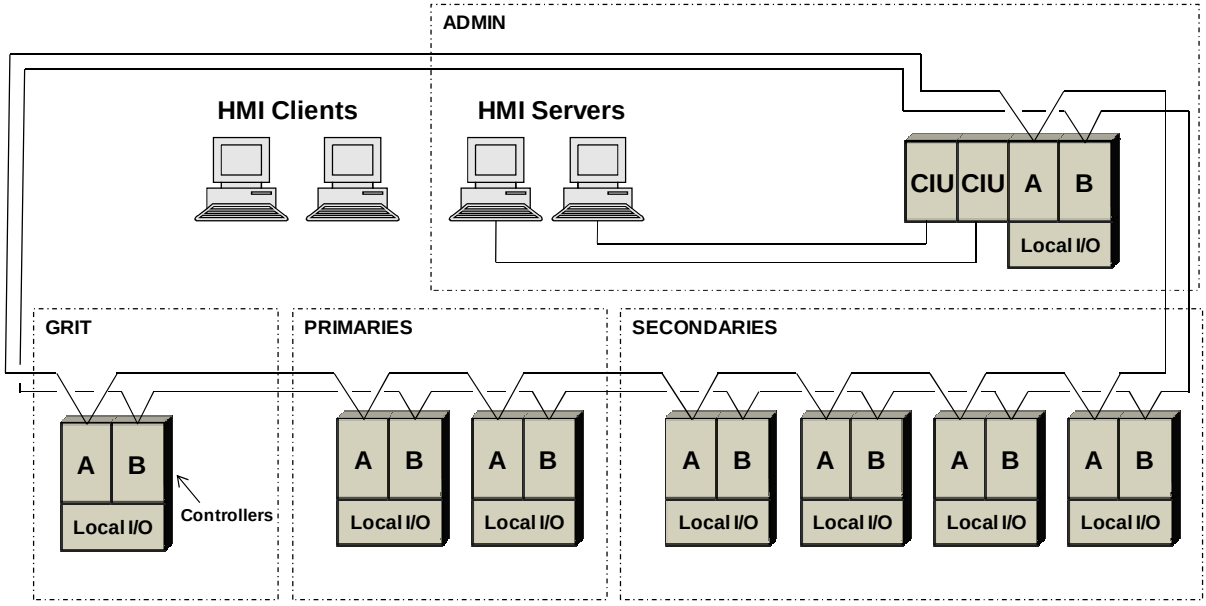


Figure 2-1 : Typical Existing DCS Architecture (Not Complete)

2.2 New Configuration

The ultimate configuration for the NEWPCC facility is discussed in detail in the Automation Master Plan document. It is based upon a distributed PLC style configuration, rather than the existing DCS configuration. All new process areas will be implemented with PLC-based controls, and monitored via a new HMI system. However, integration of the existing process areas to be maintained will be required. It is expected that within the process areas to be retained, that the process modifications will be limited. Thus, the interface between the existing DCS and the equipment will largely be retained, and the new PLC in these areas will simply replace the DCS I/O and reutilize most of the existing wiring. Any new equipment within the existing process areas could be connected to the same or different PLCs.

A summary of the City's current plans for the various NEWPCC process areas are summarized in Table 2-1.

Table 2-1 : Plans For the Existing Facilities

Process Area	Sub-Area	Current Control System	Proposed Plan	Notes
Administration	Miscellaneous incl. HVAC	DCS	Convert to PLC	
Main Building	Raw Sewage Pumping	DCS	Maintain until Demolished	
	Miscellaneous incl. HVAC	DCS	Convert to PLC	
Grit Building	Grit Process	DCS	Maintain until Demolished	
	Flushing Water System	DCS	TBD	
	Electrical System	DCS (M)[1]	Convert to PLC	
	Miscellaneous incl. HVAC	DCS (M)[1]	Convert to PLC	
Primary Clarifiers	Primary Clarifiers	DCS	Convert to PLC	
	Miscellaneous Systems	DCS (M)[1]	Convert to PLC	
Oxygen Reactors	Reactor Process	DCS	Maintain until Demolished	
	Miscellaneous Systems	DCS	Convert to PLC	
Secondary Clarifiers	Secondary Clarifiers 1-10	DCS	Convert to PLC	
	Secondary Clarifiers 11-26	DCS	Convert to PLC (Chlorination Tanks)	
	Miscellaneous Systems	DCS (M)[1]	Convert to PLC	
UV Disinfection	Low / Lift Pumps	DCS	Convert to PLC	Controlled from Admin Building PCU via remote I/O
	Disinfection	PLC/DCS	Convert to PLC	
	Miscellaneous Systems	DCS (M)[1]	Convert to PLC	
Boilers	All	DCS	Convert to PLC	
Digesters	Digesters 9-14	DCS	Maintain [2]	
	Miscellaneous Systems	DCS (M)[1]	Maintain [2]	
Dewatering Building	Process Systems	DCS	Maintain [2]	
	Miscellaneous Systems	DCS (M)[1]	Maintain [2]	
Septage Receiving	All	PLC	Integrate into new system	
Nitrogen Removal	All	DCS	Maintain [2]	

Notes:

1. *The (M) indicates that the DCS is primarily utilized for monitoring and alarming of the indicated process.*
2. *The existing DCS is expected to be maintained in the bio-solids areas until the new bio-solids plan is developed.*

3.0 DCS CONVERSION TO THE NEW CONTROL SYSTEM

3.1 General Description of the Work

As identified in Section 2.0, some of the process areas within the NEWPCC facility will be retained or upgraded, and will require replacement of the DCS system with the new PLC-based control system.

The migration of each existing DCS PCU to the new control system is not overly complex, however there are specific constraints associated with an operating facility. It is expected that the migration of equipment not significantly changed by the upgrades will take place by connecting the existing Infi90 I/O termination units to new PLC I/O modules. Many control system vendors have developed custom cordsets, which can connect existing Infi90 field termination units to the PLC I/O modules. This allows field wiring to remain unmodified, and allows the transition to occur during a relatively short shutdown window.

A representation of the final configuration of the migrated DCS system for a single process area, such as the Primary Clarifiers, is shown in Figure 3-1.

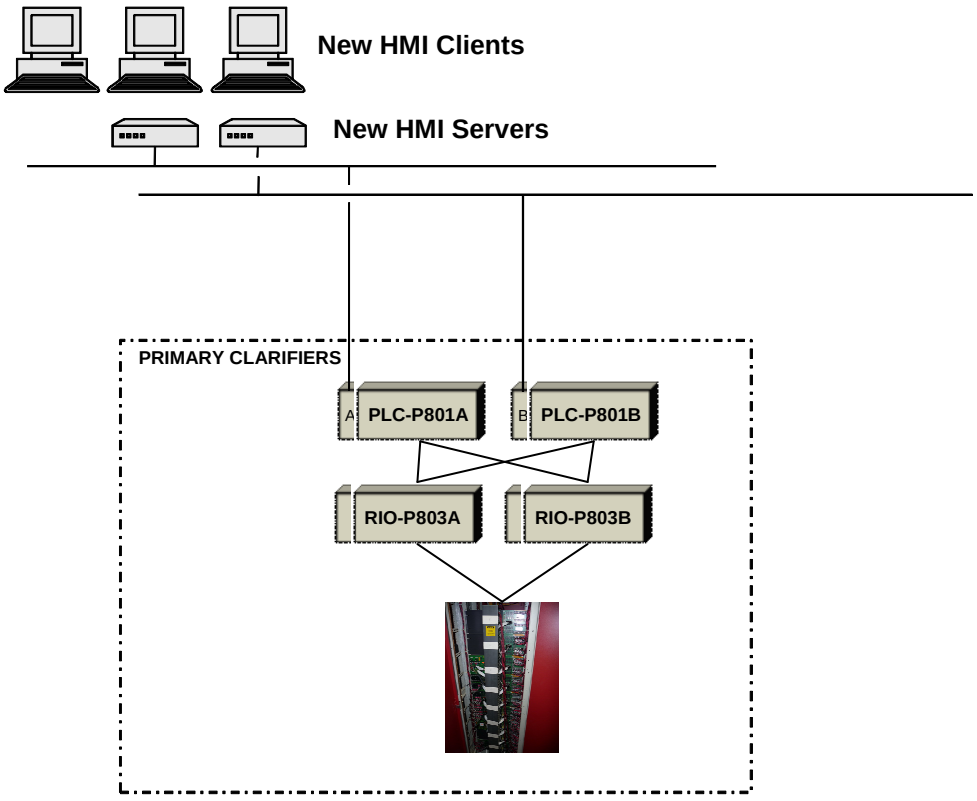


Figure 3-1 : Architecture of DCS to PLC Migration

3.2 Migration Tasks

The general migration sequence for each process area is shown in Table 3-1. The tasks in the table would be replicated for each process area. The actual period for the tie-in for each process area is typically quite short. With appropriate preparation and planning, the actual transition from DCS to PLC control can be made over a short period of as little as one or two days, not including commissioning. However, to accomplish these short tie-in windows, the predecessor tasks must be diligently completed to a high level of detail and quality. Any errors or omissions of the predecessor tasks will result in extended tie-in durations and issues during commissioning.

Table 3-1 : DCS Conversion Tasks

Task	Notes	Addressed under Tie-In[1]
Engineering design including preparation of comprehensive design drawings.		No
Preparation of a Functional Requirements Specification for the existing process areas to be re-utilized.		No
General engineering associated with the tie-ins and DCS system modifications.		Yes
Manufacture and installation of new control panels.		No
PLC and HMI Programming		No
Perform a comprehensive Factory Acceptance Test (FAT) on the area PLCs and HMI.		No
Migration Planning - Prepare detailed shutdown protocols to detail operation of the facility during the tie-in.		Yes
Install new PLCs in the area and connect the new equipment.		No
Existing equipment with significant modifications would be rewired to new PLC I/O in new PLC cabinets. This would include decommissioning of associated DCS I/O.		No
Existing DCS controlled equipment would be converted to PLC control during a short shutdown window.	2	Yes
Commissioning of existing processes controlled by the new control system.		Yes
Training of Operators		Yes

Notes:

1. *Only the items designated as being addressed under the tie-in are included in the cost estimate in Section 8.0.*
2. *The success of a transition to the new control system during a short shutdown window is dependent upon a detailed and comprehensive FAT process.*

3.3 Migration Planning

The successful migration of the DCS to PLC-based control within a short shutdown window is dependent upon careful and detailed planning. A detailed shutdown protocol should be prepared, which at minimum, includes the following:

- Pre-shutdown checklist
- Identification of operational impacts
- Protocol, including times, tasks, and responsibilities:
    - Operational requirements to transition to manual / backup control
    - Continuous manual operation requirements
    - Operational requirements when transitioning to PLC control
    - Contractor requirements
- Identification of contingency plans in response to significant risks
- Emergency contacts

3.4 Specific Tie-In Details

During the tie-in, the associated process area would be manually controlled, or turned-off as appropriate. Fortunately, most of the existing process areas within the NEWPCC facility have Field Device Panels with manual control capability, independent of the DCS. With appropriate planning and resource allocation, it is feasible to operate the facility manually on a temporary basis. During the DCS upgrade performed in 2005, manual control of the various process areas was performed during the DCS shutdowns.

Once the process is isolated from the DCS, the DCS would be turned off, and the DCS communication network jumpered to isolate the node. Where space is limited, the DCS modules and power supply would be removed to make space within the existing cabinet for the new PLC modules. The PLC modules installed would be pre-manufactured on a backplane to allow for a rapid installation. However, where space if available, it is recommended to consider installing the PLC in a separate, new control panel, to avoid the requirement to rework the DCS cabinets during the tie-in shutdown.

The PLC I/O modules would subsequently be connected to the existing DCS termination units with prefabricated cordsets, such that no rewiring of actual I/O wiring would be required. This allows for a significantly reduced shutdown window, and greatly reduces the potential for I/O errors upon startup.

Subsequent to the shutdown installation work, the new PLC would be powered and commissioned. The process would be switched back to automatic PLC control, unit by unit and commissioned. While subject to further review, there is potential for a 2-stage commissioning process. Given a comprehensive FAT process, and the fact that equipment and I/O errors should be minimal, it may be possible to perform a very brief commissioning on each piece of equipment to restart the entire process, and then on subsequent days, perform a more thorough commissioning process to comprehensively verify the new PLC control system. Further review of the commissioning process is required at the detailed design stage.

4.0 INTEGRATION OF EXISTING DCS IN BIO-SOLIDS PROCESSES

The City is currently developing a plan regarding the future bio-solids treatment processes. At this time, the continued use, or reconfiguration of any of the existing bio-solids buildings has not been determined, and as such the City does not desire to upgrade the existing DCS system associated with the bio-solids processes. However, the DCS system must be configured in a manner to allow for an appropriate level of continued monitoring and control, as other process areas are transitioned to the new control system.

4.1 DCS Network Modifications

Continued use of the existing DCS controllers as the new process areas are commissioned on the new control system will require some level of coordination. Specifically, the DCS Infi-Net communication loop must be maintained. The general routing of the existing redundant DCS network loop is shown on Figure 4-1

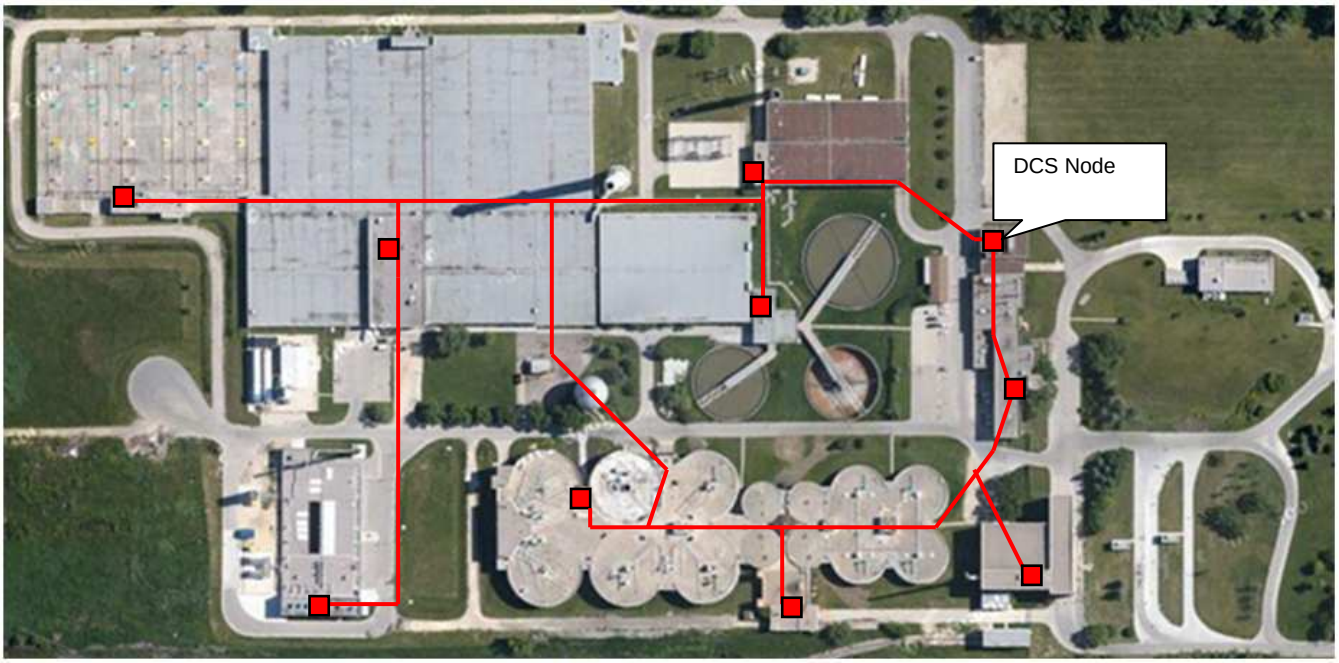


Figure 4-1 : Existing DCS Infi-90 Communication Network

As part of the proposed migration work, many of the DCS nodes will be migrated to PLC-based control and will communicate via a new process network for the PLC systems. The existing DCS network will need to be maintained to allow for continued communication between the DCS controllers and the associated HMI. It is anticipated that segment of the DCS network that are no longer required will be eliminated, but that most of the network will actually be maintained to avoid routing of new cables for the DCS network. See Figure 4-2 for the revised DCS communication network routing. Note that a DCS node is proposed to be maintained at the Admin Building for HMI system access.

Where DCS nodes are converted to PLC nodes, it is expected that the network cables, which are based upon twisted-pair wiring, will be jumpered to eliminate the migrated node. However, there will be some impedance at the jumper, and with increased segment lengths, there is some risk of network issues with the revised network layout. It is recommended that the revised DCS network layout be reviewed further during detailed design.

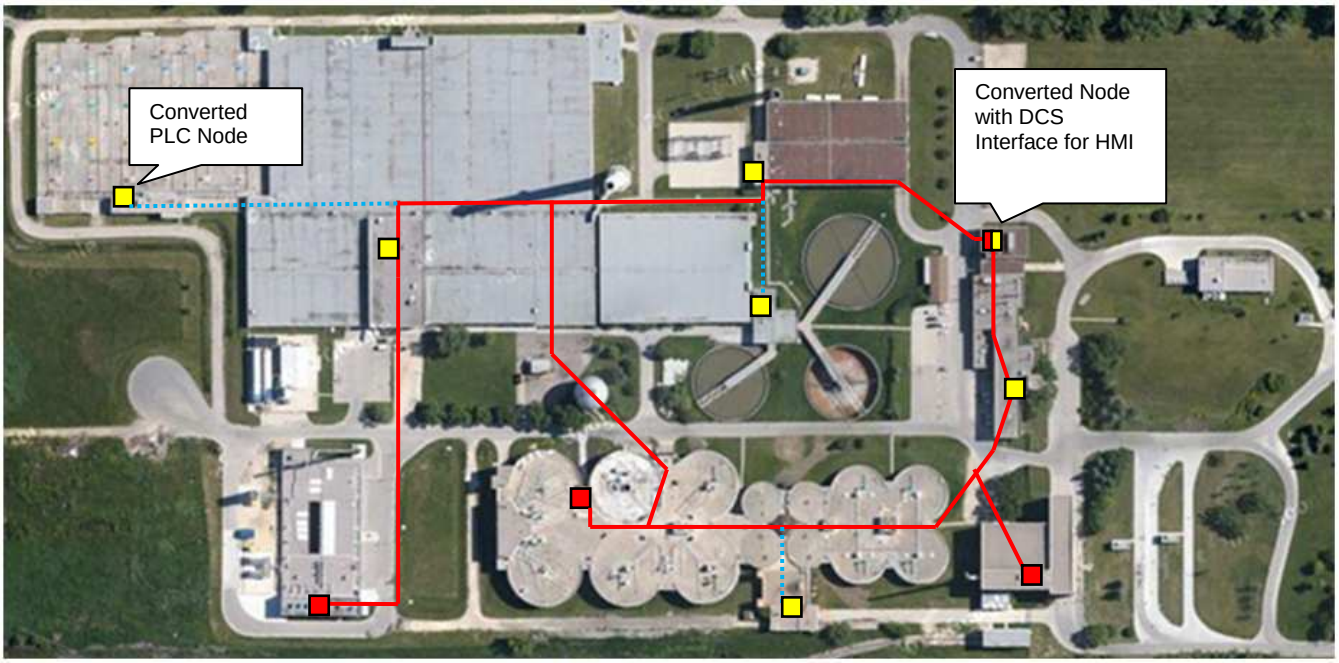


Figure 4-2 : Revised DCS Infi-90 Communication Network

4.2 DCS Signals With Other Process Areas

There are currently a limited number of control signals and interlocks between process areas in the existing facility. Currently, those interlocks are implemented over the DCS Infi-Net communication network. When process areas are converted to the new control system, the use of the Infi-Net communication loop for these signals and interlocks will be lost. The City currently has two BRC-410 DCS processor modules in the Dewatering Building. The BRC-410 processors are capable of Modbus TCP communication, and as this DCS node is proposed to remain for the near term, it is proposed to utilize these processors as an interface with the new PLC-based control system. Required signals would be communicated via this interface. The new PLC process network must be extended to the Dewatering Building to support this interface.

4.3 HMIS Servers and Computer Interface Units (CIUs)

The DCS Computer Interface Units (CIUs) allow the HMI servers to connect to the DCS control network. The HMI Servers are currently located in the Administration Building and Secondary Clarifiers Control Room. CIUs are currently located in the Administration Building, Secondary Clarifiers Control

Room, and the Nitrogen Removal Facility. Note that the Nitrogen Removal Facility CIU is currently unused.

As the Secondary Clarifier DCS will be decommissioned during the upgrades, it is proposed to relocate the redundant backup server from the Secondary Clarifiers to the Nitrogen Removal Facility, where a spare CIU is present. This is proposed to be performed as part of Tie-In 7C-1, described in Section 5.0.

4.4 DCS HMI

The existing DCS HMI is PCV, which suffers from obsolescence issues. There is a significant risk of a failure that could impact plant operation, prior to completion of the PLC replacement. At minimum, replacement of the DCS HMI is required to maintain operation of the existing facilities. The DCS hardware was upgraded in 2005, and with some maintenance, is expected to have a continued service life for the durations discussed in this report.

Options for addressing the DCS HMI obsolescence for continued use in the existing facilities are as follows:

1. Partial HMI Integration Integrate the bio-solids DCS hardware into the new main HMI system.
2. Complete HMI Integration Integrate the entire DCS hardware into the new main HMI system.
3. Independent S+ HMI Upgrade the existing HMI to ABB's S+ product line.
4. Independent PCV HMI Maintain the operation of the existing PCV HMI.

Each option is discussed further in the sections below.

4.4.1 Option 1 – Partial HMI Integration

Integration of the DCS control for the existing process areas to be maintained into the new control system HMI would be a near ideal scenario from an operations perspective. However, it must be acknowledged that this option would have a high cost and resource requirement. It should also be noted that the integration would not be seamless. The Infi90 control system uses a block method of communication, and the orientation of the HMI equipment faceplates must remain somewhat analogous to the existing DCS faceplates. However, the new control system may be set up utilized different control methodologies and have a more modern appearance and interface. Thus, while it is possible to integrate the two systems into a single HMI, it must be acknowledged that the interface to the equipment connected to the new control system will have a slightly different "look and feel" than the equipment connected to the existing DCS.

It should also be noted that few systems integrators have experience in integrating the Infi90 DCS with another HMI package. It is expected that significant efforts may be required in training the systems integrator personnel on the required development, in addition to performing the actual work.

Estimated Cost: $1,000,000 (Class 5 estimate)

Note: The above cost is to integrate the Bio-solids areas only into the new HMI system. The remaining systems would be controlled by the PCV HMI until replaced by the PLC-based control system.

4.4.2 Option 2 – Complete HMI Integration

Option 2 is similar to Option 1, except that it would be implemented earlier to allow for migration away from the current PCV HMI, and would be comprehensive for the entire DCS system. The primary advantage to this scenario is that it would allow for retirement of the existing PCV HMI, along with its associated risks. However, it must be acknowledged that this option would have the highest cost and resource requirements. This option would also suffer from some of the same disadvantages discussed under Option 1.

Estimated Cost: $2,000,000 (Class 5 estimate)

Note: The above cost is to integrate all process areas under current DCS control to be monitored by the new control system HMI, prior to DCS to PLC conversion.

4.4.3 Option 3 – Independent S+ HMI

The second option is to maintain an independent HMI for the existing process areas controlled by the DCS. ABB currently offers the S+ HMI software as the primary upgrade path from the existing PCV HMI software that the City utilizes. The S+ software has PCV migration capabilities, which would significantly reduce, but not eliminate, the development efforts associated with the conversion. At the end of the S+ conversion, the City would have an independent and stable HMI for the DCS. The HMI would have a comparable, although slightly newer, look and feel compared to the existing PCV HMI.

One advantage of this option is that the City could initiate the S+ conversion at any time, and it would address the current stability and maintenance issues that affect the existing PCV HMI system.

It should also be noted that the S+ HMI would have a different look and feel compared to the new control system HMI. The S+ HMI would be based upon existing graphics and have different faceplates compared the new control system HMI. It is recommended to perform some simple changes to some major items, such as the color scheme, to ease operator transition between the two HMI's. As the two HMI systems would be in parallel operation for an extended period, consideration of the impact on operators is appropriate. For example, it would be recommended to change the color for pump running status from red to pale green, to match the new graphics standard.

However, some operational risk would still persist, in the fact that two dissimilar HMI systems would co-exist, and operators would need to switch between the two HMIs when looking at the different process areas. This increases the risk of an operational error. Additional training may be required to reduce this risk.

Estimated Cost: $450,000 (Class 5 estimate)

Note: The above cost is to integrate the entire facility into the new HMI system, which would be completed prior to the DCS to PLC conversions.

4.4.4 Option 4 – Independent PCV HMI

Option 3 is the easiest to implement, in that it involves minimal rework for the existing DCS/HMI system. Under this plan, the PCV HMI would be retained and operated utilizing aged computer hardware that is compatible with PCV. However, there is significant risk associated with this option in that the PCV software is obsolete, and obtaining compatible hardware is very difficult. New hardware for the version of PCV which the City owns has not been available for many years, and thus the City is currently relying on sources of second-hand hardware, to maintain the operation of the PCV HMI. Thus, the risk of computer failure and associated operational issues associated with this option is high. It should also be noted that changes to the PCV HMI are relatively difficult to implement, and thus it is expected that no upgrades to the existing HMI would be made to ease the transition from the PCV HMI to the new control system HMI. For example, on the old HMI, the pump running color would be red, and on the new HMI a pale green. This could cause confusion and increases the risk of operational errors. See Figure 4-3 for a comparison between the existing and proposed graphic schemes.

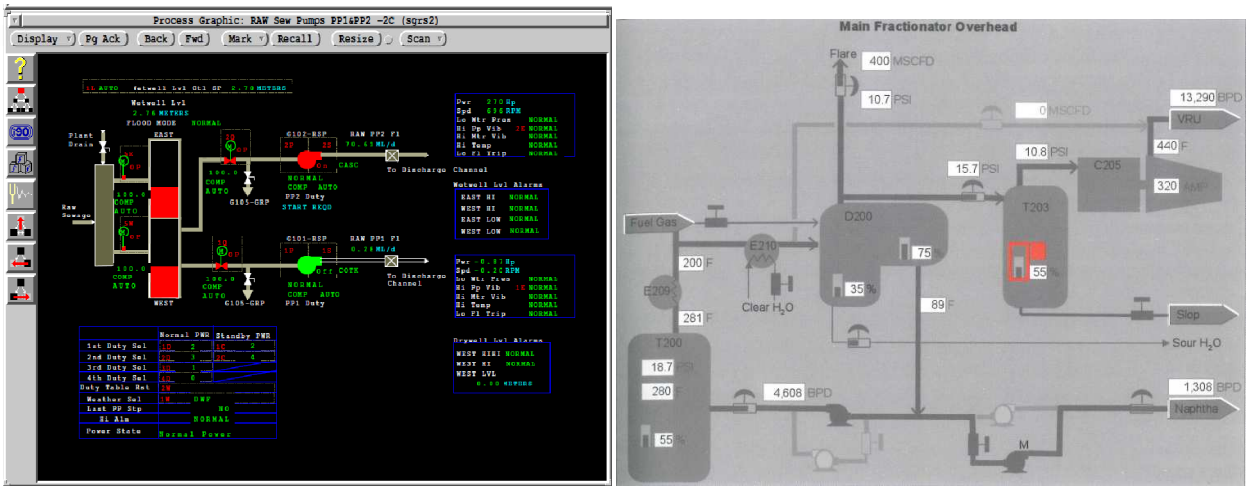


Figure 4-3 : Existing / Proposed Graphic Scheme

The cost associated with this option is based on an estimated maintenance cost.

Estimated Cost: $100,000 (Class 5 estimate)

4.4.5 Comparison of HMI Options

A comparison of the HMI options presented is summarized in Table 4-1. From an operational perspective, Option 2 – Complete HMI integration would be preferred; however it has the highest cost and implementation effort by significant margins. Option 1 and Option 4 are deemed to be a non-viable option due the high risk of failure. In addition, Option 4 also has significant operational issues that would exist during the period the HMI would co-exist with the new HMI. Thus, it is deemed that Option 3 – Independent S+ HMI is the preferred option for maintaining HMI monitoring and control over the existing process areas at the NEWPCC facility.

Table 4-1 : Comparison of HMI Options

Option	Relative Cost	Effort to Implement	Failure Risk	Operational Issues
1 – Partial HMI Integration	5 (High)	9 (High)	9 (High)	4 (Med)
2 – Complete HMI Integration	10 (High)	10 (High)	5 (Medium)	3 (Med-Low)
3 - Independent S+ HMI	2 (Low)	2 (Low)	3 (Med-Low)	6 (Med-High)
4 - Independent PCV HMI	1 (Minimal)	1 (Minimal)	10 (High)	10 (High)

4.4.6 DCS HMI Recommendation

It is recommended that the City pursue an upgrade of the existing PCV HMI with a S+ HMI (Option 3), prior to the start of the control system migrations. Due to the obsolescence issues, it is recommended that the City initiate this project as soon as possible. However, it must be noted that when the new control system is introduced, the co-existence of the S+ HMI with the new control system HMI will not be ideal from an operational perspective. Operators will be required to be familiar with two difference HMI systems. These issues must be acknowledged and plans put in place to mitigate any significant concerns. The costs included for the PCV to S+ conversion in Section 8.0 included a small allocation for some associated modifications and training.

It is noted that the City has not committed to Option 3, however all subsequent work in this Technical Memorandum is based upon Option 3.

5.0 TIE-INS

The significant control system tie-ins are identified and briefly described below. The tie-ins are presented in a proposed sequence that should generally correspond with the City's proposed implementation plan for the NEWPCC upgrades. The proposed sequence is subject to review and revision as the implementation plan becomes further defined.

Tie-In Identifier	**7C-1**
Process Area	**All**
Current Control	PCV HMI Software
Required Work	Transition HMI to ABB S+ HMI.
Predecessor Work	None
Special Construction Considerations	Some networking issues must be addressed.
Operational Implications	Minor disruption to operations during commissioning. Training Required.
Other Comments	This is highly recommended, however not a mandatory tie-in. Relocation of the backup HMI server from the Secondaries Control Room to the Nitrogen Removal facility is recommended at this time. An existing CIU is present in Nitrogen Removal facility.

Tie-In Identifier	**7C-2**
Process Area	**Primary Clarifiers**
Current Control	DCS PCU 10
Required Work	Switchover the DCS controls with PLC-based controls. Disconnect the DCS network segment to the Primary Clarifiers process area.
Predecessor Work	Install new PLCs. FAT
Special Construction Considerations	Limited space available in the existing control room. Recommend performing when primary clarifiers are out of service (~Nov 2017 - Jan 2018)
Operational Implications	Temporary Primary Clarifier Control System Shutdown. Manual Control Will be Required During Shutdown. Tie-In Duration: ~1 day Post Tie-In Commissioning: 2 Weeks
Other Comments	

Tie-In Identifier	**7C-3**
Process Area	**UV Building**
Current Control	DCS PCU 35 (Admin Building)
Required Work	Switchover to new PLC-based controls.
Predecessor Work	Install new PLC controllers. FAT
Special Construction Considerations	May perform when UV facility out of service to allow for Tie-Ins 5a and 5b (~Dec 2017)
Operational Implications	Temporary UV Control System Shutdown. Brief Administration Building Control System Shutdown. Manual Control May be Required During Shutdown. Tie-In Duration: ~1 day Post Tie-In Commissioning: 1 Week
Other Comments	DCS PCU 35 controls the UV Building Process

Tie-In Identifier	**7C-4**
Process Area	**Main Building**
Current Control	DCS PCU 11
Required Work	Switchover the misc remaining controls with PLC-based controls.
Predecessor Work	Decommission the DCS controls associated with raw sewage pumping. (New Grit Process is in service) Install new PLCs. FAT
Special Construction Considerations	Space within existing control room is very limited.
Operational Implications	Temporary Main Building Control System Shutdown. Manual Control May be Required During Shutdown. Tie-In Duration: ~1 day Post Tie-In Commissioning: 1 Week
Other Comments	City to confirm if the existing raw sewage pumps are to remain as a backup for a period of time.
Tie-In Identifier	**7C-5**
Process Area	**Grit Building**
Current Control	DCS PCU 14
Required Work	Switchover the miscellaneous remaining controls with PLC-based controls.
Predecessor Work	Decommission the DCS controls associated with Grit process. Install new PLCs. FAT Phase 1
Special Construction Considerations	Space within existing control room is somewhat limited.
Operational Implications	Temporary Grit Building Control System Shutdown. Manual Control May be Required During Shutdown. Tie-In Duration: ~1 day Post Tie-In Commissioning: 1 Week
Other Comments	

Tie-In Identifier	**7C-6**
Process Area	**Administration Building**
Current Control	DCS PCU 35
Required Work	Switchover to new PLC-based controls.
Predecessor Work	Tie-In 7C-5 Install new PLC controllers. FAT
Special Construction Considerations	Limited space available in the existing server room.
Operational Implications	Temporary Administration Building Control System Shutdown. Manual Control Required During Shutdown. Duration: ~1 day Post Tie-In Commissioning: 3 days
Special Considerations	CIU for HMI access must be maintained for use after the tie-in to allow for the continued operation of the DCS HMI.

Tie-In Identifier	**7C-7**
Process Area	**Boilers**
Current Control	DCS PCU 23
Required Work	Switchover the DCS controls with PLC-based controls. Disconnect the DCS network segment to the Boilers process area.
Predecessor Work	Install new PLCs. FAT
Special Construction Considerations	Limited Space in the existing control room Recommend performing during warm weather.
Operational Implications	Temporary Boiler Control System Shutdown. Manual Control May be Required During Shutdown. Tie-In Duration: ~1 day Post Tie-In Commissioning: 1 Week
Other Comments	

Tie-In Identifier	**7C-8**
Process Area	**Secondary Clarifiers**
Current Control	DCS PCUs 15 and 17
Required Work	Switchover the DCS controls with PLC-based controls.
Predecessor Work	Partial demolition of the DCS controls associated with the Secondary Clarifier 11-26 process. Install new PLCs. FAT
Special Construction Considerations	Coordinate to occur during construction of the chlorination tanks.
Operational Implications	Temporary Secondary Clarifiers Control System Shutdown. Manual Control May be Required During Shutdown. Tie-In Duration: ~2 days Post Tie-In Commissioning: 2 Weeks
Other Comments	

Tie-In Identifier	**7C-9**
Process Area	**Oxygen Reactors**
Current Control	DCS PCUs 12 and 13
Required Work	Switchover the miscellaneous remaining controls with PLC-based controls. Disconnect the DCS network segment to the Oxygen Reactors process area.
Predecessor Work	Decommission the DCS controls associated with the Reactor process. Install new PLCs. FAT Must not occur until end of commissioning phase 2.
Special Construction Considerations	
Operational Implications	Temporary Oxygen Reactors Control System Shutdown. O_2 Plant shutdown. Manual Control May be Required During Shutdown. Tie-In Duration: ~1 day Post Tie-In Commissioning: 1 Week
Other Comments	

6.0 OTHER CONSIDERATIONS

6.1 New Control Room

It is expected that the central control room for the NEWPCC facility will act as the central monitoring hub for all three wastewater treatment facilities. As such, additional computers and monitors will be required to support both the required functions. The existing control room currently does not have the required configuration for the desired long term functionality. Thus, it is recommended to upgrade or replace the existing control room to meet the required configuration. While the new control room is not specifically within the scope of this report, it is a critical component of the new control system and will be required to effect the transition to the new system. Refer to the Automation Master Plan document for additional information. Costs for a new control room are not included in this technical memorandum.

A proposed arrangement for the central control room, while both the DCS HMI (S+) and the new control system HMI co-exist, is shown in Figure 6-1. Note that the integration of the SEWPCC and WEWPCC facility monitoring is dependent upon other projects.

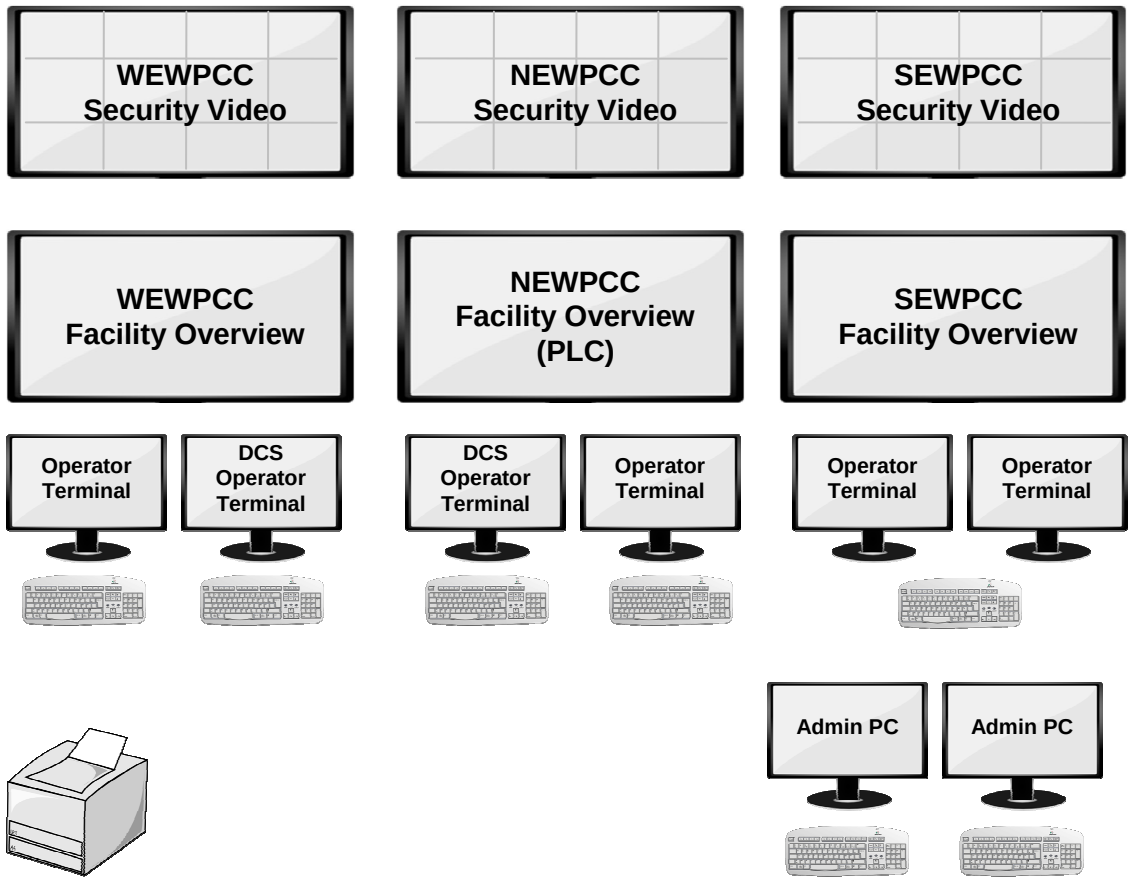


Figure 6-1 : Central Control Room Proposed Arrangement

6.2 New Server Rooms

It is recommended that the NEWPCC facility be provided with two independent server rooms for control system computer and networking equipment. Note that the advantage of two server rooms over a single server room is that additional redundancy is provided in the event of a fire or comparable risk.

It is noted that the NEWPCC facility currently has a single server room located adjacent to the control room in the Administration Building. The existing server room at the NEWPCC facility has been congested due to be utilized as a storage room and is currently affected by numerous issues, such as ventilation, cooling, and security. The City Process Control Group has indicated that plans are in place to make improvements to the current server room; however these plans have not been reviewed in the context of the NEWPCC upgrade requirements. It is recommended that the functional and physical requirements for the new server rooms be developed. The potential re-use of the existing server room space as one of the future server rooms should be to be reviewed, to determine if the renovation of the existing space is viable.

It is recommended that the new server room(s) be constructed prior to completion of final commissioning of the SEWPCC upgrades, to allow for remote monitoring of the SEWPCC facility from the NEWPCC facility during non-working hours. New server rooms are discussed further in the Automation Master Plan document. Costs for new server rooms are not included in this technical memorandum.

6.3 Networking

The existing Ethernet networking at the NEWPCC suffers from numerous issues including capacity, configuration, and obsolescence. While networking upgrades are not part of the specific tie-ins that are discussed in this report, upgrades and replacement of the networking are imperative to the success for the control system and the associated tie-ins. It is recommended that the Automation Master Plan document be utilized as a reference for the overall networking architecture to be provided.

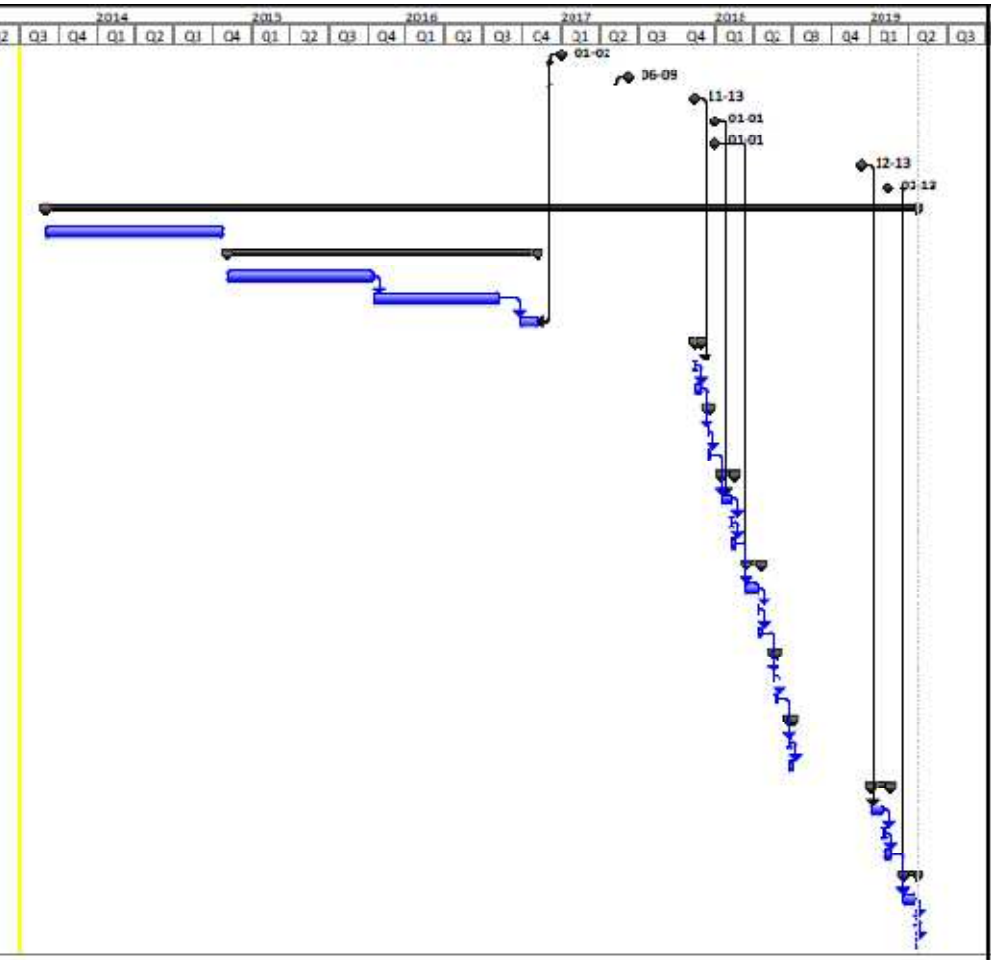
7.0 SCHEDULE

The schedule for the control system tie-ins is highly integrated with the overall process upgrade schedule, and will be subject to revision as the overall process schedule becomes further clarified. Based upon the preliminary schedule received from the City, and the work described in this document, the proposed schedule for the control-system tie-ins is shown on the following page. Note that the construction of the server and control rooms is not technically within the scope of this report, however it is included for reference.

Based upon the schedule, key dates are as follows:

Milestone	**Date Complete**
PCV to S+ Migration (7c-1)	October 2014
New Server and Control Rooms	August 2016
Primary Clarifiers Tie-In (7C-2)	November 2017
UV Building Tie-In (7C-3)	December 2017
Main Building Tie-In (7C-4)	February 2018
Grit Building Tie-In (7C-5)	April 2018
Administration Building Tie-In (7C-6)	May 2018
Boilers Tie-In (7C-7)	July 2018
Secondary Clarifiers Tie-In (7C-8)	February 2019
Oxygen Reactors Tie-In (7C-9)	April 2019

ID	Task Name	Duration	Start	Finish	Predecessors
1	NEWPCC Commissioning	0 days	Mon 17-01-02	Mon 17-01-02	
2	Initiate Commissioning of BNR Tank 1	0 days	Fri 17-05-09	Fri 17-05-09	
3	Primary Clarifiers Temporarily Taken Out of Service	0 days	Mon 17-11-13	Mon 17-11-13	
4	Initiate Decommissioning of Existing Raw Sewage Pu	0 days	Mon 18-01-01	Mon 18-01-01	
5	Initiate Decommissioning of Grit Building	0 days	Mon 18-01-01	Mon 18-01-01	
6	Initiate Chorination Tank Construction	0 days	Thu 18-12-13	Thu 18-12-13	
7	Initiate Decommissioning of Oxygen Reactors	0 days	Wed 19-02-13	Wed 19-02-13	
8	**Control System Tie-Ins**	**1473 days**	**Mon 13-09-02**	**Wed 19-04-24**	
9	PCV to S+ Migration (Tie-In 7C-1)	300 days	Mon 13-09-02	Fri 14-10-24	
10	**New Server and Control Rooms**	**525 days**	**Mon 14-11-03**	**Mon 16-11-07**	
11	Design	250 days	Mon 14-11-03	Fri 15-10-16	
12	Construction	210 days	Mon 15-10-19	Fri 16-08-05	11
13	Network and HMI Setup	30 days	Mon 16-09-26	Mon 16-11-07	SF-80 days
14	**Primary Clarifiers PCU 10**	**11 days**	**Mon 17-11-13**	**Mon 17-11-27**	
15	PLC Tie in 7C-2	1 day	Mon 17-11-13	Mon 17-11-13	3
16	Commissioning	10 days	Tue 17-11-14	Mon 17-11-27	15
17	**UV Building**	**6 days**	**Tue 17-12-12**	**Tue 17-12-19**	
18	PLC Tie in 7C-3	1 day	Tue 17-12-12	Tue 17-12-12	FS+10 days
19	Commissioning	5 days	Wed 17-12-13	Tue 17-12-19	18
20	**Main Building PCU 11**	**21 days**	**Wed 18-01-17**	**Wed 18-02-14**	
21	Partial Control System Decommissioning	15 days	Wed 18-01-17	Tue 18-02-06	+20 days,4
22	PLC Tie-In 7C-4	1 day	Wed 18-02-07	Wed 18-02-07	21
23	Commissioning	5 days	Thu 18-02-08	Wed 18-02-14	22
24	**Grit Building PCU 14**	**26 days**	**Thu 18-03-15**	**Thu 18-04-19**	
25	Partial Control System Decommissioning	20 days	Thu 18-03-15	Wed 18-04-11	+20 days,5
26	PLC Tie in 7C-5	1 day	Thu 18-04-12	Thu 18-04-12	25
27	Commissioning	5 days	Fri 18-04-13	Thu 18-04-19	26
28	**Administration Building**	**6 days**	**Fri 18-05-18**	**Fri 18-05-25**	
29	PLC Tie in 7C-6	1 day	Fri 18-05-18	Fri 18-05-18	FS+20 days
30	Commissioning	5 days	Mon 18-05-21	Fri 18-05-25	29
31	**Boiler Building**	**6 days**	**Mon 18-06-25**	**Mon 18-07-02**	
32	PLC Tie in 7C-7	1 day	Mon 18-06-25	Mon 18-06-25	FS+20 days
33	Commissioning	5 days	Tue 18-06-26	Mon 18-07-02	32
34	**Secondary Clarifiers**	**34 days**	**Thu 19-01-03**	**Tue 19-02-19**	
35	Partial Control System Decommissioning	22 days	Thu 19-01-03	Fri 19-02-01	6
36	PLC Tie in 7C-8	2 days	Mon 19-02-04	Tue 19-02-05	35
37	Commissioning	10 days	Wed 19-02-06	Tue 19-02-19	36
38	**Oxygen Reactors**	**26 days**	**Wed 19-03-20**	**Wed 19-04-24**	
39	Partial Control System Decommissioning	20 days	Wed 19-03-20	Tue 19-04-16	+20 days,7
40	PLC Tie in 7C-9	1 day	Wed 19-04-17	Wed 19-04-17	39
41	Commissioning	5 days	Thu 19-04-18	Wed 19-04-24	40



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8.0 COST ESTIMATE

A Class 5 cost estimate for the proposed tie-ins is presented in Table 8-1. The estimate does not include the overall construction cost for the proposed control system, but rather only the additional costs necessary to facilitate the installation due to specific requirements for phasing of the installation and associated risk mitigation.

Table 8-1 : Cost Estimate

Tie-In	Item	Cost
7C-1	PCV to S+ Conversion	
	Conversion	$ 450,000
	Modifications for Operator benefit	$ 25,000
	Operator Training	$ 20,000
7C-2	Primary Clarifiers Tie-In & Commissioning Work	$ 51,000
7C-3	UV Building Tie-In & Commissioning Work	$ 31,000
7C-4	Main Building Tie-In & Commissioning Work	$ 26,000
7C-5	Grit Building Tie-In & Commissioning Work	$ 26,000
7C-6	Administration Building Tie-In & Commissioning Work	$ 19,000
7C-7	Boiler Building Tie-In & Commissioning Work	$ 26,000
7C-8	Secondary Clarifiers Tie-In & Commissioning Work	$ 61,000
7C-9	Oxygen Reactors Tie-In & Commissioning Work	$ 26,000
Other	Preparation of Detailed Shutdown Protocols	$ 110,000
	General Tie-In Engineering	$ 100,000
	Engineering Coordination and Witnessing	$ 81,000
	Operator Training	$ 50,000
	Total	**$ 1,102,000**

Notes:

1. The cost estimate is a Class 5 cost estimate and is in 2013 dollars. No allowances for escalation have been made.

9.0 RISK ANALYSIS

(subject to revision based on the outcome of the formal risk review session)

A number of potential risk issues may arise during the course of execution of the work. A formal risk registry based on an interactive review between SNC-Lavalin, Veolia and the City of Winnipeg is part of the risk analysis discussed herein. Results of that analysis in tabular format are included in Appendix C. The major risk items identified are listed as follows:

Due to (Cause Event)	this could occur (Result Event)	Resulting in (this Effect)
ABB is sole supplier of S+ software / migration.	Non-competitive bid.	Price increase, delays, and contractual issues.
Selection of a poor Systems Integrator	Project delays, process upset, additional resource requirements	Additional costs for remediation of issues.
Two HMI Systems in parallel	Operator Error due to confusion	Potential equipment mis-operation or process upset.
Inadequate City Operations Resources	Poor operation support for control system tie-ins	Delay in the work, plant conformance issues
Installation delays due to phasing requirements, coordination and overall complexity	Project delays	Additional costs due to contractor / consultant delays.
Modifications to the DCS Network	DCS Network Issues	Loss of partial or whole plant monitoring and some control implications.
DCS and PLC must communicate.	Communication Errors between DCS and PLC	Operational upset.
DCS Cabinet rework	Inability to install new PLC controls after DCS has been removed.	Delays, operational issues, extended manual control period, non-compliance.
Installation of new controls into an existing environment.	Hidden issues.	Delays, operational issues, extended manual control period, non-compliance.

APPENDIX A – RISK REGISTRY

SNC·LAVALIN	Technical Memorandum no. 1 Tie-in 1a Raw water pumping station	Document Code:	612962-0000-49EN-0001
		Revision	0
Client: City of Winnipeg	Project: NEWPCC Expansion and Upgrade	Package / Area:	0000

Prepared By:	P. Williams, Eng.		20/06/2013
	Name	Signature	Date
Checked By:	T. Ball, Eng., M. Sc. A.		20/06/2013
	Name	Signature	Date
Approved By:	E. Ryczkowski, M. Sc., P. Eng.		20/06/2013

Professional Seal

APEGM
Certificate of Authorization
SNC-Lavalin Inc.
No. 4489

PROVINCE OF MANITOBA
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21/06/13.
REGISTERED ENGINEER

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REVISION REGISTER

Rev.	Description	Date	By	Checked	Approved
PA	Issued for information and comment	14/05/13	PW	CK	ER
0	Final Issue	20/06/13	PW	TB	ER

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NOTICE

This document contains the expression of the professional opinion of SNC-Lavalin Inc. (SLI) as to the matters set out herein, using its professional judgment and reasonable care. It is to be read in the context of the agreement between SLI and the City of Winnipeg, and the methodology, procedures and techniques used, SLI's assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the agreement, and for the sole and exclusive benefit of the City of Winnipeg, whose remedies are limited to those set out in the agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SLI disclaims any liability to the City of Winnipeg and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party.

Contents

1.0 Constructability assessment of the tie-in 1a

1.1 General

The City of Winnipeg has initiated a program to perform upgrades to the wastewater treatment systems at the NEWPCC, SEWPCC, and WEWPCC facilities (Winnipeg Sewage Treatment Program – WSTP). This technical memorandum is presented specific to the conduit and pipe tie-ins for the NEWPCC facility that will arise due to the proposed upgrades to the facility. A high-level overview of the tie-ins including expected scope of work, constructability, schedule, constraints and risks related to the tie-ins as presented by the City of Winnipeg/Veolia NEWPCC Process Selection Report, Phase 2 Rev. 0 is outlined. A Class 5 cost estimate for the proposed tie-ins is presented in Section 4.0. The estimate does not include the overall civil/structural/piping construction cost for the proposed expansion work, but rather only the additional costs necessary to facilitate the installation due to specific requirements for phasing of the installation and associated risk mitigation.

The overall objective for this undertaking is to provide a technical review of the conceptual planning associated with the NEWPCC master plan development. The review provided herein is based on SNC-Lavalin Inc. (SLI) professional opinion regarding "proof of concept" for tie-ins between existing and new facilities. However, it is recognized and expected that the actual implementation of the work described herein, when it occurs, will be subject to change. The intent of this investigation is to establish the feasibility of the concept and identify potential issues and not the development of a specific design or construction plan.

Tie-in 1a allows for the construction of a new pumping facility to replace the old pumping wells and surge tank while the old facilities remain in service. A connection between the 90 inch Ø main interceptor and the new pumping facility is required and no upstream bypass exists for the interceptor. The connection must take place approximately 16 m below ground level at the hydraulic level of the existing interceptor pipe. The flow in this pipe cannot be stopped during the connection works for more than a few hours; therefore ideally, the tie-in must be made in a way that allows the wastewater flows to be maintained before, during and after the tie-in. If the flow is blocked in the pipe, raw sewage overflows will occur upstream in the network, directly to the river.

1.2 Technical Disciplines required

Tie-in 1a will require civil, piping and structural disciplines to be involved in the tie-in process.

1.3 Implementation options

The tie-in for the raw water pumping station must take place in such as way as to avoid stopping the flow in the interceptor pipe. In addition, the tie-in is subject to two additional constraints:

- Location of the new raw water pumping plant which could be located north or south of the existing final effluent/outfall conduit; and
- The raw sewage must pass over or under the existing final effluent/outfall conduit to the new grit building. Depending on the location of the new pumping plant, this conduit would be gravity (before pumping) or pressurized (after pumping).

The existing structures, including the UV building channels, as well as the old pump discharge and outfall conduits are all constructed on piles. This means that passing any new conduits under these existing structures is virtually impossible (by conventional excavation, or using jacked pipe/pushed pipe method). Under the UV influent channel, one portion of the channel was left without piles as shown on drawing 1-0101U-S0002-001-03, between piles #120 and #121 (approximately 9.0 meters wide). This was done during the design of the UV building to avoid damaging the existing 78 inch Ø North-East interceptor (during the driving of the piles) which runs approximately 14 m below ground level.

Given the limitations of the site, and the requirement to keep the existing pumping plant in operation during the construction, this 'opening' between the piles is expected to be the only location where a new raw sewage conduit could can pass under the existing structures to access the north side of the site.
This limitation prevents the use of a gravity pipe for the conveyance of the sewage to the north of the existing outfall conduit, because the 78 inch Ø North-East interceptor runs at this location. Due to the hydraulic gradient, the only way that the new pipe could be gravity fed would be to run it at the same location as the existing North-East interceptor pipe, which obviously must remain in service.

These limitations impose two constraints:

- The new pumping station must be located south of the existing outfall/final effluent conduit (and UV building).
- Two new pressurized raw sewage pipes can run over-top of the outfall conduit, to the east of and parallel to the existing raw sewage pump discharge conduits towards the new grit building (see possible routings on the Site plan drawing in Appendix A).

The two new raw sewage pipes must be installed fairly close to the surface in order to pass over the existing outfall/effluent conduit. The installation of the pipes must ensure that they are protected from frost penetration below the pipe during the winter, and also from concentrated vertical compressive loads due to vehicles operating on the ground above the pipe. The pipes would be installed with approximately 1.0 to 1.2 m of cover which is acceptable for HS20 vehicle circulation provided the correct type of pipe is used, and the installation (excavation and backfill) are done correctly. In order to provide frost protection, rigid foam insulation will be required (typically 50 to 100 mm thick, overtop of the pipe). Different grades of rigid foam insulation exist with compression ratings of up to 100 psi (690 kPa) for direct burial and pipe protection.

The installation of the two new raw sewage pipes overtop of the existing outfall/effluent conduit does not present a risk to the outfall conduit. Proper care must be taken during the excavation and installation of the new pipes, and appropriate backfill and compaction will be required to avoid settling in the area. According to the information provided by the CofW, this pipe is constructed of 12 inch thick (300mm) concrete and no significant or special protection of the existing pipe is required.

A new raw water pumping station overflow conduit will have to be installed and connected to the existing outfall/treated effluent conduit or the existing gate chamber structure.

Implementation steps for the tie-in are as follows:

1. In order to provide access to the existing Main sewage interceptor, an access chamber must be constructed on top of the interceptor, downstream of the existing connection between the North-East interceptor and the Main interceptor. Approximate dimensions are 6000 mm x 6000 mm to allow room for construction of walls and a floor slab bellow the interceptor pipe. This chamber will be adjacent to the new pumping plant. The entire structure will be constructed using vertical wall excavation techniques (for example sheet piles) in order to avoid

destabilizing the existing administration building and to limit the size of the excavation required.

2. The chamber must include a floor, four walls and an access point from the top. The existing interceptor pipe must be embedded in the concrete walls of the manhole (East and West walls). On the adjacent wall (south side) a connection must be made toward the new pumping station.
3. On the west wall of the chamber where the current interceptor exits the chamber (towards the existing pumping station), a bulkhead gate guide frame must be installed to accept a future gate (approximate size 3000 x 4000 mm), which will allow the current surge well to be isolated once the connection is made to the new pumping station. The existing interceptor pipe must be temporarily supported (using wooden blocks or equivalent means) in preparation for the cutting of the interceptor and removal of the section of pipe that traverses the chamber.
4. Using a diamond cable saw or concrete cable saw[1] (see Appendix A for further information) the interceptor pipe must be cut on both the upstream and downstream sides so that a section approximately 5 meters long can be removed. The saw drive mechanism can be installed on a platform above the pipe (using a crane) with only the cable touching the pipe. The current pumping station must remain in service during the tie-in, in order to keep sewage level in the interceptor and surge well as low as possible. As the pipe is cut, the bottom of the chamber will slowly be flooded with raw sewage. Once the two sides of the pipe are cut, the section of pipe can be removed with a crane. This step must be carried out when the new pumping station is ready to be commissioned.
5. In order to isolate the old surge well, a new west side bulkhead gate must be installed (using a crane) into the new gate frame. After isolating the existing surge well, it can be cleaned and decommissioned. A permanent gate will also be required on the existing surge well side, to isolate the opening (from the interceptor) using a steel plate.

A new comprehensive geotechnical study will be required at the specific location of the proposed construction; however based on the results of the study done nearby in 2004 (for the new UV building), certain preliminary observations and remarks can be made regarding the particular challenges of the excavation work required for this tie-in:

[1] This type of saw is used for the rapid cutting of large concrete and steel sections particularly in demolition work, including underwater applications. It can be used for the cutting of bridge decks, columns, large pipes, concrete walls etc...

a) Soil stability and shoring

The construction of this type of structure (tie-in chamber and pumping station) will require a shored type excavation due to the nature of the highly plastic silt till which extends from ground surface to a depth of approximately 20 meters.

Potential shoring options include shotcrete, sheet piles or soil nailing retaining walls which would need to be designed based on hydrostatic pressures and existing soil conditions. A slope stability analysis of the temporary slopes and shoring works must be completed during the detailed design prior to beginning excavation work.

b) Groundwater and infiltration mitigation

A pressurized aquifer is present at a depth of approximately 20 m below ground surface and the head within the aquifer is approximately 15 m above the top of the aquifer. The presence of ground water leads to the potential of hydraulic "blow-in" at the base of the excavation during construction. Excavating to a depth of 18 m below ground surface removes the overburden pressure that is currently resisting the upward pressure within the aquifer. With only approximately 2 m of overburden pressure remaining after excavation, the risk of blow-in at the base of the excavation is very high. This risk could potentially be mitigated by installing a mud slab which would act as a cap or seal at the base of the excavation (no structural capacity) or localized dewatering at the site of the excavation. Further hydrotechnical analysis will be required to assess and design a mitigation plan for the groundwater concerns.

In addition, a perched water table at a depth of approximately 3 – 4m below ground surface exists within a silt layer approximately 2 - 3m thick. It may be necessary to control seepage from this silt layer during excavation. Seepage analysis will be required to assess the potential inflow concerns.
See also the risk assessment in Appendix C where this issue is described.

1.4 Comparisons and recommendations

Because of all the existing structures in the area of the tie-in, and the limitations on the ability to stop the flow of raw sewage during the work, no other implementation options exist for this tie-in. Although it is potentially feasible that a balloon could be inserted into the main interceptor using divers in order to interrupt the flow during the time the pipe is cut (using conventional cutting saws), the time required to cut the pipe could be quite long (several hours) and it is expected that the sewers would certainly backup and

overflow to the river for some period of time. At this point in the planning, it is preferable to use a wire saw in order to avoid as much as possible any planned overflows to the river in the construction sequences. Dominion Divers of Winnipeg have been contacted (www.dominiondivers.com ; (204) 237-8639) and have confirmed that the interceptor could be temporarily blocked (using a balloon) by divers entering from the surge well. The use of divers could be established as part of a contingency plan for the tie-in (final cutting of the pipe).

In order to improve safety and facilitate access during the construction, it is recommended that a permanent ladder (with cage) be installed in the new chamber in addition to temporary scaffolding (with stairs).

The construction of the new tie-in chamber and pumping well should be made during the summer of 2016. The actual tie-in (cutting of the pipe) should be done during the winter (2016-2017) when flows are lowest and to minimize the risk of rapid flooding of the chamber during the work due to an electrical power interruption or short term mechanical pump or control system failure. This cutting could be done during the day provided there is no risk of rain or rapid snow melt.

The cutting of the pipe must be carried out by a specialized contractor. Di-tech international of Winnipeg (204-222-7400; http://www.di-techinternational.com) has been contacted and has confirmed the feasibility of doing this type of work. An example of the type of saw used for this type of work is the Husqvarna CS2512 (shown in appendix B). Actual cutting of the pipe is expected to take approximately 12 hours (6 hours per cut) excluding the time required for saw installation and set-up.

2.0 Risk assessment of the tie-in

Results of the risk analysis are included in Appendix C in tabular format.

3.0 Phasing requirements

The schedule for tie-ins is influenced by the overall construction schedule which includes the construction of other major civil works structures on the site.

This construction schedule is based on the assumption that the Expansion and Upgrade project will begin in August of 2015, and that construction works on the raw sewage pumping plant and tie in will begin in February 2016. The exact construction method has not been determined, so the durations and identification of the activities are preliminary. For example, 'Excavation' and 'Construction' are shown as two different activities, one following the other. It is quite possible that the two activities will be carried out simultaneously, depending on the excavation method chosen during the detailed design phase.

Note that certain activities are dependent on the pumping station being ready for commissioning which is planned for July 2017 (based on overall initial construction schedule provided by Veolia and the C of W).

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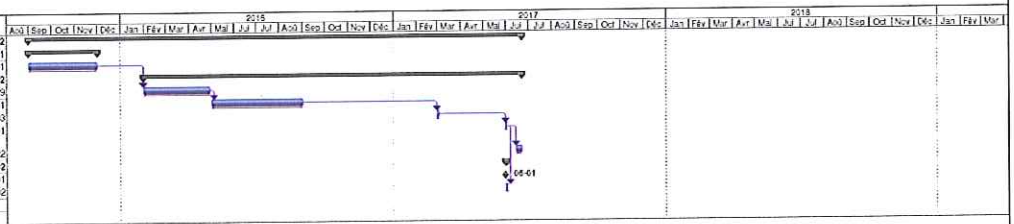
North End Water Pollution Control Centre (NEWPCC)
NEWPCC Facility Planning

City of Winnipeg

N°	Nom de la tâche	Durée	Début	Fin
1	Raw pumping plant tie-in 1a	473 jours	Mar 15-09-01	Jeu 17-06-22
2	Engineering	66 jours	Mar 15-09-01	Mar 15-12-01
3	Design	66 jours	Mar 15-09-01	Mar 15-12-01
4	Construction	364 jours	Lun 16-02-01	Jeu 17-06-22
5	Excavation with pumping station	65 jours	Lun 16-02-01	Ven 16-04-29
6	Construction of chamber (civil works)	89 jours	Lun 16-05-02	Jeu 16-09-01
7	Tie in (cutting of pipe)	3 jours	Mer 17-03-01	Ven 17-03-03
8	Isolation of existing pumping station using stop gate	1 jour	Jeu 17-06-01	Jeu 17-06-01
9	Closing of chamber (top)	6 jours	Jeu 17-06-15	Jeu 17-06-22
10	Commissioning	2 jours	Jeu 17-06-01	Ven 17-06-02
11	Pumping station ready for commissioning	0 jour	Jeu 17-06-01	Jeu 17-06-01
12	Commissioning of tie-in	1 jour	Ven 17-06-02	Ven 17-06-02
13				
14				



Projet : Échancier_Winnipeg mpp
Date : Ven 13-05-10

Tâche
Fractionnement
Avancement
Jalon
Récapitulative
Récapitulatif du projet
Tâches externes
Jalons externes
Échéance

4.0 Class 5 Cost estimate of the tie-in

The cost estimate for the tie-in covers items required for the **phasing** of the installations and any risk mitigation measures required to carry out the tie-in. Normal capital costs (without special phasing provisions) are excluded from the cost estimate. The costs shown herein should therefore be added to capital cost estimates for the installation that is being developed by others.

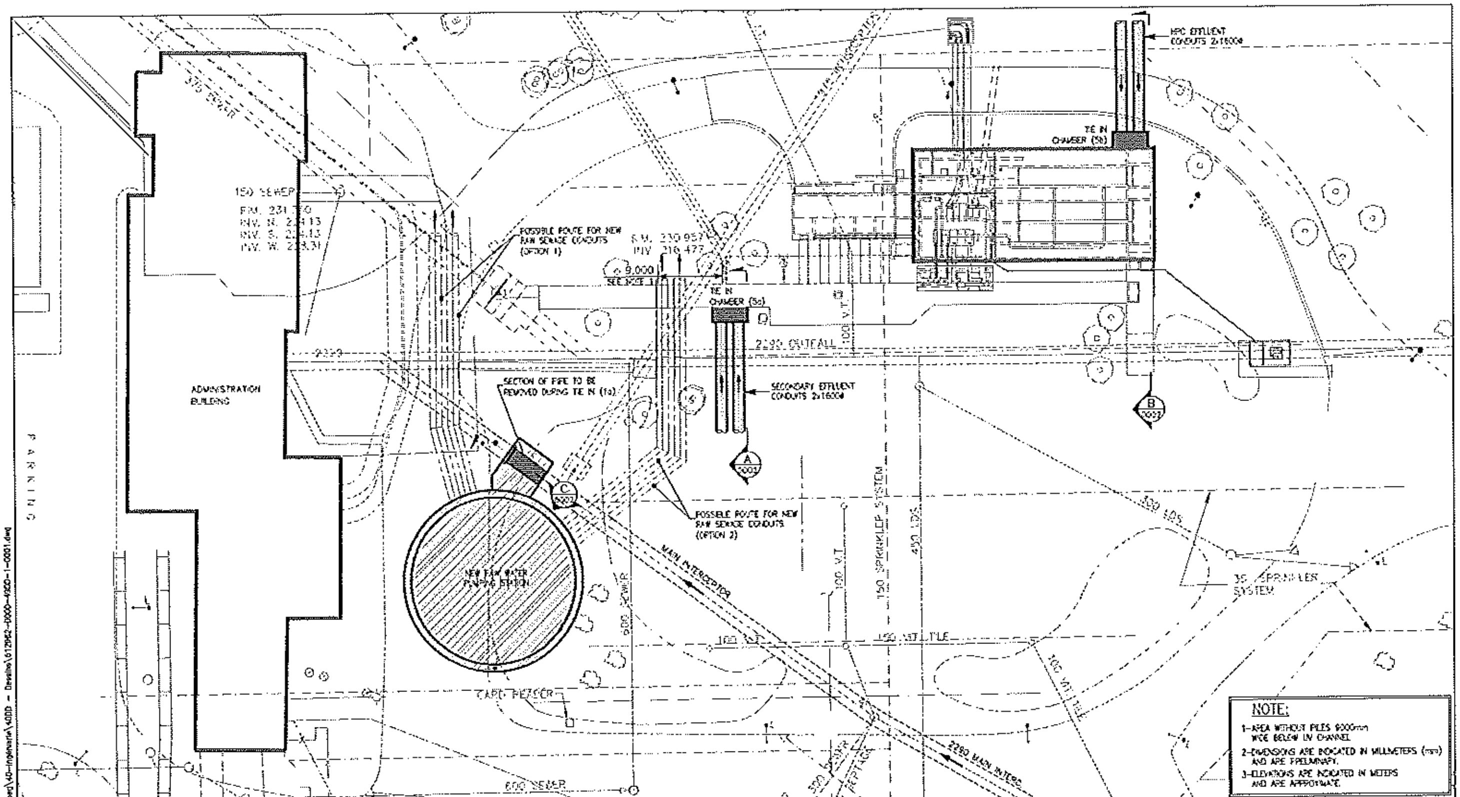
At this early stage, the level of accuracy of the estimates shown herein is Class 5 (+/-50%). All values are shown in 2013 CDN dollars.

Item	Description	Estimated Value
1.	Shoring for excavation (tie-in chamber only)	$125,000
2.	Excavation (tie-in chamber only) and disposal costs	$80,000
3.	Form work (tie-in chamber only)	$50,000
4.	Concrete and reinforcing steel (Concrete chamber construction 6 x 6 x 18 m)	$250,000
5.	Dewatering costs	$75,000
6.	Safety supervision	$100,000
7.	Stop gate and frame 3m x 4m	$30,000
8.	Risk Contingencies	$45,000
	TOTAL DIRECT COSTS	$755,000
	CONTINGENCY (35%)	$265,000
	TAXES (PST – 8%)	$60,000
	Engineering (Design and Construction Services)	$100,000
	Indirect Costs – Owner (Finance and Administrative Charges – 3%)	$35,000
	TOTAL	**$1,215,000**

Table 1 Class 5 cost estimate for tie-in

Appendix A : Drawings

612962-0000-49DD-0001	Tie-ins 1a, 5a and 5b - Site plan
612962-0000-49DD-0002	Tie-ins 1a, 5a and 5b - Sections "A", "B" and "C"
1-0101U-S0002-001-03	NEWPCC UV Disinfection Facility - Structural Piling Plan



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ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
02	00	13/06/20	ISSUED FOR FINAL REPORT
01	PA	13/05/01	FOR COMMENT

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
00	ISSUED FOR FINAL REPORT	13/06/20	P.W.	P.W.
PA	FIRST ISSUE	13/05/01	P.W.	P.W.

REVISION REGISTER * DESIGNED ** APPROVED

PROFESSIONAL SEAL

SNC·LAVALIN
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455, boul. René-Lévesque Ouest
Montréal (Québec)
Canada H2Z 1Z3

CLIENT
THE CITY OF WINNIPEG
Winnipeg WATER AND WASTE DEPARTMENT

DESIGNED P. WILLIAMS
DRAWN C. FORTIER
CHECKED T. BALL
APPROVED P. WILLIAMS
DATE 2013-04-30
SCALE 1:500

PROJECT
NEWPCC EXPANSION AND UPGRADE

TITLE
FACILITY PLANNING REVIEWS
TIE-INS 1a, 5a AND 5b
SITE PLAN

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
612962	0000	49 DD	0001	00

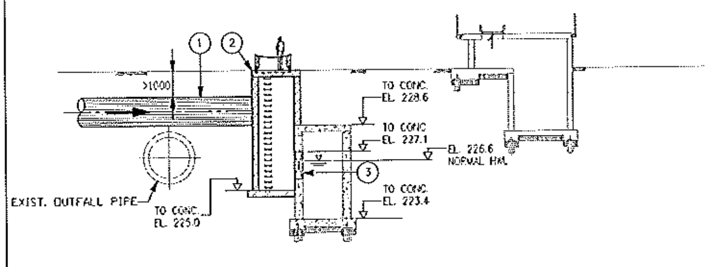
STOSL_BHEN - FRAME B IMPERIAL ENGLISH (11"x17")

LEGEND

1. SECONDARY EFFLUENT CONDUITS (QTY=2)
2. CHAMBER (2000x5000) FOR TIE IN 5a
3. NEW OPENING IN UV CHANNEL WALL (1500x1500) (QTY=2)
4. EFFLUENT CONDUITS FROM HPC AND CHLORINE CONTACT TANK (QTY=2)
5. CHAMBER (2000x5000) FOR TIE IN 5b
6. NEW OPENING IN UV CHANNEL WALL (2000x2000) (QTY=1)
7. EFFLUENT STOP LOG (U-400-SL-4) (EXISTING)
8. SECTION OF INTERCEPTOR PIPE TO BE REMOVED
9. NEW ISOLATION STOP GATE AND FRAME
10. OPENING TOWARDS NEW PUMPING STATION

NOTE:

1- DIMENSIONS ARE INDICATED IN MILLIMETERS (mm) AND ARE PRELIMINARY.
2- ELEVATIONS ARE INDICATED IN METERS AND ARE APPROXIMATE.



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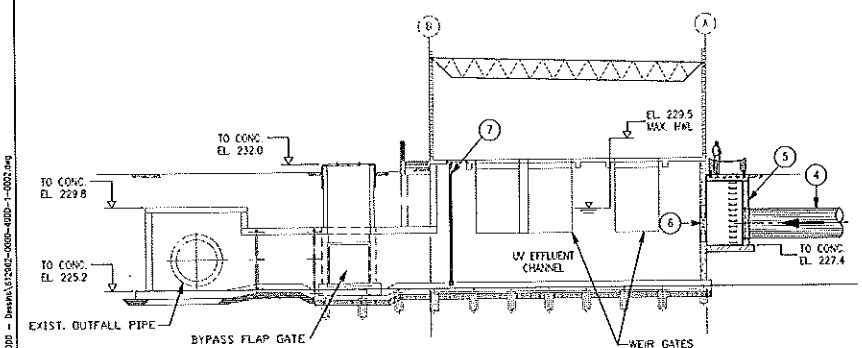

SECTION B 0001
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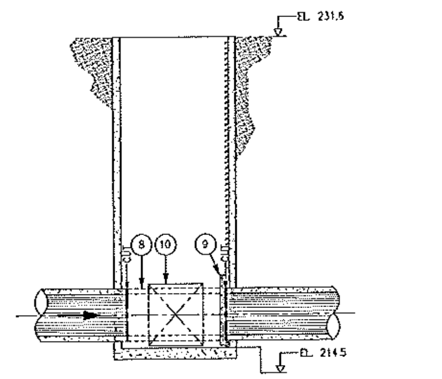

SECTION C 0001
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ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE
02	00	13/05/20	ISSUED FOR FINAL REPORT
01	PA	13/05/01	FOR COMMENT

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
00	ISSUED FOR FINAL REPORT	13/05/20	P.W.	P.W.
PA	FIRST ISSUE	13/05/01	P.W.	P.W.

REVISION REGISTER * DESIGNED ** APPROVED

PROFESSIONAL SEAL

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455, boul. René-Lévesque Ouest
Montréal (Québec)
Canada H2Z 1Z3

CLIENT
THE CITY OF WINNIPEG
Winnipeg WATER AND WASTE DEPARTMENT

DESIGNED: P. WILLIAMS
DRAWN: E. FORTIER
CHECKED: T. BALL
APPROVED: P. WILLIAMS
DATE: 2013-04-30
SCALE: 1:200

PROJECT: NEWPCC EXPANSION AND UPGRADE

TITLE: FACILITY PLANNING REVIEW TIE-INS 1a, 5a AND 5b SECTIONS A, B AND C

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV
612962	0000	49 DD	0002	00

STDLI_BHEN – FRAME B IMPERIAL ENGLISH (11"x17")

LAST SAVE: 2013/05/20 – 10:11am
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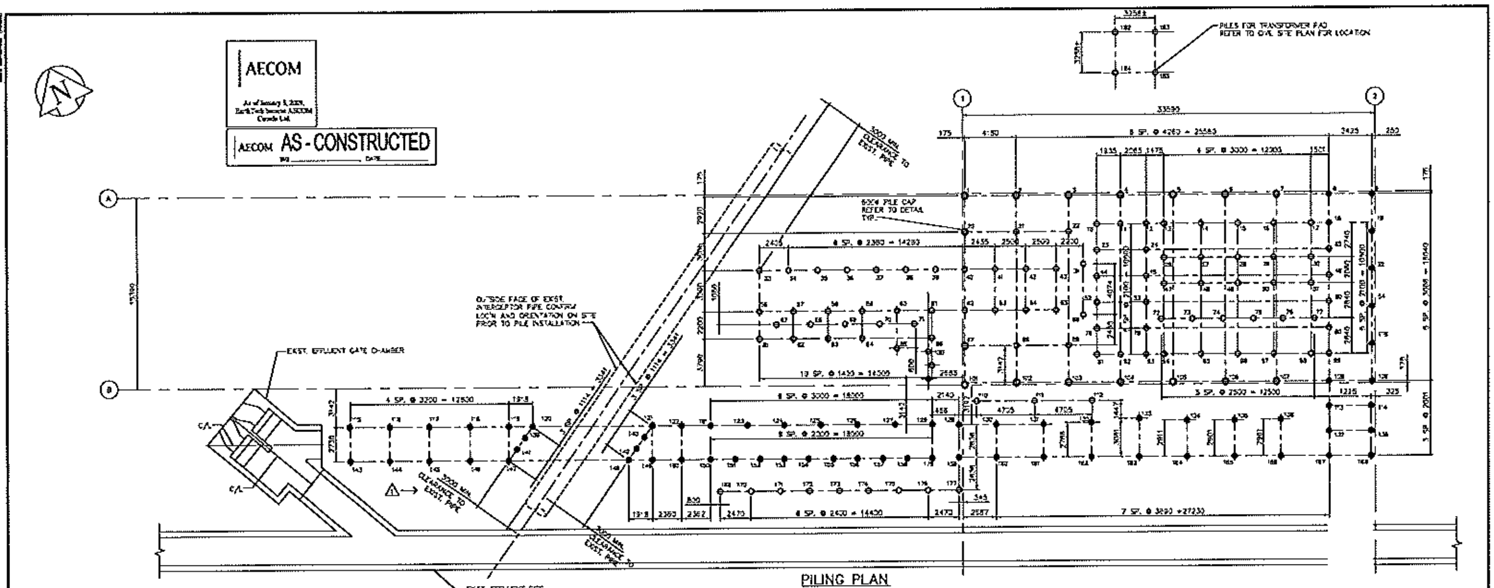

PILING PLAN

SCALE: 1:150

PRECAST CONCRETE PILE SCHEDULE

DESIGNATION	MARK	DIAMETER	CUT-OFF EL.	PILING REMARKS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PRECAST CONCRETE PILE SCHEDULE

DESIGNATION	MARK	DIAMETER	CUT-OFF EL.	PILING REMARKS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PRECAST CONCRETE PILE SCHEDULE

DESIGNATION	MARK	DIAMETER	CUT-OFF EL.	PILING REMARKS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LEGEND:

P-1 ○ DENOTES 300Ø PRECAST PILE
P-2 ● DENOTES 400Ø PRECAST PILE

PILING REMARKS:

1. EXPOSE, CLEAN AND EXTEND STRANDS 450 INTO CONCRETE.
2. EXTERIOR PAD. EXPOSE, CLEAN AND BEND STRANDS INTO CONCRETE.
3. EXTERIOR TRANSFORMER PAD. EXPOSE, CLEAN AND BEND STRANDS INTO CONCRETE.
4. LOCATION AND CUT OFF TO BE DETERMINED

AS BUILT PER
GATEWAY
CONSTRUCTION & ENGINEERING LTD.
MARCH 14/07

APEGM
Certificate of Authorization
AECOM Canada Ltd.
No. 4875 Date: 2005-02-18

NOTES:

1. FOR GENERAL NOTES AND SCHEDULES REFER TO DRAWING S1.01.
2. FOR STANDARD DETAILS REFER TO DRAWINGS S4.01, S4.02, AND S4.03.

NO.	REVISIONS	DATE	BY
3	AS CONSTRUCTED	07/03/14	GC
2	ISSUED FOR CONSTRUCTION	05/02/18	LAE
1	ISSUED FOR ADDENDUM 1	05/02/04	JEH
0	ISSUED FOR TENDER	05/01/18	JEH

B.M. ELEV.

EARTH TECH

DESIGNED BY: RE, MK	CHECKED BY: GCP
DRAWN BY: C.T.	APPROVED BY: DT
HOR. SCALE: AS NOTED; VERTICAL SCALE: AS NOTED	RELEASED FOR CONSTRUCTION BY: T. KJARTANSON
DATE: 2005/01/27	DATE: 2005-02-18

ENGINEER'S SEAL
ORIGINAL SIGNED BY R.B. ERC
FEB. 15/05

CONSULTANT DRAWING NO.: 883030-S2.01

THE CITY OF WINNIPEG
Winnipeg WATER AND WASTE DEPARTMENT

NEWPCC - SECONDARY EFFLUENT UV DISINFECTION FACILITY

STRUCTURAL
PILING PLAN

CITY FILE NUMBER:
SHEET 2 OF 19
CITY DRAWING NUMBER: 1-0101J-S0002-001-03

Appendix B: Wire cutting saws

Figure 1 Cutting of a large wastewater pipe using a wire saw under wet conditions (Thunder Bay, ON)

Figure 2 Cutting of large wastewater pipe using a wire saw (Thunder Bay, ON)

Figure 3 Removal of pipe section at the end of the cut (Thunder Bay, ON)

Figure 4 Pipe submerged in wastewater once the cut is completed (Thunder Bay, ON)

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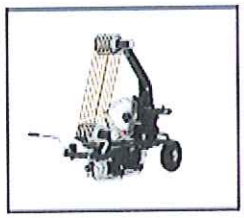
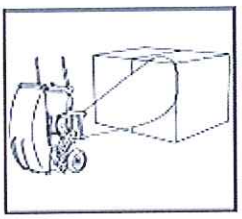
Husqvarna

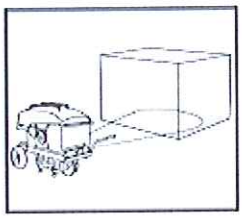
Husqvarna CS 2512

The Husqvarna CS2512, in combination with the hydraulic unit PP455 E, is a powerful and easy to use wire saw. It can handle very large jobs while, at the same time, being sufficiently compact and mobile to handle smaller jobs. It can be used for a wide range of applications, both on the ground or mounted on walls.

On the CS2512, the drive wheel is located on the output side of the machine so that slack in the wire never occurs in the machine even when the feeding power is low. The adjustable pressure valve provides accurate control of the sawing operation and superior performance. The machine is easy to rig and many cuts can be made directly without external pulley wheels.







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Features Husqvarna CS 2512

- Thanks to modular systems, the wire saws are easy to install. They can be positioned both vertically and horizontally. The motor can be detached for easier transportation.
- Our wire saws are compact yet have large magazine capacity, so large cuts can be made without cutting the wire.
- The saw has a large magazine capacity, enabling larger cuts without cutting the wire.

TECHNICAL SPECIFICATION	
Max output:	20kW/268hp
Hydraulic flow, max	17gal/min
Hydraulic pressure	230bar
Motor for wire drive	Hydraulic multiple gear
Max drive torque at drive wheel	200Nm
Starting torque	190Nm
Feeding system / control	Hydraulic/Auto
Magazine capacity	39feet
Wire speed	65.62fm
Wire storage	49ft
Weight	330lbs
Product size. LxWxH	44x30x36inch

Husqvarna

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Appendix C: Risk Analysis for Tie-in 1a

Risk Identification				Risk Evaluation (Assessment)						Risk Response Assessment (based on an implemented Risk Management Plan - future state)								
Risk or Opportunity (R / O)	Due to (Cause Event)	this could occur (Result Event)	Resulting in (this Effect)	Magnitude of Risk Event(1-5)	Likelihood (1-5)	Assessed Score C X L	Estimated Impact (1,000) what is cost if risk occurred)	Financial Impact (% Target Cost)	Financial risk prior to Mitigation	Risk Response Type (Avoidance, Transference, Mitigation, Acceptance)	Risk Response Plan - Actions	Residual Magnitude occur (1-5)	Residual Likelihood (1-5)	Assessed Residual Score	Cost of Mitigation (1,000)	Adopted	Financial risk after mitigation	Trigger date (mandatory review date)
R	Cutting of large (potentially steel reinforced) concrete pipe containing wastewater	Considered 'Hot work' and potential contact with raw waste water	Safety risk for workers	3	3	9				Mitigation and transference	Provide adequate safety safeguards and safe work procedures (ex. PPE, permits etc.)	2	1	2				
R	Specialised contractor for specialised deep excavation and cutting works	Low competition	Higher overall project cost + potential schedule impact	3	4	12				Mitigation	Sounding market and procurement strategy	3	2	6				
R	Deep excavation	Geotechnical uncertainty that can change the correct construction method	Cost, delay	3	3	9				Mitigation and transference	Have comprehensive geotechnical survey + appropriate excavation methods	3	1	3				
R	Deep excavation under the water table	Possible control of the water infiltration (duration and certainty of the control)	Cost, delay	2	4	8				Mitigation and transference	Have comprehensive geotechnical survey + appropriate excavation and dewatering methods	2	2	4				
R	Deep excavation under the water table	Lower water table with impact on the wells used for the plant process water	Additional operational cost	2	3	6				Acceptance or Mitigation	Use potable water (temporary) or use dewatering water pumped as process water via temporary connection	1	3	3				
R	Deep excavation near existing structures (foundations included)	Damage to existing structures	Cost, delay, operational impact ultimately leading to spillage	4	3	12				Mitigation and transference	Have comprehensive geotechnical survey + appropriate excavation method + continuous and independent monitoring of existing structures	3	1	3				
R	Exposure of the main interceptor to breakage or damage	Movement of the pipe, uncontrolled damage to the interceptor	Interruption of the plant and spillage to the river	5	3	15				Mitigation and transference	Proper planning choosing the right time of the year (low flow) and contingency plan (using balloons and/or divers)	4	2	8				
R	Cold winter conditions (below freezing)	Out of spec concrete	Cost, delay	2	3	6				Mitigation and transference	Phasing allows for all major concrete work for tie in to be done during summer. Construction specification to include cold weather concrete procedures, admixtures, heated enclosures, heating of water, aggregates etc.)	1	2	2				
R	Crane lifting of big pipe section after cutting	Fall of materials or crane overturn or blockage of the pipe inside in the chamber	Safety issues, delays, damage, partial blockage of the flow	4	2	8				Mitigation and transference	Proper lifting procedures, mechanical inspection of equipment, use of stabilizers, use guide lines to stabilize load, avoid overhead lifting, metal safety perimeter	4	1	4				
R	Work interruption during the pipe cutting window timeframe (e.g. power failure)	Inability to complete the connection within the expected timeframe and insufficient storage capacity in the network to avoid spillage	Flooding of the working area, time and cost impact	2	2	4				Mitigation and avoidance	Plan to carry out cutting during a time when risk of seasonal influences on power reliability (power failure) are low	2	1	2				
R	Unexpected higher flow during pipe cutting	Inability to complete the connection within the expected timeframe and insufficient storage capacity in the network to avoid spillage	Flooding of the working area, time and cost	2	2	4				Mitigation and avoidance	Plan to carry out cutting during a time when risk of seasonal influences on power reliability (power failure) are low	2	1	2				
R	Inability to test the pipe before the pipe cutting	Inability to install pipe or installation stopped half way	Delay in decommissioning the existing pumping plant	3	2	6				Mitigation and transference	Carry out dimensional inspection (quality control) on pipe frame after installation. Prepare contingency plan using divers and a balloon to block interceptor and make repairs	3	1	3				

SNC·LAVALIN	Technical Memorandum no. 2 Tie-in 5a Secondary Clarifier to UV inlet	Document Code:	612962-0000-49EN-0002
		Revision	0
Client: City of Winnipeg	Project: NEWPCC Expansion and Upgrade	Package / Area:	0000

Prepared By:	P. Williams, Eng.	Paul Williams	27/06/2013
	Name	Signature	Date
Checked By:	T. Ball, Eng., M. Sc. A.	Tyler Ball	27/06/2013
	Name	Signature	Date
Approved By:	E. Ryczkowski, M. Sc., P. Eng.		27/06/2013

Professional Seal

APEGM Certificate of Authorization
SNC-Lavalin Inc.
No. 4489

PROVINCE OF MANITOBA
E. M. RYCZKOWSKI
27/06/13
REGISTERED ENGINEER

INGÉNIEUR - ENGINEER
Paul Williams
128784
QUÉBEC

REVISION REGISTER

Rev.	Description	Date	By	Checked	Approved
PA	Issued for information and comment	14/05/13	PW	CK	ER
0	Final Issue	27/06/13	PW	TB	ER

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NOTICE

This document contains the expression of the professional opinion of SNC-Lavalin Inc. (SLI) as to the matters set out herein, using its professional judgment and reasonable care. It is to be read in the context of the agreement between SLI and the City of Winnipeg, and the methodology, procedures and techniques used, SLI's assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the agreement, and for the sole and exclusive benefit of the City of Winnipeg, whose remedies are limited to those set out in the agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SLI disclaims any liability to the City of Winnipeg and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party.

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Contents

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1.0 Constructability Assessment of the tie-in 5a

1.1 General

The City of Winnipeg has initiated a program to perform upgrades to the wastewater treatment systems at the NEWPCC, SEWPCC, and WEWPCC facilities (Winnipeg Sewage Treatment Program – WSTP). This technical memorandum is presented specific to the conduit and pipe tie-ins for the NEWPCC facility that will arise due to the proposed upgrades to the facility . A high-level overview of the tie-ins including expected scope of work, constructability, schedule, constraints and risks related to the tie-ins as presented by the *City of Winnipeg/Veolia NEWPCC Process Selection Report, Phase 2 Rev. 0 is* outlined. A Class 5 cost estimate for the proposed tie-ins is presented in Section 4.0. The estimate does not include the overall civil/structural/piping construction cost for the proposed expansion work, but rather only the additional costs necessary to facilitate the installation due to specific requirements for phasing of the installation and associated risk mitigation.

The overall objective for this undertaking is to provide a technical review of the conceptual planning associated with the NEWPCC master plan development. The review provided herein is based on SNC-Lavalin Inc. (SLI) professional opinion regarding "proof of concept" for tie-ins between existing and new facilities. However, it is recognized and expected that the actual implementation of the work described herein, when it occurs, will be subject to change. The intent of this investigation is to establish the feasibility of the concept and identify potential issues and not the development of a specific design or construction plan.

Tie-in 5a allows for the connection of the new secondary clarifier effluent to the inlet of the existing ultraviolet (UV) facility. Effluent from the existing clarifiers is already routed to the UV facility through the existing channels. This new tie-in must be made before the commissioning of the new secondary clarifiers, and will require the shutdown of the UV facility in order to make the connection into the existing secondary effluent channel (upstream of the low-lift pumps). According to the preliminary layout drawings available and the *Process Selection Report, Phase 2* mentioned above, two (2) 1600 mm Ø pipes are proposed for this connection, coming from the south of the UV building.

1.2 Technical Disciplines Required

The tie-in will require that civil, piping and structural disciplines be involved in the tie-in development and design. If remedial disinfection is required (chlorination, for example), the process discipline would need to be involved. However, this is not anticipated to be required at this time.

1.3 Implementation Options

The tie-in for the secondary clarifier effluent to the inlet of the existing UV plant should take place on the south wall of the secondary effluent channel, upstream of the UV influent pumps. The channel was constructed in 2005/2006, and recent and accurate drawings of the structure are available. Although it will be necessary to shut down the UV plant at one point during the tie-in, the sequence has been elaborated in such a way that the bypass of the UV plant can be quite short (approximately one week). The strategy adopted also allows the majority of the work to be done at any time of the year, with the UV in service.

The implementation steps are as follows:

1. Directly adjacent to and south of the existing channel, a large rectangular chamber must be constructed. Three new walls and a floor slab are required; the fourth wall will be formed by the existing concrete channel wall. The approximate size of the chamber will be 2000 x 5000 mm. On the south wall, the new conduits must be connected into the concrete chamber using waterstops during the construction of the wall. Because these conduits must pass above the existing final effluent / outfall conduit, the connection to the chamber wall will be at EL. 229.3 m (center line). The top of the chamber should be fitted with two 2000 x 2000 mm access manholes for future access to the channel. The floor slab of this chamber (TOC) would be at EL. 225.0 m.
2. The UV system (pumps, UV lamp modules etc…) must be stopped and the inlet channels isolated in order to make the final tie-in by closing gate(s) at junction chamber YG-12A/B.
3. The gate(s) at the existing junction chamber YG-12A/B must be opened in order to ensure the bypass of the UV building via the South effluent channel.
4. Using one of the existing UV low lift pumps (U-010-P-1), the secondary effluent channel can be pumped out as much as possible (in manual mode). The UV effluent weir gates should be opened as much as possible to lower the level in the channel.

By removing one of the UV low lift pumps, and by using a (portable) submersible pump, the UV channel can be emptied even further.

5. Using the access provided by the new rectangular chamber, two openings must be cut in the channel wall to connect the chamber to the existing secondary effluent channel. The size of the openings must be calculated according to the hydraulic profile and in consultation with a structural engineer. Two openings of approximately 1500 x 1500 mm are required.
6. The cut rebar must be sealed using an appropriate product, Sika Top Armetec for example (to prevent corrosion of the exposed steel).
7. The UV system can be returned to regular service after completing the previous steps.
8. The secondary clarifiers can be placed into service at any time once the tie-in is completed.

Note that the final tie-in for 5a and 5b (for the tie-in of the high rate clarifier effluent) can be done at the same time (one after the other) in such a way that only one UV shut-down would be required.

The two new secondary effluent conduits must be installed quite close to the ground surface in order to pass over the existing outfall/effluent conduit. The pipes must be installed so that they are protected from frost penetration below the pipe during the winter, and also from concentrated vertical compressive loads due to vehicles operating on the ground above the pipe. The pipes would be installed with approximately 1.0 to 1.2 m of cover, which is acceptable for HS20 vehicle circulation provided, the correct type of pipe is used, and that the installation (excavation and backfill) are done correctly. In order to provide frost protection, rigid foam insulation will be required (typically 50 to 100 mm thick overtop of the pipe). Different grades of rigid foam insulation exist with compression ratings of up to 100 psi (690 kPa) for direct burial and pipe protection.

The installation of the two new secondary effluent conduits over the existing outfall/effluent conduit does not present a risk to the outfall conduit. Proper care must be taken during the excavation and installation of the new pipes, and appropriate backfill and compaction will be required to avoid settling in the area. According to the information provided by the CofW, this pipe is constructed of 12-inch thick (300mm) concrete so no specialized protection of the existing pipe is required.

Dewatering of the excavation will likely be required, as for any excavation below the water table, but special or particular dewatering procedures are not expected to be necessary.

1.4 Comparisons and Recommendations

By constructing a chamber adjacent to the existing channel, it is possible to carry out a significant portion of the work 1) without stopping the UV system; and 2) at any time of the year, although construction during the warmer months is preferable. In addition, no access is required to the existing channel to carry out the tie-in. This avoids issues of confined space access, additional ventilation, and the risk of working in an unsanitary environment (health hazard).

The complete excavation of the zone will be carried out before the beginning of the construction (formwork and concrete work), because the excavation can be carried out using standard sloped excavation techniques with minimal risk.

Additional piling may be required to support the chamber. This will need to be investigated during the detailed structural design.

2.0 Risk Assessment of the Tie-in

Results of the risk analysis in tabular format are included in Appendix B.

3.0 Phasing Requirements

The schedule for tie-ins is a function of the overall construction schedule which includes the construction of other major civil works structures.

This construction schedule is based on the assumption that the Expansion and Upgrade project will begin in August of 2015.

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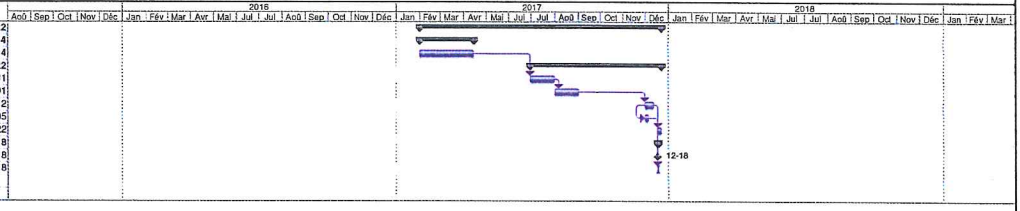
North End Water Pollution Control Centre (NEWPCC)
NEWPCC Facility Planning

City of Winnipeg

N°	Nom de la tâche	Durée	Début	Fin
15	**Secondary clarifier outlet tie-in 5a**	**233 jours**	**Mer 17-02-01**	**Ven 17-12-22**
16	**Engineering**	**53 jours**	**Mer 17-02-01**	**Ven 17-04-14**
17	Design	53 jours	Mer 17-02-01	Ven 17-04-14
18	**Construction**	**126 jours**	**Ven 17-06-30**	**Ven 17-12-22**
19	Excavation adjacent to existing channel	22 jours	Ven 17-06-30	Lun 17-07-31
20	Construction of chamber (civil works)	24 jours	Mar 17-08-01	Ven 17-09-01
21	Bypass of UV facility	8 jours	Ven 17-12-01	Mar 17-12-12
22	Tie in (cutting of exsting UV channel wall)	3 jours	Ven 17-12-01	Mar 17-12-05
23	Closing of chamber (top)	5 jours	Lun 17-12-18	Ven 17-12-22
24	**Commissioning**	**1 jour**	**Lun 17-12-18**	**Lun 17-12-18**
25	Secondary clarifiers ready for commissioning	0 jour	Lun 17-12-18	Lun 17-12-18
26	Commissioning of tie-in	1 jour	Lun 17-12-18	Lun 17-12-18
27				
28				



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Tâche — Avancement — Récapitulative — Tâches externes — Échéance
Fractionnement — Jalon — Récapitulatif du projet — Jalons externes

4.0 Class 5 Cost Estimate of the Tie-in

The cost estimate for the tie-in covers items required for the **phasing** of the installations and any risk mitigation measures required to carry out the tie-in. Normal capital costs (without special phasing provisions) are excluded from the cost estimate. The costs shown herein should therefore be added to capital cost estimates for the installation that is being developed by others.

At this early stage, the level of accuracy of the estimates shown herein is Class 5 (+/-50%). All values are shown in 2013 CDN dollars.

Item	Description	Estimated Value
1	Excavation and disposal costs	$25,000
2	Form work	$10,000
3	Concrete and reinforcing steel (Concrete chamber construction 2.0 m x 6.0 m x 7.0 m)	$50,000
4	Dewatering costs	$15,000
5	Safety supervision	$15,000
	TOTAL DIRECT COSTS	$115,000
	CONTINGENCY (35%)	$40,000
	TAXES (PST – 8%)	$9,000
	Engineering (Design and Construction Services)	$25,000
	Indirect Costs – Owner (Finance and Administrative Charges – 3%)	$6,000
	TOTAL	**$195,000**

Table 1 Class 5 cost estimate for tie-in

Appendix A: Drawings

612962-0000-49DD-0001	Tie-ins 1a, 5a and 5b - Site plan
612962-0000-49DD-0002	Tie-ins 1a, 5a and 5b - Sections A, B and C

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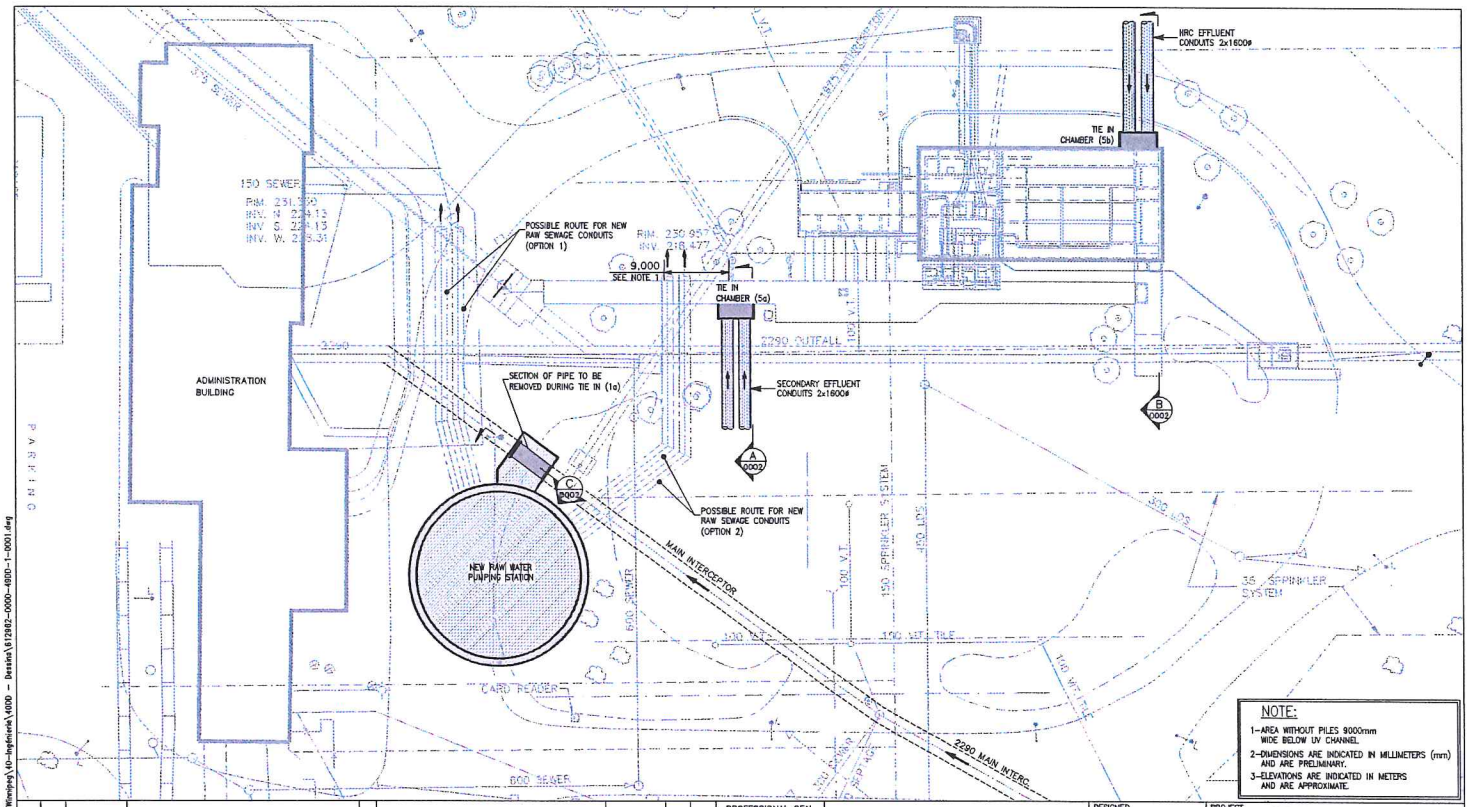

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PA	FIRST ISSUE	13/05/01	P.W.	P.W.

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Canada H2Z 1Z3

CLIENT
THE CITY OF WINNIPEG
Winnipeg WATER AND WASTE DEPARTMENT

DESIGNED	P. WILLIAMS
DRAWN	E. FORTIER
CHECKED	T. BALL
APPROVED	P. WILLIAMS
DATE	2013-04-30
SCALE	1:500

PROJECT
NEWPCC EXPANSION AND UPGRADE

TITLE
FACILITY PLANNING REVIEWS
TIE-INS 1a, 5a AND 5b
SITE PLAN

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
612962	0000	49_DD	0001	00

STDSLL_BMDN – FRAME B IMPERIAL ENGLISH (11"x17")

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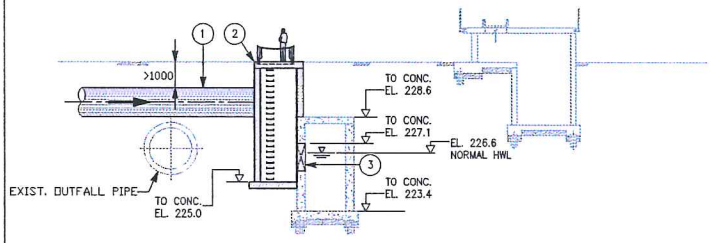

SECTION A
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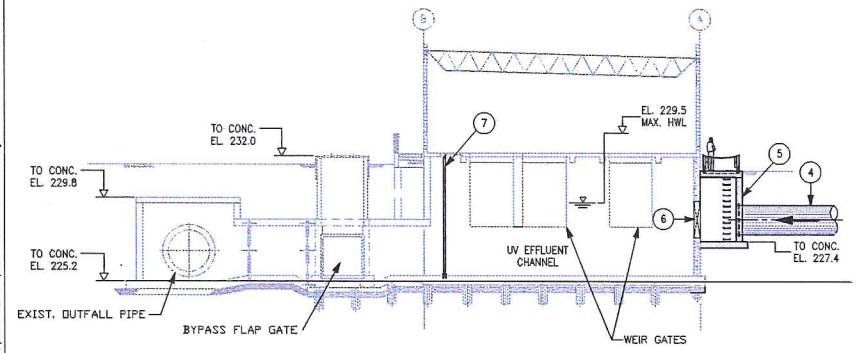
LEGEND

1. SECONDARY EFFLUENT CONDUITS (QTY=2)
2. CHAMBER (2000x5000) FOR TIE IN 5a
3. NEW OPENING IN UV CHANNEL WALL (1500x1500) (QTY=2)
4. EFFLUENT CONDUITS FROM HRC AND CHLORINE CONTACT TANK (QTY=2)
5. CHAMBER (2000x5000) FOR TIE IN 5b
6. NEW OPENING IN UV CHANNEL WALL (2000x2000) (QTY=1)
7. EFFLUENT STOP LOG (U-400-SL-4) (EXISTING)
8. SECTION OF INTERCEPTOR PIPE TO BE REMOVED
9. NEW ISOLATION STOP GATE AND FRAME
10. OPENING TOWARDS NEW PUMPING STATION

NOTE:

1-DIMENSIONS ARE INDICATED IN MILLIMETERS (mm) AND ARE PRELIMINARY.
2-ELEVATIONS ARE INDICATED IN METERS AND ARE APPROXIMATE.



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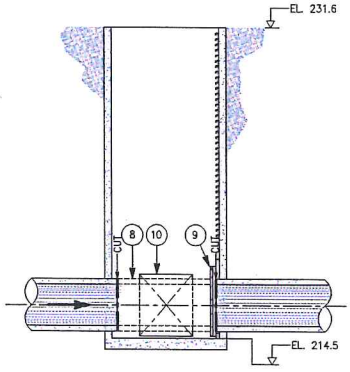

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PROJECT
NEWPCC EXPANSION AND UPGRADE

TITLE
FACILITY PLANNING REVIEW
TIE-INS 1a, 5a AND 5b
SECTIONS A, B AND C

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
612962	0000	49 | DD	0002	00

STDSLI_BMEN – FRAME B IMPERIAL ENGLISH (11"x17")

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Appendix B: Risk Analysis Tie-in 5a

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Risk Event Identification				Risk Event Assessment						Risk Response Assessment (based on an implemented Risk Management Plan - future state)								
Risk or Opportunity (R / O)	Due to (Cause Event)	this could occur (Result Event)	Resulting in (this Effect)	Magnitude of Risk Event(1-5)	Likelihood (1-5)	Assessed Score C X L	Estimated Impact ($,000) what is cost if risk occurred)	Financial Impact (% Target Cost)	Financial risk prior to Mitigation	Risk Response Type (Avoidance, Transference, Mitigation, Acceptance)	Risk Response Plan - Actions	Residual Magnitude occur (1-5)	Residual Likelihood (1-5)	Assessed Residual Score	Cost of Mitigation ($,000)	Adopted	Financial risk after mitigation	Trigger date (mandatory review date)
R	Working directly adjacent to existing concrete structures	Damage to UV channels or other part of the UV building due to use of heavy excavation equipment	Delays and increased cost due to repairs and potential temporary effluent non compliance	2	3	6				Mitigation and transference	Independent monitoring and supervision of contractor during works, safe work procedures, transfer cost of eventual damage to contractor (through contract documents)	2	1	2				
R	Construction below water table	Difficult excavation, water infiltration	Delays, cost increase, safety issues	2	4	8				Mitigation and transference	Appropriate excavation and dewatering methods	2	1	2				
R	UV out of service during part of work (1 week)	No disinfection / non compliant effluent	Temporary partial non compliance regarding disinfection	4	5	20				Mitigation	Communication with Regulator, proper planning of the tie-in period and possible temporary chlorination/dechlorinatio n as contingency alternative	1	5	5				
R	Water tightness of existing sluice gates in junction chamber.	Presence of water in Secondary Effluent channel	Inability to make tie-in, delays, additional costs	2	5	10				Mitigation and avoidance	Small leaks can be managed with submersible pumps. Provide for gate replacement or refurbishment in project planning.	2	1	2				

SNC·LAVALIN	Technical Memorandum no. 3 Tie-in 5b HRC to UV outlet	Document Code: 612962-0000-49EN-0003
		Revision 0
Client: City of Winnipeg	Project: NEWPCC Expansion and Upgrade	Package / Area: 0000

Prepared By:	P. Williams, Eng.		27/06/2013
	Name	Signature	Date
Checked By:	T. Ball, Eng., M. Sc. A.		27/06/2013
	Name	Signature	Date
Approved By:	E. Ryczkowski, M. Sc., P. Eng.		27/06/2013

Professional Seal

APEGM
Certificate of Authorization
SNC-Lavalin Inc.
No. 4489

PROVINCE OF MANITOBA
E. M.
RYCZKOWSKI
27/06/13
REGISTERED ENGINEER

INGÉNIEUR - ENGINEER
Paul Williams
128784
QUÉBEC

REVISION REGISTER

Rev.	Description	Date	By	Checked	Approved
PA	Issued for information and comment	14/05/13	PW	CK	ER
0	Final Issue	27/06/13	PW	TB	ER

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NOTICE

This document contains the expression of the professional opinion of SNC-Lavalin Inc. (SLI) as to the matters set out herein, using its professional judgment and reasonable care. It is to be read in the context of the agreement between SLI and the City of Winnipeg, and the methodology, procedures and techniques used, SLI's assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the agreement, and for the sole and exclusive benefit of the City of Winnipeg, whose remedies are limited to those set out in the agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SLI disclaims any liability to the City of Winnipeg and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party.

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Contents

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1.0 Constructability Assessment of the Tie-in5b

1.1 General

The City of Winnipeg has initiated a program to perform upgrades to the wastewater treatment systems at the NEWPCC, SEWPCC, and WEWPCC facilities (Winnipeg Sewage Treatment Program – WSTP). This technical memorandum is presented specific to the conduit and pipe tie-ins for the NEWPCC facility that will arise due to the proposed upgrades to the facility. A high-level overview of the tie-ins, including expected scope of work, constructability, schedule, constraints and risks related to the tie-ins as presented by the *City of Winnipeg/Veolia NEWPCC Process Selection Report, Phase 2 Rev. 0* is outlined. A Class 5 cost estimate for the proposed tie-ins is presented in Section 4.0. The estimate does not include the overall civil/structural/piping construction cost for the proposed expansion work, but rather only the additional costs necessary to facilitate the installation due to specific requirements for phasing of the installation and associated risk mitigation.

The overall objective for this undertaking is to provide a technical review of the conceptual planning associated with the NEWPCC master plan development. The review provided herein is based on SNC-Lavalin Inc. (SLI) professional opinion regarding "proof of concept" for tie-ins between existing and new facilities. However, it is recognized and expected that the actual implementation of the work described herein, when it occurs, will be subject to change. The intent of this investigation is to establish the feasibility of the concept and identify potential issues and not the development of a specific design or construction plan.

Tie-in 5b allows for the connection of the discharge of the high-rate clarifiers (HRC) to the outlet of the UV facility. No existing connection points are available for this effluent downstream of the UV facility. It will require the shutdown of the UV facility in order to make the connection into the UV effluent channel. In addition, the tie-in will require the isolation of the UV effluent channel from the outfall pipe to prevent flooding of the channel during the bypass of the UV facility, as the channel and outfall pipe are hydraulically connected. According to the *Process Selection Report, Phase 2* mentioned above, two (2) 1600 mm Ø pipes will be used for this connection, coming from the north.

1.2 Technical Disciplines Required

The tie-in will required that civil, piping and structural disciplines be involved in the tie-in development and design. If remedial disinfection is required (chlorination, for example), process discipline would need to be involved. However, this is not anticipated to be required at this time.

1.3 Implementation Options

The tie-in for the HRC effluent to the outlet of the existing UV plant will take place on the north wall of the UV effluent channel, downstream of the UV system. The channel was constructed in 2005/2006 and recent and accurate drawings for the structure are available. Although it will be necessary to shut down the UV plant at one point during the tie in, the sequence has been elaborated in such a way that the bypass of the UV plant can be quite short (approximately one week). The strategy adopted also allows the majority of the work to be done at any time of the year, with the UV system in service.

The implementation steps are as follows:

1. Directly adjacent to the channel, a large rectangular chamber must be constructed. Three new walls and a floor slab are required; the fourth wall will be formed by the existing concrete channel wall. The approximate size of the chamber will therefore be 2000 x 5000 mm. On the north wall, the new conduits coming from the HRC must be connected into the concrete using waterstops during the construction of the wall. In order to maintain a cover of approximately 1800 mm over the pipe (for protection from frost and vehicle circulation), the connection to the wall should be at EL. 228.6 m (centerline). The top of the chamber should be fitted with a 2000 x 2000 mm access manhole for future access to the channel. The floor slab of this chamber would be at EL. 227.4 m
2. The UV system (pumps, UV lamp modules, etc) must be stopped and the inlet channels isolated in order to make the final tie-in by closing gate(s) at junction chamber YG-12A/B.
3. The gate(s) at the existing junction chamber YG-12A/B must be opened in order to ensure the bypass of the UV building via the South effluent channel.
4. The effluent gate U-400-SL-4 must be installed in order to drain the UV effluent canal (this can be done with a submersible pump) and prevent backup of water during the final tie-in steps.
5. Using the access provided by the new rectangular chamber, an opening can be cut in the channel wall to connect the new chamber to the existing channel. The

size of the openings must be calculated according to the hydraulic profile and in consolation with a structural engineer. An opening of approximately 2000 x 2000 mm is required.

6. The cut rebar must be sealed using an appropriate product, Sika Top Armetec for example (to prevent corrosion of the exposed steel).
7. Effluent gate U-400-SL-4 can be removed.
8. UV system can be returned to regular service after completing the previous steps.
9. The HRC units and chlorination / dechlorination system can be placed into service at any time once the tie-in is completed.

Note that the final tie-in for 5a (for the tie-in of the secondary clarifier effluent) and 5b should be done at the same time (one after the other) in such a way that only one UV shut-down would be required.

The addition of the flow of the HRC effluent to the UV effluent channel is not expected to have a significant effect on the maximum water level in the channel. This channel is drained by the existing outfall conduit, and the level in the channel is determined by the headloss generated in the outfall conduit, and the water level in the Red River. Hydraulic losses in the UV effluent channel (due to this additional flow) are negligible compared to the losses generated in the outfall conduit.

Dewatering of the excavation will likely be required, as for any excavation below the water table, but special or particular dewatering procedures are not expected to be necessary.

1.4 Comparisons and Recommendations

By constructing a chamber adjacent to the existing channel, it is possible to carry out a significant portion of the tie-in work 1) without stopping the UV system; and 2) at any time of the year. This allows the work to be done in the summer (instead of winter). In addition, no access is required to the existing channel to carry out the tie in. This avoids issues of confined space access, additional ventilation, and the risk of working in an unsanitary environment (health hazard).

The complete excavation of the zone will be carried out before the beginning of the construction (formwork and concrete work), because the excavation can be carried out using standard sloped excavation techniques with minimal risk.

Additional piling may be required to support the chamber. This will need to be investigated during the detailed structural design.

2.0 Risk Assessment of the Tie-in

Results of the risk analysis in tabular format are included in Appendix B.

3.0 Phasing Requirements

The schedule for tie-ins is a function of the overall construction schedule, which includes the construction of other major civil works structures.

This construction schedule is based on the assumption that the Expansion and Upgrade project will begin in August of 2015.

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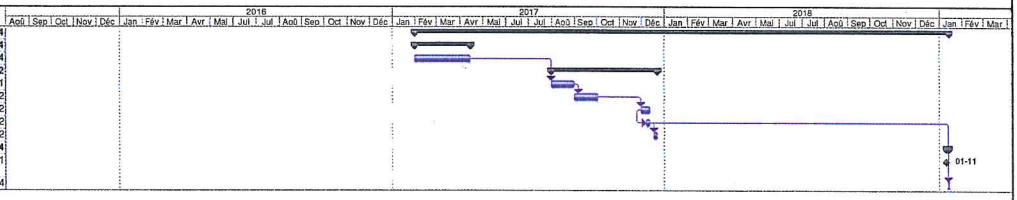
North End Water Pollution Control Centre (NEWPCC)
NEWPCC Facility Planning

City of Winnipeg

N°	Nom de la tâche	Durée	Début	Fin
29	**HRC clarifier outlet tie-in 5b**	**509 jours**	**Mer 17-02-01**	**Lun 19-01-14**
30	**Engineering**	**53 jours**	**Mer 17-02-01**	**Ven 17-04-14**
31	Design	53 jours	Mer 17-02-01	Ven 17-04-14
32	**Construction**	**104 jours**	**Mar 17-08-01**	**Ven 17-12-22**
33	Excavation adjacent to existing channel	23 jours	Mar 17-08-01	Jeu 17-08-31
34	Construction of chamber (civil works)	22 jours	Ven 17-09-01	Lun 17-10-02
35	Bypass of UV facility	8 jours	Ven 17-12-01	Mar 17-12-12
36	Tie in (cutting of exsting UV channel wall)	3 jours	Ven 17-12-08	Mar 17-12-12
37	Closing of chamber (top)	5 jours	Lun 17-12-18	Ven 17-12-22
38	**Commissioning**	**2 jours**	**Ven 19-01-11**	**Lun 19-01-14**
39	HRC and chlorination tank ready for commissioning	0 jour	Ven 19-01-11	Ven 19-01-11
40	Commissioning of tie-in	1 jour	Lun 19-01-14	Lun 19-01-14



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4.0 Class 5 Cost Estimate of the Tie-in

The cost estimate for the tie-in covers items required for the **phasing** of the installations and any risk mitigation measures required to carry out the tie-in. Normal capital costs (without special phasing provisions) are excluded from the cost estimate. The costs shown herein should therefore be added to capital cost estimates for the installation that is being developed by others.

At this early stage, the level of accuracy of the estimates shown herein is Class 5 (+/-50%). All values are shown in 2013 CDN dollars.

Item	Description	Estimated Value
1	Excavation (tie-in chamber only) and disposal costs	$20,000
2	Form work (tie-in chamber only)	$7,000
3	Concrete and reinforcing steel (Concrete chamber construction 2 x 6 x 7.0 m)	$38,000
4	Dewatering costs	$15,000
5	Safety supervision	$15,000
	TOTAL DIRECT COSTS	$95,000
	CONTINGENCY (35%)	$34,000
	TAXES (PST – 8%)	$8,000
	Engineering (Design and Construction Services)	$25,000
	Indirect Costs – Owner (Finance and Administrative Charges – 3%)	$5,000
	TOTAL	**$167,000**

Table 1 Class 5 cost estimate for tie-in

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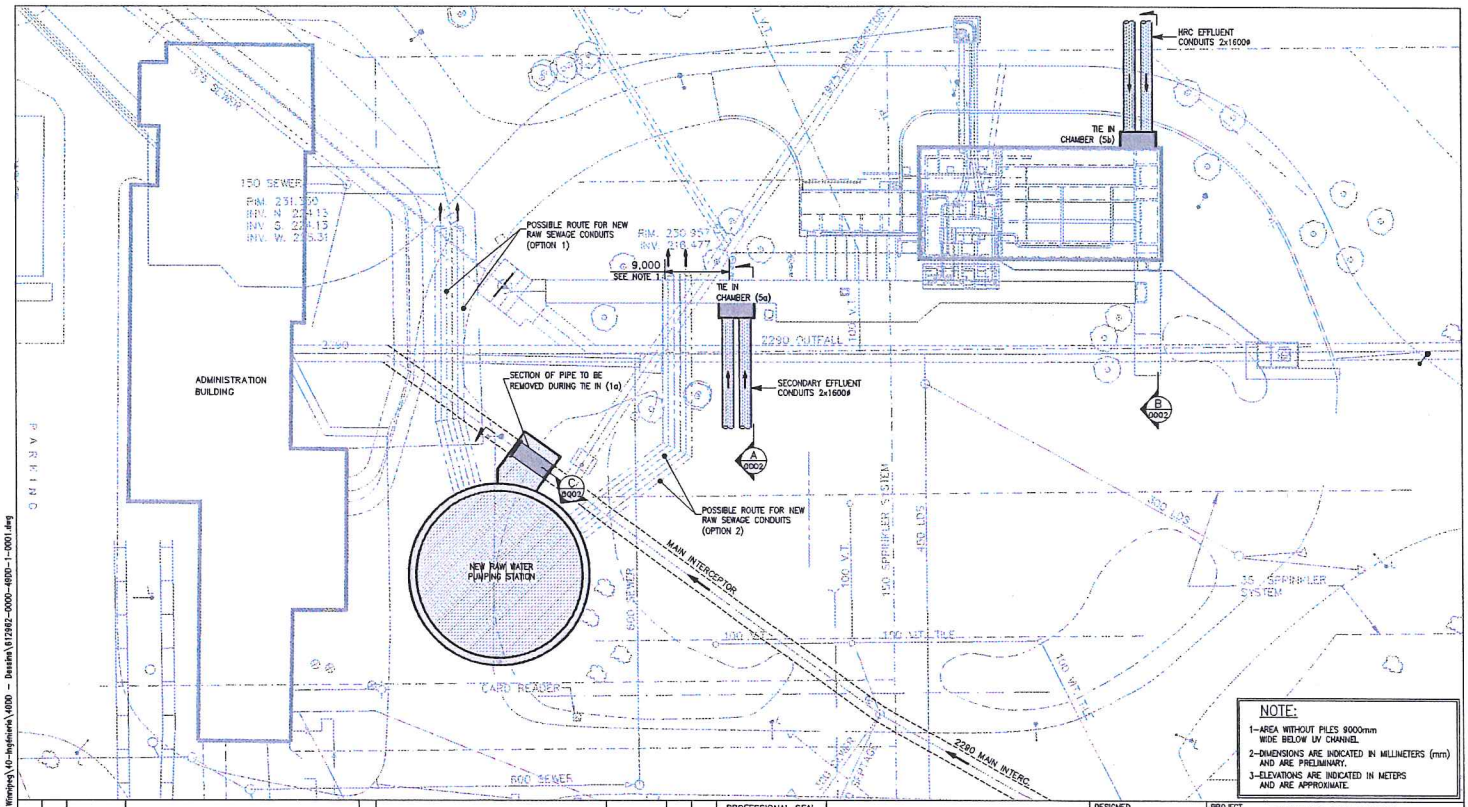

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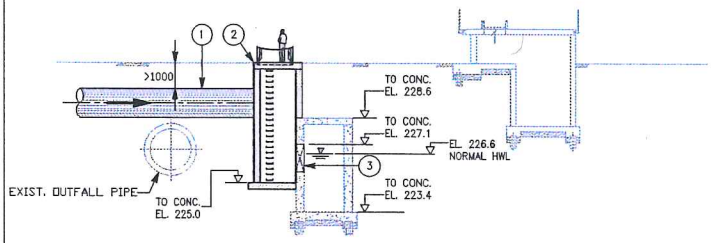

SECTION A 0001
1:200

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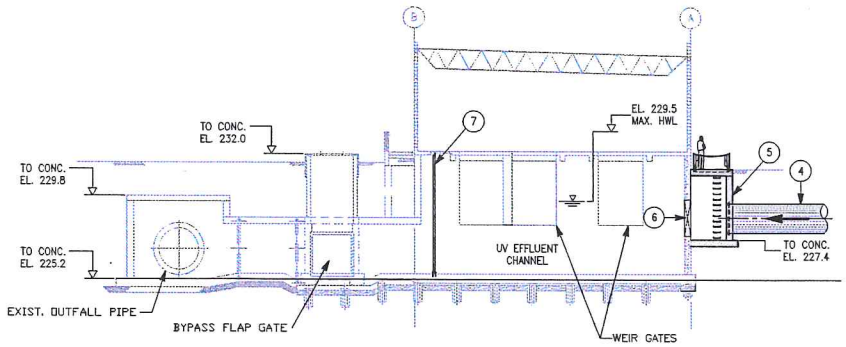

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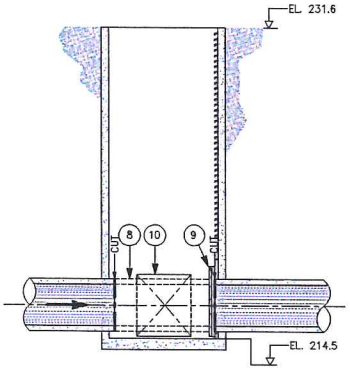

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PROJECT
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TIE-INS 1a, 5a AND 5b
SECTIONS A, B AND C

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
612962	0000	49 | DD	0002	00

STDSLI_BMDN – FRAME B IMPERIAL ENGLISH (11"x17")

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Appendix B: Risk Analysis Tie-in 5b

SNC·LAVALIN

Risk Event Identification				Risk Event Assessment						Risk Response Assessment (based on an implemented Risk Management Plan - future state)								
Risk or Opportunity (R / O)	Due to (Cause Event)	this could occur (Result Event)	Resulting in (this Effect)	Magnitude of Risk Event(1-5)	Likelihood (1-5)	Assessed Score C X L	Estimated Impact ($,000) what is cost if risk occurred)	Financial Impact (% Target Cost)	Financial risk prior to Mitigation	Risk Response Type (Avoidance, Transference, Mitigation, Acceptance)	Risk Response Plan - Actions	Residual Magnitude occur (1-5)	Residual Likelihood (1-5)	Assessed Residual Score	Cost of Mitigation ($,000)	Adopted	Financial risk after mitigation	Trigger date (mandatory review date)
R	Working directly adjacent to existing concrete structures	Damage to UV channels or other part of the UV building due to use of heavy excavation equipment	Delays and increased cost due to repairs and potential temporary effluent non compliance.	2	3	6				Mitigation and transference	Independent monitoring and supervision of contractor during works, safe work procedures, transfer cost of eventual damage to contractor (through contract documents)	2	1	2				
R	Construction below water table	Difficult excavation, water infiltration	Delays, cost increase, safety issues	2	4	8				Mitigation and transference	Appropriate excavation and dewatering methods	2	1	2				
R	UV out of service during part of work (1 week)	No disinfection / non compliant effluent	Temporary partial non compliance regarding disinfection	4	5	20				Mitigation	Communication with Regulator, proper planning of the tie-in period and possible temporary chlorination/dechlorinatio n as contingency alternative	1	5	5				
R	Water tightness of existing sluice gates in junction chamber.	Presence of water in Secondary Effluent channel	Inability to make tie-in, delays, additional costs	2	5	10				Mitigation and avoidance	Small leaks can be managed with submersible pumps. Provide for gate replacement or refurbishment in project planning.	2	1	2				