Surveyor

Occupational Analysis Report

March 2013

Commission
de la construction
du Québec

The purpose of this report is to describe as accurately as possible the occupation of surveyor as currently practiced in Québec's construction industry. It is a record of discussions held by a group of workers who met for the occasion after industry partners recommended them to the Commission de la construction du Québec for their expertise.

The occupational analysis is a first step in the definition of the competencies required for practicing the occupation. This report becomes one of the reference and decision-making tools used by the Commission for teaching and learning purposes.

This report does not bind the Commission in any way. It has no legal effect and is meant as a reflection of discussions held on the date of the analysis workshop.

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The masculine gender is used generically
in this document to facilitate reading.

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APPROVAL

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April 4, 2014

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INTRODUCTION

In early 2009, the Direction de la formation professionnelle of the Commission de la construction du Québec (CCQ) launched a large-scale operation to review the occupational analyses[1] of all construction industry trades.

The CCQ undertook this operation for many reasons, particularly the following:

- the project to reform the construction workforce apprenticeship and management system, and the eventual design of qualitative apprenticeship logbooks requiring a detailed description of each trade;

- the fact that most construction occupational analyses[2] had been conducted between 1987 and 1991 and had not been reviewed since;

- implementation of Chapter 7 of the Agreement on Internal Trade (AIT) and of the Québec-France Understanding on the Mutual Recognition of Professional Qualifications.

These factors demonstrate the necessity of updating the occupational analyses in order to obtain a current and complete profile of the various trades and specialized occupations in Quebec.

The occupational analysis of the specialized occupation of surveyor belongs to this context[3]. Its purpose is to describe this specialized occupation as currently practiced in the construction industry. This report was written in order to collate and organize the information gathered during the occupational analysis workshop held in Laval on January 26 and 27, 2012.

This analysis aims to draw a portrait of the occupation (tasks and operations) and its working conditions, and to identify the skills and behaviours required. The report of the occupational analysis workshop is an accurate reflection of the consensus reached by a group of experienced surveyors. A special effort was made to include in this report all the data collected during the workshop and to ensure that the data accurately depict the realities of the occupation analysed.

1. The terms “profession” and “trade” are considered synonymous.
2. Called “Work Situation Analyses” at the time.
3. This occupational analysis was conducted according to the *Cadre de référence et instrumentation pour l’analyse d’une profession*, produced in 2007 by the ministère de l’Éducation, du Loisir et du Sport (Direction générale de la formation professionnelle et technique) and the Commission des partenaires du marché du travail, ministère de l’Emploi et de la Solidarité sociale.

1. GENERAL CHARACTERISTICS OF THE OCCUPATION

1.1 DEFINITION OF THE SPECIALIZED OCCUPATION

Under Schedule B, Subschedule B, Subsection 20 of the Civil Engineering and Roadwork Sector Collective Agreement, “surveyor” is defined as follows:

> Instrument man (surveyor): Anyone who, using surveying instruments, plans or software, provides:
>
> - alignments;
> - construction axes;
> - elevations and survey points on a piece of land or on a structure which are necessary for the execution of construction work.
>
> The Surveyor’s job description also comprises the production of drawings, the computation of volumes relating to concrete quantities, excavations, excavated material, embankments and the planning of coordinated concrete pouring, but only when performed at the site of the execution of these operations, with the exception of the person who exclusively and only performs the duties specified in this paragraph (calculator).

According to the participants in the occupational analysis workshop, the term “specialized occupation” to describe the employment status is inappropriate; the work of surveyors on construction sites should be recognized as a trade to the same extent as the other trades mentioned in the Regulation respecting the vocational training of workforce in the construction industry.

The participants also specify that the terms “instrument man” and “chainman” are no longer used on construction sites. Those terms have disappeared from the vocabulary because of technological developments, which have made the work more individualized.

The participants add that distinctions between the work of calculators and surveyors are not always easy to draw on construction sites.

1.2 JOB TITLES

The job titles used for describing the specialized occupation are “surveyor,” “construction surveyor” or “surveyor technician.”

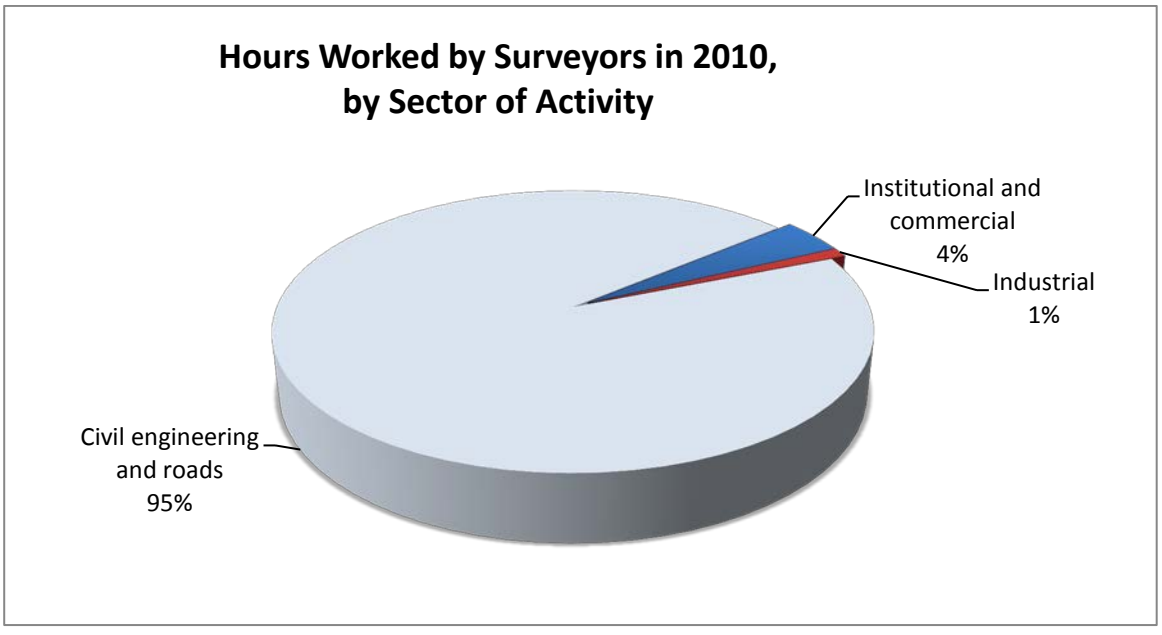
Job titles not to be confused with “surveyor” are “land surveyor” and “semiskilled worker.”

1.3 SECTORS OF ACTIVITY

Surveyors are active mainly in three of the four sectors of the construction industry:

- civil engineering and roads;
- industrial;
- institutional and commercial.

The graphic below illustrates the allocation of hours worked by surveyors in Quebec in 2010[4]:



4. Commission de la construction du Québec, *Careers - Construction*, Québec City, 2009-2010 edition.

The surveyors attending the workshop consider that this graphic corresponds relatively well to their perception of the areas where their specialized occupation is practiced, but they specify that the institutional and commercial sector appears under-represented. They point out that the residential sector is also a relevant work area, although with a low volume of work.

When asked about the sector of activity in which they work, all the participants reported working mainly in the civil engineering and roads sector.

Seven participants also work in another sector: four reported having also worked in the institutional and commercial sector, and the remaining three in the industrial sector.

1.4 FIELD OF PRACTICE

The occupation's field of practice is the construction industry. The Act respecting labour relations, vocational training, and workforce management in the construction industry (R.S.Q., c. R-20) defines construction as follows:

> […] the foundation, erection, maintenance, renewal, repair, alteration and demolition work on buildings and civil engineering works carried out on the job site itself and vicinity including the previous preparatory work on the ground;
>
> In addition, the word "construction" includes the installation, repair and maintenance of machinery and equipment, work carried out in part on the job site itself and in part in the shop, moving of buildings, transportation of employees, dredging, turfing, cutting and pruning of trees and shrubs and laying out of golf courses, but solely in the cases determined by regulation.

1.5 LEGISLATION, REGULATIONS AND STANDARDS

Surveyors in the construction industry are subject to:

- the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20);
- the Regulation respecting the vocational training of workforce in the construction industry (R-20, r.6.2);
- the four sector-based collective agreements of the construction industry;

- the Act Respecting Occupational Health and Safety (R.S.Q., c. S-2.1);
- the Safety Code for the construction industry (R.Q. c. S-2.1, r.6);
- municipal by-laws.

Moreover, the work of surveyors must not infringe on that of land surveyor and must observe professional intervention limits defined by laws and regulations in the field of legal surveying.

In addition, some work done by surveyors must meet the requirements of federal and provincial environmental regulations or of certain standards, such as the LEED (Leadership in Energy and Environmental Design) standard. On some construction sites, the client may give specific safety instructions.

Finally, the surveyor's field book is considered a legal document.

1.6 WORKING CONDITIONS

The following information[5] provides an overview of the conditions and context of the work of surveyors, as commented by the participants in the occupational analysis workshop. To obtain up-to-date and complete information that has legal effect, it is necessary to refer to the four sector-based collective agreements of the construction industry.

Salary

The average annual salary of a construction industry surveyor having worked at least 500 hours in 2010 was 58,526. The hourly wage varies slightly according to the sector of activity. As of May 1, 2011, the daytime hourly wage was as follows:

- Industrial, institutional and commercial: $33.70
- Civil engineering and roads: $33.70
- Light residential: $28.45
- Heavy residential: $30.16

5. The data presented in this section are taken from the four collective agreements of the construction industry, and from the following document, published by the Commission de la construction du Québec: *Careers – Construction*, Québec City, 2011-2012 edition.

Vacations and time off

Mandatory annual holidays of four weeks – two weeks in summer and two in winter at fixed periods determined in collective agreements – are the general rule in the construction industry. To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow certain changes to these prescribed vacation periods. In addition to these vacation periods, employees receive eight statutory holidays and a lump sum for sick leave.

In that regard, the participants mentioned that they had rarely been able to take their summer vacation at the fixed period determined by collective agreements.

Pension plan

Construction industry workers participate in a pension plan. They retain their eligibility for this pension plan throughout their career in construction, even if they change employer, trade or sector.

Insurance

The group insurance plan (medications, illness, disability, death) is fully paid by employers. Workers (and their families, as the case may be) are eligible for it so long as they remain active in the construction industry and work the required number of hours, whether or not they change employer.

Physical requirements

Surveyors need endurance, because the work is sometimes done in difficult weather conditions. In addition, good physical strength is required for carrying surveying equipment, particularly on rough terrain. Surveyors also need dexterity and good visual acuity.

According to the participants, not being subject to vertigo and claustrophobia is an advantage for surveyors working at heights and in confined spaces.

Work schedules

A 40-hour workweek from Monday to Friday is the general rule in all construction industry sectors. The daily limit is 8 hours a day, except in the light residential sector, where it can be up to 10 hours within a 40-hour week.

To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow many possibilities for changing the schedule prescribed by the general rule: compressed schedule, schedule shift, make-up time in the light residential sector, etc. These special schedules confer flexibility to the work schedules in effect in the construction industry.

According to the participants in the occupational analysis, the work usually takes place in the daytime. However, many construction sites have specific schedules. Thus, in the civil engineering and roads sector, surveyors often work 45 hours a week, and more during the peak period for roadwork sites; some surveyors may work early in the morning, during the evening, the night and on weekends. In addition, some surveyors work on call and must be available for 24-hour periods.

Stress factors

The specialized occupation of surveyor involves many stress factors. Here are some mentioned by the surveyors attending the analysis:

- working under pressure and within tight deadlines;
- frequent requests for immediate availability;
- uncertainties related to work done in other trades and occupations, and the consequences of such work on the sequence of surveying tasks to be performed;
- relations with other trades and occupations;
- individual work and the level of responsibility related to the consequences of an error of execution;
- stress due to the high level of precision required for field work;
- the easy blame of colleagues for errors of execution that are not necessarily attributable to surveyors.

1.7 WORK ORGANIZATION

Previously, surveyors worked in teams of two or three (team leader, instrument man and chainman), but this situation is becoming rarer. In fact, due to technological developments, robotic total stations and the increased use of GPS[6], the field work is now done individually to an ever greater extent. The participants point out that individual work can have consequences for the follow-up and progress of work if the surveyor is absent.

The type of supervision varies according to company size. In large companies, surveyors work under the supervision of a chief surveyor. In small companies, surveyors may work alone, supervised by the company owner or a project manager.

In large companies and major construction sites, there is usually a chief surveyor supervising the work of teams, comprised of team leader surveyors and other surveyors.

1.8 JOB MARKET ENTRY CONDITIONS

To exercise the specialized occupation of surveyor in the construction industry, a candidate must:

- be at least 16 years of age;
- have successfully passed the course *Santé et sécurité générale sur les chantiers de construction*;
- have successfully passed the *Cours de connaissance générale de l'industrie de la construction* (CCGIC).
    - To register for the CCGIC, candidates must present to the CCQ the original version of an academic transcript or apprenticeship transcript attesting that they have passed a course of study recognized by the CCQ and giving access to the industry – i.e., leading to the DEP - Arpentage et topographie[7].

6. The Direction de la formation professionnelle of the Commission de la construction du Québec wishes to clarify the term "GPS" in this document. The Global Positioning System (GPS) is a localization system using satellites. When referring to the instrument used in surveying, it means rather the "GPS receiver." In addition, given the existence of other satellite navigation systems, this term may also include the "GNSS receiver" (Global Navigation Satellite System).
7. Other conditions than those listed may apply. For a complete list of entry conditions for this occupation, see the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20). The CCQ's website may also be consulted: http://www.ccq.org/en/DevenirTravailleur/E_CertificatsCompetence.

Although the construction industry favours graduates for access, labour shortages may at times make it necessary for the CCQ to give non-graduates access to the specialized occupation of surveyor. Thus, candidates without a diploma are eligible to obtain an occupation competency certificate if they meet the following requirements:

- be at least 16 years of age;
- have successfully passed the course *Santé et sécurité générale sur les chantiers de construction*;
- present, during a labour-pool opening, a guarantee of employment produced by an employer registered with the CCQ, for at least 150 hours over a period of at most three consecutive months[8].

Candidates having obtained a competency certificate during a labour shortage must meet certain requirements when renewing their certificate.

Among the participants in the analysis, four have taken the training in *Arpentage et topographie*, three have taken technical training in *Technologie du génie civil*, two have taken technical training in *Géodésie*, two have learned in the workplace, one has taken vocational training in *Dessin Industriel* and one has taken training in *Arpentage et topographie* and in *Géodésie*.

Finally, certain qualities are sought by employers hiring new surveyors. The following list presents the main qualities, in the order they were mentioned and not in order of importance:

- mobility;
- experience;
- training;
- proficiency of a specific measuring instrument model;
- proficiency of specific software;
- availability;
- autonomy.

8. Ibid.

1.9 PLACE OF WOMEN IN THE OCCUPATION

Section 126.0.1 of the Act respecting labour relations, vocational training and workforce management in the construction industry pertains to women's access to the construction industry: "The Commission, after consultation with the Commission des droits de la personne et des droits de la jeunesse, shall develop measures to favour the access of women to and their maintenance and greater representation on the labour market in the construction industry."

According to the CCQ, 100 women were practicing the specialized occupation of surveyor in 2010, out of a total of 1,171 surveyors, i.e., a percentage of 8.5%.

According to the surveyors in attendance, the low presence of women may be explained by the demanding physical requirements of the specialized occupation, by the necessary endurance for doing the work and by the persistence of some prejudice.

1.10 CAREER PROSPECTS

With experience, surveyors can become team leaders, foremen, group leaders, chief surveyors, calculators or draftsmen. But the participants mentioned that there are few opportunities for becoming group leader or chief surveyor, because those positions are found only on very big construction sites.

1.11 DEVELOPMENT OF THE SPECIALIZED OCCUPATION

Surveying has been in constant evolution for several years, and technological changes are frequent. As examples of ongoing changes that should continue for many years, the participants cite the following: the robotization of total stations, the increasing use of GPS, the arrival of 3D scanners, the greater precision of measuring instruments, the continual development of new data processing and drawing software, the evolving data-entry functions of electronic notebooks, the installation of measuring instruments on heavy machinery, and the ever-stricter accuracy requirements for readings and layouts.

Those considerable technological changes oblige surveyors to frequently work alone, more quickly and with greater accuracy. They also lead to greater retraining needs.

1.12 IMPACT OF ENVIRONMENTAL STANDARDS ON THE PRACTICE OF THE SPECIALIZED OCCUPATION

Among workers in construction trades and occupations, surveyors are often the first to arrive on construction sites and to view a site's particular constraints in terms of environmental protection (humid environments, animal protection or presence of contaminated soils, for example). So surveyors will have to delimit the part of the terrain that must be protected, or to estimate the excavation volume for evacuating contaminated soils.

The adoption of LEED (Leadership in Energy and Environmental Design) standards also has impacts on the work, and surveyors must, like all construction site personnel, comply with those standards.

2. WORK DESCRIPTION

2.1 TASKS AND OPERATIONS

List of tasks

The following list presents the main tasks performed by surveyors. The order in which the tasks are presented does not necessarily reflect their importance in the specialized occupation.

Task 1	Check and maintain the equipment
Task 2	Conduct a field survey
Task 3	Process the data
Task 4	Do the layout
Task 5	Do the mapping
Task 6	Estimate quantities

The table of surveyor tasks and operations is presented in the following pages.

Table 2.1 Tasks and Operations

TASKS	OPERATIONS					
1. CHECK AND MAINTAIN THE EQUIPMENT	1.1 Ensure equipment supplies	1.2 Clean and maintain surveying equipment	1.3 Check and adjust the accuracy of measuring instruments	1.4 Have measuring instruments calibrated	1.5 Manage computer files	
2. CONDUCT A FIELD SURVEY	2.1 Prepare the work	2.2 Prepare the area	2.3 Establish or choose stations	2.4 Draw a sketch, if applicable	2.5 Reference the stations	2.6 Set up measuring instruments
	2.7 Take measurements	2.8 Verify the closure	2.9 Compile the notes			
3. PROCESS THE DATA	3.1 Find out about the work	3.2 Transfer the data	3.3 Produce a list of points surveyed	3.4 Correct the data	3.5 Proceed with necessary calculations	3.6 Draw a list of points calculated
	3.7 Transmit the data					
4. DO THE LAYOUT	4.1 Prepare the work	4.2 Do reconnaissance of the area	4.3 Draw a sketch, if applicable	4.4 Set up measuring instruments	4.5 Proceed with doing the layout	4.6 Calculate additional points or data, if applicable
	4.7 Take necessary notes	4.8 Check the layout	4.9 Reference staked and station points, if applicable			
5. DO THE MAPPING	5.1 Prepare the work	5.2 Consult the list of measured or calculated points	5.3 Classify the entities	5.4 Produce the drawing	5.5 Add detail to the plan	5.6 Print the preliminary plan
	5.7 Transmit the preliminary plan for verification, if applicable	5.8 Verify and correct the plan	5.9 Print the final plan			
6. ESTIMATE QUANTITIES	6.1 Prepare the work	6.2 Import the data	6.3 Calculate the areas	6.4 Calculate the volumes	6.5 Calculate the lengths	

2.2 OPERATIONS, SUB-OPERATIONS AND CLARIFICATIONS

In the following pages are presented the sub-operations related to some of the operations, as well as a few clarifications made by the participants.

Table 2.2 Sub-Operations and Operation Clarifications

TASK 1 CHECK AND MAINTAIN THE EQUIPMENT

Operations		Sub-Operations	Clarifications
1.1	Ensure equipment supplies	1.1.1 Ensure equipment availability: ▪ measuring instrument equipment ▪ calculator ▪ nails, stakes and iron rods ▪ pencil ▪ plumb line ▪ measuring tape ▪ USB keys or memory card ▪ fluorescent tape, paint and benchmarks ▪ rope ▪ etc. 1.1.2 Recharge the batteries: ▪ of the total station or the robotic total station ▪ of the radio transmitter ▪ of the cell phone ▪ of the GPS ▪ of the rotary level ▪ of the electronic field book ▪ etc. 1.1.3 Make sure to have fuel for tools and machines	
1.2	Clean and maintain surveying equipment	1.2.1 Clean field equipment: ▪ chains ▪ range poles ▪ total station ▪ robotic total station ▪ theodolite ▪ rotary and manual levels ▪ tripods ▪ vehicles ▪ etc. 1.2.2 Do mechanical maintenance on: ▪ the chain-saw ▪ the brush cutter ▪ the impact drill ▪ the stud gun ▪ the all-terrain vehicle	

TASK 1 CHECK AND MAINTAIN THE EQUIPMENT

Operations		Sub-Operations	Clarifications
1.3	Check and adjust the accuracy of measuring instruments	1.3.1 Check and adjust the centering of the optical plummet (total station and theodolite) 1.3.2 Check and adjust the socket's centering 1.3.3 Check and adjust the prism pole's level vial 1.3.4 Check and adjust the target's level vial 1.3.5 Periodically check and adjust the robotic total station: ▪ collimation ▪ trunnion axis 1.3.6 Check the telemeter or the total station 1.3.7 Check measuring instruments installed on heavy machinery 1.3.8 Check measuring instruments used in other trades and occupations 1.3.9 Perform a collimation test on the level	
1.4	Have measuring instruments calibrated		
1.5	Manage computer files	1.5.1 Create folders 1.5.2 Make saves 1.5.3 Defragment the drive 1.5.4 Use antivirus software 1.5.5 Delete irrelevant files 1.5.6 Update software	

TASK 2 CONDUCT A FIELD SURVEY

Operations		Sub-Operations	Clarifications
2.1	Prepare the work	2.1.1 Find out about the work ▪ type of work ▪ location ▪ limits ▪ tolerances and requirements ▪ deadlines ▪ check the construction site plans ▪ performance constraints 2.1.2 Plan the work time and schedule 2.1.3 Choose the necessary equipment	

TASK 2 CONDUCT A FIELD SURVEY

Operations		Sub-Operations		Clarifications
2.2	Prepare the area	2.2.1	Locate relevant elements: ▪ boundaries ▪ pipes ▪ stakes ▪ remains ▪ benchmarks ▪ services (Info-Excavation)	
		2.2.2	Clear the area or have it done by other trades or occupations	
2.3	Establish or choose stations	2.3.1	Choose the starting points: ▪ boundaries ▪ georeferenced nails ▪ benchmarks ▪ etc.	Sub-operation 2.3.1 applies if there are sufficient existing station points.
		2.3.2	Establish [with the total station, the robotic total station or the positioning system (GPS)] station points: ▪ nails ▪ rods ▪ pipes ▪ etc.	Sub-operation 2.3.2 applies if there are insufficient existing station points.
2.4	Draw a sketch, if applicable	2.4.1	Tour the area and draw it, if applicable	
		2.4.2	Indicate code points if there are many details to include	
		2.4.3	Provide the information to the foreman or the draftsman	
2.5	Reference the stations	2.5.1	Locate the stations in relation to existing elements (post, house, etc.)	
		2.5.2	Note the code points (the points and their description)	
		2.5.3	Record the data in the notebook (manual or electronic)	

TASK 2 CONDUCT A FIELD SURVEY

Operations		Sub-Operations		Clarifications
2.6	Set up measuring instruments	2.6.1	Do the centering or resection, as well as the levelling and adjustment, of instruments on the chosen station: ▪ total station ▪ robotic total station ▪ GPS receiver ▪ laser or electronic level	
		2.6.2	Perform the backsight with: ▪ the total station ▪ the robotic total station ▪ the level ▪ the laser or electronic level ▪ the GPS (verification on a benchmark)	
		2.6.3	Optimize the accuracy of stations	Sub-operation 2.6.3 applies when the reading requires high precision.
		2.6.4	Prepare the field book and the electronic field book	
2.7	Take measurements	2.7.1	Measure the angles with: ▪ the total station ▪ the robotic total station ▪ the theodolite	
		2.7.2	Measure distances with: ▪ the total station ▪ the robotic total station ▪ the chain ▪ the odometer ▪ the measuring tape ▪ the GPS	
		2.7.3	Measure the elevation with: ▪ the total station ▪ the robotic total station ▪ the level ▪ the laser or electronic level ▪ the GPS	
		2.7.4	Take an X, Y, Z reading with: ▪ the total station ▪ the robotic total station ▪ the GPS ▪ the 3D scanner	
		2.7.5	Enter the code points (the points and their description)	

TASK 2 CONDUCT A FIELD SURVEY

Operations		Sub-Operations	Clarifications
2.8	Verify the closure	2.8.1 Perform the backsight with: ▪ the total station ▪ the robotic total station ▪ the level ▪ the laser or electronic level ▪ the GPS (verification on a benchmark) 2.8.2 Optimize the accuracy of stations	Sub-operation 2.8.2 applies when the reading requires high precision.
2.9	Compile the notes	2.9.1 Classify the notes 2.9.2 Add detail to the sketches: ▪ pagination ▪ street alignments ▪ north arrow ▪ etc. 2.9.3 Transfer the data in the computer 2.9.4 Back up the data or make photocopies	Reading data must be kept for legal reasons.

TASK 3 PROCESS THE DATA

Operations		Sub-Operations	Clarifications
3.1	Find out about the work	3.1.1 Check data reliability (plans, digital terrain model, specifications) 3.1.2 Choose the software	
3.2	Transfer the data	3.2.1 Open a computer file, enter the data manually or use transfer software	
3.3	Produce a list of points noted		
3.4	Correct the data	3.4.1 Check notebook data (code, numbering, backsight, instrument height, etc.) 3.4.2 Correct the information of the points measured 3.4.3 Draw a list of corrected points	

TASK 3 PROCESS THE DATA

Operations		Sub-Operations	Clarifications
3.5	Proceed with necessary calculations	3.5.1 Verify the closure and compensate the polygonal line 3.5.2 Calculate the offset 3.5.3 Design or modify temporary roads or ditches 3.5.4 Create a digital terrain model or a 3D road model 3.5.5 Program the digital terrain model for heavy machinery 3.5.6 Integrate the polygonal line coordinates in a benchmark system (a geodesic or an existing arbitrary one) by translation or rotation	
3.6	Draw a list of points calculated		Depending on work organization and company size, the surveyor or the calculator performs this operation.
3.7	Transmit the data	3.7.1 Transmit the digital terrain model to the heavy machinery operator 3.7.2 Transmit the data to engineering consulting firms, other surveyors, the employer, etc.	

TASK 4 DO THE LAYOUT

Operations		Sub-Operations	Clarifications
Field of application: for alignment axes, linear elements, chaining, etc.			
4.1	Prepare the work	4.1.1 Find out about the work to be done: ▪ type of work (sewers, manholes, road infrastructures, bridges, etc.) ▪ location ▪ requirements ▪ deadlines ▪ performance constraints 4.1.2 Find out about the level of precision and the execution time 4.1.3 Collect the necessary data for doing the work: ▪ electronic plan ▪ layout plan 4.1.4 Acquire the necessary equipment (instruments and stakes)	

TASK 4 DO THE LAYOUT

Operations		Sub-Operations		Clarifications
4.2	Do reconnaissance of the area	4.2.1	Locate the stations: ▪ geodesic ▪ local ▪ altimetric ▪ reflectorized targets	
		4.2.2	Install intermediate stations, if applicable	
		4.2.3	Create a polygon, if applicable	
4.3	Draw a sketch, if applicable	4.3.1	Produce the drawing and write: ▪ the work location ▪ the team members' names ▪ the date ▪ the weather conditions ▪ the work to be done	The sketch is useful for documenting the work. It is produced less frequently during this task than task 2, "Conduct a field survey."
4.4	Set up measuring instruments	4.4.1	Do the centering or resection, as well as the levelling and adjustment, of instruments on the chosen station: ▪ total station ▪ robotic total station ▪ GPS receiver ▪ laser or electronic level	
		4.4.2	Perform the backsight with: ▪ the total station ▪ the robotic total station ▪ the level ▪ the laser or electronic level ▪ the GPS (verification on a benchmark)	
		4.4.3	Optimize the accuracy of stations	Sub-operation 4.4.3 applies when the layout requires high precision.
		4.4.4	Prepare the field book and the electronic fieldbook	
4.5	Proceed with doing the layouts	4.5.1	Select the element to be staked	
		4.5.2	Measure the points to be staked	
		4.5.3	Place required references (offsets)	
		4.5.4	Stake the point (iron rod, stake, etc.)	
		4.5.5	Proceed to identify the points staked	
4.6	Calculate additional points or data, if applicable	4.6.1	Take known points to verify the installation	
		4.6.2	Stake the new stations	
		4.6.3	Modify a digital terrain model	

TASK 4 DO THE LAYOUT

Operations		Sub-Operations		Clarifications
4.7	Take necessary notes	4.7.1	Write down the points staked or save the data	
		4.7.2	Enter any other relevant information (e.g.: description of codes or symbols)	
4.8	Check the layout	4.8.1	Perform the backsight with: ▪ the total station ▪ the robotic total station ▪ the level ▪ the laser or electronic level ▪ the GPS (verification on a benchmark)	
		4.8.2	Measure the points staked, starting with previously existing points	
		4.8.3	Measure the distances between the points staked	
4.9	Reference staked and station points, if applicable	4.9.1	Reference the points likely to be pulled out by the heavy machinery	

TASK 5 DO THE MAPPING

Operations		Sub-Operations		Clarifications
Fields of application: for plans such as as-built, for quantity estimates, bypass lanes, layouts, etc. Mapping is done by computer only, and the use of manual drafting tools has disappeared from the specialized occupation.				
5.1	Prepare the work	5.1.1	Find out about the project	
		5.1.2	Consult engineering plans and specifications	
		5.1.3	Consult cadastral plans, if applicable	
		5.1.4	Consult prior as-built plans	
		5.1.5	Collect missing information	
5.2	Consult the list of measured or calculated points	5.2.1	Validate the data format	
		5.2.2	Transfer the points to the computer	
5.3	Classify the entities	5.3.1	Assign the layers	
		5.3.2	Determine the style of lines, colours, etc.	

TASK 5 DO THE MAPPING

Operations		Sub-Operations		Clarifications
5.4	Produce the drawing	5.4.1 5.4.2 5.4.3 5.4.4	Link the points, if applicable Trace alignments, profiles, cuts and surfaces Trace the curves level Show infrastructure elements	
5.5	Add detail to the plan	5.5.1 5.5.2 5.5.3 5.5.4 5.5.5 5.5.6 5.5.7 5.5.8	Place the north arrow Determine the scale Complete the title block Enter the dimensions (volume, area, length), if applicable Produce the legend, if applicable Enter the elevation numbers Enter other relevant details Lighten the plan	
5.6	Print the preliminary plan			
5.7	Transmit the preliminary plan for verification, if applicable	5.7.1 5.7.2	Consult the person who did the field work Consult the personnel in charge (chief surveyor, project manager, engineer, etc.)	
5.8	Verify and correct the plan	5.8.1 5.8.2	Make corrections Transmit the plan for final approval	
5.9	Print the final plan			

TASK 6 ESTIMATE QUANTITIES

Operations		Sub-Operations		Clarifications
6.1	Prepare the work	6.1.1 6.1.2 6.1.3 6.1.4 6.1.5	Find out about the situation Consult engineering plans and specifications Consult cadastral plans, if applicable Consult prior as-built plans Collect missing information	
6.2	Import the data			

TASK 6 ESTIMATE QUANTITIES

Operations		Sub-Operations		Clarifications
6.3	Calculate the areas	6.3.1 6.3.2 6.3.3 6.3.4	Perform necessary calculations Determine missing or excess quantities Verify the calculations Write a data report	
6.4	Calculate the volumes	6.4.1 6.4.2 6.4.3 6.4.4	Perform necessary calculations Determine missing or excess quantities Verify the calculations Write a data report	
6.5	Calculate the lengths	6.5.1 6.5.2 6.5.3 6.5.4	Perform necessary calculations Determine missing or excess quantities Verify the calculations Write a data report	

2.3 ACHIEVEMENT CONDITIONS AND PERFORMANCE CRITERIA

2.3.1 ACHIEVEMENT CONDITIONS

Data on achievement conditions were collected for the surveyor specialized occupation as a whole. The data pertain to aspects such as work areas, level of collaboration, work instructions, reference documents consulted, material resources used, and health and safety hazards.

In Annex 1 is a list of tools and equipment used for each task.

Table 2.3 Achievement Conditions

TASK 1 CHECK AND MAINTAIN THE EQUIPMENT
Work areas On the construction site. Indoors and outdoors.
Sectors Civil engineering and roads. Industrial. Institutional and commercial. Residential.
Level of collaboration Alone and in a team. Under the supervision of the chief surveyor or the superintendent.
Instructions and references Based on standards and procedures, technical specifications and the contractor’s instructions.
Health and safety hazards In a context that poses hazards related to: • work on construction sites (when maintenance is done on-site); • heavy loads; • the use of cleaning products; • stress.

TASK 2 CONDUCT A FIELD SURVEY
Work areas On the construction site. Outdoors and indoors.
Sectors Civil engineering and roads. Industrial. Institutional and commercial. Residential.
Level of collaboration Alone and in a team. Under the supervision of the chief surveyor, project manager or superintendent. In collaboration with clients, construction site foremen, engineers in various specializations, geologists and construction site supervisors.
Instructions and references Based on plans, specifications, survey data, Info-Excavation data and the contractor's instructions. Using a digital terrain model (or a 3D road model) and lists of reference points, standards and regulations.
Health and safety hazards In a context that poses hazards related to: • working at heights; • weather conditions; • nearby heavy machinery; • road traffic; • repetitive gestures; • working in confined spaces; • heavy loads; • the presence of bacteriological contaminants (sewers); • working on rough terrain; • the presence of explosive gases; • exposure to ultraviolet rays; • the presence of animals; • the use of spray paint;

TASK 2 CONDUCT A FIELD SURVEY *(Cont'd)*
• being buried; • being crushed by a load; • eye fatigue; • drowning; • stress.
TASK 3 PROCESS THE DATA
Work areas On the construction site. Outdoors and indoors.
Sectors Civil engineering and roads. Industrial. Institutional and commercial. Residential.
Level of collaboration Alone and in a team. Under the supervision of the chief surveyor.
Instructions and references Based on specifications, survey data, standards, regulations and the contractor's instructions.
Health and safety hazards In a context that poses hazards related to: • office work; • stress.

TASK 4 DO THE LAYOUT

Work areas

On the construction site.

Outdoors and indoors.

Sectors

Civil engineering and roads.
Industrial.
Institutional and commercial.
Residential.

Level of collaboration

Under the supervision of the chief surveyor, the project manager or the superintendent.

In collaboration with clients, construction site foremen, engineers in various specializations, geologists and construction site supervisors.

Instructions and references

Based on plans, specifications, survey data and the contractor's instructions.

Using a digital terrain model (or a 3D road model) and reference charts.

Health and safety hazards

In a context that poses hazards related to:

- working at a height;
- weather conditions;
- nearby heavy machinery;
- road traffic;
- repetitive gestures;
- working in confined spaces;
- heavy loads;
- the presence of bacteriological contaminants (sewers);
- working on rough terrain;
- the presence of explosive gases;
- exposure to ultraviolet rays;
- the presence of animals;
- the use of spray paint;
- the use of a stud gun;
- being buried;
- being crushed by a load;
- eye fatigue;
- drowning;
- stress.

TASK 5 DO THE MAPPING
Work areas On the construction site. Indoors.
Sectors Civil engineering and roads. Industrial. Institutional and commercial. Residential.
Level of collaboration Alone and in a team. Under the supervision of the chief surveyor or the project manager.
Instructions and references Based on lists of measured or calculated points, plans, specifications, survey data and the contractor's instructions. According to standards and regulations.
Health and safety hazards In a context that poses hazards related to: • office work; • stress.

TASK 6 ESTIMATE QUANTITIES
Work areas On the construction site. Outdoors and indoors.
Sectors Civil engineering and roads. Industrial. Institutional and commercial. Residential.
Level of collaboration Alone and in a team. Under the supervision of the chief surveyor or the project manager.
Instructions and references Based on plans, specifications, survey data and the contractor’s instructions.
Health and safety hazards In a context that poses hazards related to: • office work; • stress.

2.3.2 PERFORMANCE CRITERIA

Performance criteria were gathered for each task. They are used for assessing whether the tasks were performed satisfactorily. The criteria pertain to aspects such as the quantity and quality of work done, the observance of a work procedure, the attitudes adopted, etc.

To draw the list of criteria for each task, the participants worked in teams. Their results were then collected and presented in full session.

Table 2.4 Performance Criteria

TASK 1 CHECK AND MAINTAIN THE EQUIPMENT	
Performance Criteria	
Wearing personal protective and safety equipment	Precise calibration of measuring instruments
Clean measuring instruments	Appropriate storage of measuring instruments
Dried measuring instruments	Battery charging according to requirements
Periodic meticulous verification of measuring instruments	Observance of occupational health and safety rules
TASK 2 CONDUCT A FIELD SURVEY	
Performance Criteria	
Appropriate choice and use of measuring instruments	Clear and precise note-taking
Wearing personal protective and safety equipment	Taking into consideration the temperature and atmospheric pressure
Setting up the instrument correctly	Meeting deadlines
Accurate readings	Observance of occupational health and safety rules
Appropriate choice and use of work methods for readings (modes: Direct Reflex, high precision, low precision, continuous topography readings)	

TASK 3 PROCESS THE DATA	
Performance Criteria	
Appropriate choice and use of software	Correct file classification
Using adequate formulas	Correct data updates
Precise calculations	Using a rigorous work method
Clear and accurate reports	Observance of occupational health and safety rules
TASK 4 DO THE LAYOUT	
Performance Criteria	
Appropriate choice and use of measuring instruments	Precise calculations
Wearing personal protective and safety equipment	Taking into consideration the temperature and atmospheric pressure
Setting up the instrument correctly	Observance of standards in effect
Accurate readings after the layout is done	Complying with the book of specifications and the estimate
Using adequate formulas	Observance of occupational health and safety rules
Accurate layouts	
TASK 5 DO THE MAPPING	
Performance Criteria	
Appropriate choice and use of software	Appropriate choice of the font
Appropriate choice of the paper format	Sound and precise annotations
Appropriate choice of the printer	Exact information
Appropriate choice of the scale	Observance of occupational health and safety rules
TASK 6 ESTIMATE QUANTITIES	
Performance Criteria	
Appropriate choice and use of software	Correct estimate of quantities
Using adequate formulas	Observance of occupational health and safety rules
Precise calculations	

2.4 FUNCTIONS

Functions:

- are a set of related tasks;
- may be defined by the work's results or by a sequence of steps;
- are natural and concrete sets.

For the specialized occupation of surveyor, the workshop participants consider that the tasks may be classified according to two functions:

Field work

- Conduct a field survey (Task 2).
- Do the layout (Task 4).

Calculations and data processing

- Process the data (Task 3).
- Do the mapping (Task 5).
- Estimate quantities (Task 6).

3. QUANTITATIVE DATA ON TASKS

3.1 OCCURRENCE

Occurrence data concern the percentage of surveyors who perform a task in the same work environment. The data presented in the tables below are the average results of the participants. However, they account for the tasks performed not only by the surveyors attending the workshop, but also by all surveyors working in the companies represented.

Table 3.1 Task Occurrence

	Task	Occurrence
1	CHECK AND MAINTAIN THE EQUIPMENT	84.0%
2	CONDUCT A FIELD SURVEY	88.2%
3	PROCESS THE DATA	66.8%
4	DO THE LAYOUT	92.9%
5	DO THE MAPPING	41.2%
6	ESTIMATE QUANTITIES	39.9%

3.2 WORK TIME

Work time, expressed below in percentages, represents the time allocated to each task by each participant, on an annual basis.

Table 3.2 Work Time Allocated to Tasks

	Task	Work Time
1	CHECK AND MAINTAIN THE EQUIPMENT	5.6%
2	CONDUCT A FIELD SURVEY	20.4%
3	PROCESS THE DATA	7.5%
4	DO THE LAYOUT	52.6%
5	DO THE MAPPING	6.1%
6	ESTIMATE QUANTITIES	7.8%

3.3 IMPORTANCE AND DIFFICULTY OF TASKS

The **importance** of a task is estimated according to the more or less harmful consequences of performing a task poorly or not at all. The importance is assessed according to the following scale:

1. Not important at all: Poor execution of the task has no consequences on the quality of the outcome, the costs, health and safety, etc.

2. Not very important: Poor execution of the task could entail minimal costs, lead to an unsatisfactory outcome, or risk minor injuries or accidents, etc.

3. Important: Poor execution of the task could entail substantial additional costs, or risk injuries, accidents, etc.

4. Very important: Poor execution of the task could have very serious consequences in terms of costs, safety, etc.

A task's **difficulty** is assessed according to the following scale:

1. Very easy: The task involves little risk of error; it requires no notable physical or mental effort. Performing the task is less difficult than average.

2. Easy: The task involves a few risks of error; it requires minimal physical or mental effort.

3. Difficult: The task involves many risks of error; it requires a good physical or mental effort. Performing the task is more difficult than average.

4. Very difficult: The task involves a high risk of error; it requires substantial physical or mental effort. The task is among the most difficult in the specialized occupation.

The data presented in the table below are averages of the information provided by the surveyors who participated in the workshop.

Table 3.3 Importance and Difficulty of Tasks

Task		Importance	Difficulty
1	CHECK AND MAINTAIN THE EQUIPMENT	2.9	1.8
2	CONDUCT A FIELD SURVEY	3.1	2.4
3	PROCESS THE DATA	3.3	2.8
4	DO THE LAYOUT	4.0	3.4
5	DO THE MAPPING	2.7	2.4
6	ESTIMATE QUANTITIES	3.4	3.1

4. KNOWLEDGE, SKILLS AND ATTITUDES

The occupational analysis enabled us to specify some of the knowledge, skills and attitudes necessary for performing the tasks. Those qualities are transferable, i.e., applicable to a variety of tasks and situations.

The following pages present the knowledge, skills and attitudes that, according to the participants, are considered essential for performing the tasks of the specialized occupation of surveyor.

4.1 KNOWLEDGE

Mathematical knowledge

Mathematical knowledge is important in practicing the specialized occupation. Thus, performing the four elementary operations, calculating averages and solving certain algebraic equations (with one unknown) are necessary for tasks 2, 3, 4 and 6.

However, knowledge of trigonometry is most essential, being used measuring and calculating angles, distances and X, Y, Z coordinates.

Knowledge of drafting

Mapping with traditional drafting tools is no longer produced by surveyors. The only hand-drawings produced are sketches for field surveys and, to a lesser extent, for layouts.

Nowadays, measured and calculated points are thus mapped only by computer.

Plan reading knowledge

Since they are present on construction sites for much of a project, surveyors consult several types of plans in the course of their work. Surveyors working in the building sector consult engineering, architectural, formwork, reinforcement, mechanical, plumbing and electrical plans, for example.

Surveyors working in the civil engineering and roads sector consult road infrastructure, bridge, utility and landscaping plans, for example.

Computer knowledge

Practicing the specialized occupation requires basic knowledge in the use of office software such as e-mail programs, browsers and spreadsheets.

Moreover, there are many data processing and calculation programs, as well as many computer-aided drafting programs. Mastering them is important for data processing (Task 3), mapping (Task 5) and estimating quantities (Task 6).

Surveyors must also know the various drawing and calculation file formats for all data transfer operations.

Finally, electronic field books are widely used, which requires good knowledge of interface firmware.

Knowledge of construction materials

Knowledge of the various granular materials, types of steel used for reinforcement, types of concrete and other types of construction materials is necessary for understanding the nature of the work to be done, for distinguishing between elements to be surveyed (Task 2) or laid out (Task 4) and for producing quantity estimates (Task 6).

This knowledge is particularly useful in certain “critical” situations, notably for interpreting tolerances and detecting errors or omissions.

Knowledge of cadastral and surveying laws and regulations

Surveyors must have some knowledge of cadastral and surveying legislation in Quebec in order to understand and meet such requirements in the course of their work. This knowledge pertains, among other things, to margins, legal property boundaries, easements, and the location of utilities. It is particularly important for doing field surveys (Task 2) and layouts (Task 4).

4.2 SKILLS

Skills are types of know-how. They are divided into three categories: cognitive, motor and perceptual.

4.2.1 Cognitive Skills

Cognitive skills pertain to intellectual strategies applied in working. The main cognitive skills that surveyors need are the following.

Problem-solving and decision-making

Problem-solving is common in the surveyor occupation. Indeed, surveyors are on-site for much of the construction project and must constantly face and adapt to contingencies. At times they must even anticipate problematic situations and modify field survey and layout work in advance. They must often, for example, adjust station positions according to the progress of construction and the presence of machinery.

Planning activities

Surveyors must deal with tight deadlines. Coordination with other trades and occupations is essential in their work, because poor planning and tardy field survey or layout work can have a major impact on the start and continuation of construction work.

Surveyors constantly collaborate with construction site foremen and superintendents, which also requires excellent planning skills.

4.2.2 Motor Skills

Motor skills involve gestures and movements. The main motor skills that surveyors need are the following.

Surveying equipment is heavy to transport. In addition to the measuring instrument to move, the surveyor carries tools, spare batteries and the electronic field book. The work is done alone more and more often, so surveyors must have good physical strength and endurance.

In addition, equipment clutter and moving on rough terrain require good movement coordination.

The work also requires good dexterity and fine handling of measuring instruments, to attain the required precision. In fact, some layouts must be done with tolerances of a few millimetres.

4.2.3 Perceptual Skills

Perceptual skills are sensory skills enabling a person to perceive by his senses what is happening in his environment. The main perceptual skills that surveyors need are the following:

- excellent visual acuity and perception of shapes and volumes;
- good peripheral vision and hearing, to cope with occupational health and safety hazards.

4.3 ATTITUDES

Attitudes are ways of acting, reacting and relating with others or with one's environment. They involve personal skills. The main attitudes that surveyors need are the following.

Personal attitudes

Surveyors must demonstrate patience, rigor, meticulousness and autonomy.

Interpersonal attitudes

Surveyors work in collaboration with many construction trades and occupations. They must be able to communicate information adequately.

Clear and precise instructions, as well as teaching skills, are thus appreciated by surveyors' colleagues.

Often, surveyors must cope with tight deadlines and contingencies, which can cause stress and misunderstandings. In those situations, they must be able to stay calm, adapt their attitude to the situation at hand, and demonstrate detachment, in order to maintain harmonious working relations.

Professional ethics

Practicing the specialized occupation requires good professional ethics. The precision of field surveys is essential, and the collected data are used, among other things, for calculating payments and producing estimates. In certain situations, surveyors must be able to refuse a data modification request, even if that may put their job security at risk. So the work requires great probity and irreproachable honesty.

In addition, surveyors are often the ones detecting irregularities or errors of execution; they must therefore be able to report them to those in charge.

Preventive attitudes and behaviours regarding health and safety

Preventive attitudes and behaviours regarding health and safety are demonstrated, among other things, when the surveyor:

- wears safety equipment;
- safely places surveying equipment in the transportation vehicle;
- refuses to do dangerous work;
- marks out the work area;
- pays attention to his environment;
- establishes and maintains visual contact with heavy equipment operators and shovel operators.

It should be pointed out that certain operations require great concentration, which puts the surveyor in a bubble cut off from the outside world. Those situations can cause work accidents. Surveyors must therefore be able to refocus their attention on what is occurring around them in order to prevent such accidents.

5. TRAINING SUGGESTIONS

The surveyors attending the occupational analysis workshop made suggestions on the initial training, workplace training and professional development of surveyors.

With regard to initial training, several participants made the following suggestions:

- better inform future students about the realities of the work, particularly the working conditions;
- recruit students according to their interest in construction work;
- improve teachers' professional development procedures;
- dispense survey and topographical training in the same locations as other training in construction trades, when the vocational map allows it;
- dispense occupational health and safety training;
- teach the history of surveying to a greater extent;
- foster on-the-job training on construction sites.

The participants also mentioned that the vocational studies program in surveying and topography is too focused on legal surveying and should be updated by providing two options: one for construction and the other for legal surveying.

With regard to the training of surveyors in the workplace, the participants requested the following:

- improve the supervision of newcomers on construction sites by associating them with experienced surveyors;
- favour teamwork to foster the transfer of knowledge.

Finally, regarding the professional development of surveyors, the participants suggested the following:

- make training uniform across the province;
- improve the criteria for recruiting instructors;

- to start courses even if the number of candidates required for training the group is not attained;
- dispense training during the off-peak period of construction work;
- better define the prerequisites for access to professional development courses;
- develop procedures enabling surveyors to refresh their knowledge.

The participants also expressed the hope that measures be taken to recognize acquired knowledge and skills.

Annexes

Annex 1
Tools and Equipment

For each task of the specialized occupation of surveyor and according to a list submitted to them, the participants determined the tools and equipment they use: measuring and field equipment, calculation, data processing and mapping equipment, tools, protective equipment and others.

Table A.1 Tools and Equipment

TASK 1 CHECK AND MAINTAIN THE EQUIPMENT

Measuring and Field Equipment	
Barometer/altimeter	Regular prism
Compass	Measuring wheel
Prism pole	Measuring tape
Surveyor's chain	Metal tape
Target set	Level rod base (foot plate)
GPS	Total station
Telescopic range pole	Robotic total station
Mini prism	Supports (for tripod, range pole, etc.)
Telescopic levelling rod	Chain tensioner
Levels (automatic, gradient laser, digital)	Theodolite
Level vial	Tripod
Electronic planimeter	
Calculation, Data Processing and Mapping Equipment	
Survey calculator	Double optical square
Field book	Squares
Electronic field book	Protractor
USB key	Ruler
Scale of reduction (metric and imperial)	

TASK 1 CHECK AND MAINTAIN THE EQUIPMENT

Tools	
Socket adapter	Impact drill
Paint application adapter	Picks
Utility knife	Pliers (multiple slip joint, long nose, slip joint)
Magnetic detector	Vise-grip pliers
Robust steel wire with flags	Punch
Steel axe	Surveyor's multi-pocket bag
Wrench set	Pruning shears
Hammer	Hacksaw
Sledge hammer	Six-bit screwdriver
Shovel	
Protective Equipment	
Hard hat	Harness
Fluorescent safety cone	Safety glasses
Safety vest	Safety road sign
Gloves	Hearing protection
Rotating light	

TASK 2 CONDUCT A FIELD SURVEY

Measuring and Field Equipment	
Barometer/altimeter	Regular prism
Compass	Measuring wheel
Prism cane	Measuring tape
Surveyor's chain	Metal tape
Target set	3D laser scanner
Communications equipment	Level rod base (foot plate)
GPS	Total station
Telescopic range pole	Robotic total station
Mini prism	Supports (for tripod, range pole, etc.)
Telescopic levelling rod	Chain tensioner
Levels (automatic, gradient laser, digital)	Theodolite
Level vial	Tripod

TASK 2 CONDUCT A FIELD SURVEY *(Cont'd)*

Calculation, Data Processing and Mapping Equipment	
Survey calculator	Scale of reduction (metric and imperial)
Field book	Squares
Notebook	Double optical square
USB key	Ruler
Tools	
Socket adapter	Hammer
Paint application adapter	Sledge hammer
Toolbox	Shovel
Battery charger	Picks
Magnetic detector	Batteries
Brush cutter	Pliers (multigrip, long nose, slip joint)
Hand saw	Vise-grip pliers
Transceiver	Marker tape (flag)
Robust steel wire with flags	Surveyor's multi-pocket bag
Steel axe	Saws
Wrench set	Six-bit screwdriver
Protective Equipment	
Hard hat	Harness
Fluorescent safety cone	Safety glasses
Safety vest	Safety road sign
Gloves	Hearing protection
Rotating light	

TASK 3 PROCESS THE DATA

Calculation, Data Processing and Mapping Equipment	
Survey calculator	Software (office, survey, drawing, civil engineering civil, geodesic, screen capture, security, etc.)
Field book	Scanner
Notebook	Computer
Compass	Protractor
Scale of reduction (metric and imperial)	Ruler
Squares	Fax machine
Printers (infrared, colour)	
Miscellaneous	
Stapler	Office supplies
Scissors	

TASK 4 DO THE LAYOUT

Measuring and Field Equipment	
Barometer/altimeter	Regular prism
Compass	Measuring wheel
Prism cane	Measuring tape
Surveyor's chain	Metal tape
Clinometer	3D laser scanner
Target set	Level rod base (foot plate)
Communications equipment	Total station
GPS	Robotic total station
Telescopic range pole	Supports (for tripod, range pole, etc.)
Mini prism	Chain tensioner
Telescopic levelling rod	Theodolite
Levels (automatic, gradient laser, digital)	Tripod
Level vial	
Calculation, Data Processing and Mapping Equipment	
Survey calculator	Scale of reduction (metric and imperial)
Field book	Squares
Notebook	Double optical square
USB key	Ruler

TASK 4 DO THE LAYOUT *(Cont'd)*

Tools	
Socket adapter	Sledge hammer
Paint application adapter	Shovel
Toolbox	Picks
Battery charger	Batteries
Magnetic detector	Pliers (multiple slip joint, long nose, slip joint)
Brush cutter	Vise-grip pliers
Hand saw	Stud gun
Transceiver	Marker tape (flag)
Robust steel wire with flags	Surveyor's multi-pocket bag
Steel axe	Saws
Wrench set	Six-bit screwdriver
Hammer	
Protective Equipment	
Hard hat	Harness
Fluorescent safety cone	Safety glasses
Safety vest	Safety road sign
Gloves	Hearing protection
Rotating light	

TASK 5 DO THE MAPPING

Calculation, Data Processing and Mapping Equipment	
Field book	Software (office, survey, drawing, civil engineering civil, geodesic, screen capture, security, etc.)
Notebook	Scanner
USB key	Computer
External hard drive	Protractor
Printers (infrared, colour)	Ruler

TASK 6 ESTIMATE QUANTITIES

Calculation, Data Processing and Mapping Equipment	
Field book	Printers (infrared, colour)
Notebook	Software (office, survey, drawing, civil engineering civil, geodesic, screen capture, security, etc.)
Scale of reduction (metric and imperial)	Computer
	Ruler

Annex 2

Matrix of Occupational Health and Safety Hazards

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COMMISSION DE LA SANTÉ ET DE LA SÉCURITÉ DU TRAVAIL

Table A.2 Occupational Health and Safety Hazards for the Surveyor Occupation

No.	Hazards	Effects on Health and Safety	Means of Prevention
1	**Chemical Hazards and Dangers**		
	➢ Dust	• Eye and respiratory tract irritations	• Use products to reduce dust on construction sites • Wear appropriate eye and respiratory protectors
	➢ Chemicals (cleaners, spray paint)	• Headaches • Respiratory problems	• Wear appropriate respiratory protection • Have on-site the material safety data sheets of products used • Choose the least toxic products of equal effectiveness
	➢ Asbestos during demolition work	• Asbestosis • Lung cancer • Mesothelioma	• Ensure that materials containing asbestos are removed from the building before demolition (in accordance with the Safety Code for the construction industry, subsection 3.23)
	➢ Presence of gases during work in confined spaces	• Intoxication	• Use a four-gas detector • Wear appropriate respiratory protection
	➢ Presence of gases and dust during work in industrial environments	• Intoxication	• Upon arrival on the premises, obtain information from those in charge of the establishment about the nature of contaminants present • Wear appropriate respiratory protection

No.	Hazards	Effects on Health and Safety	Means of Prevention
2	**Physical Hazards and Dangers**		
	➢ Noise from heavy machinery and other machines	• Occupational deafness • Hearing loss	• Wear hearing protectors (shells, plugs)
	➢ Presence of live power lines	• Electric shock or burn • Electrification • Electrocution	• Observe the minimum approach distances prescribed by the Safety Code for the construction industry • Agree with the electric power company about safety measures to take
	➢ Heat constraints: exposure to cold and hot temperatures	• Heat stroke • Dehydration	• Adapt the pace of work to weather conditions by taking into account workers' capacities and heat tolerance • Wear light and light-coloured clothing that allows sweat to evaporate • Cover your head when working outdoors • Drink enough cool water
		• Chilblains, hypothermia	• Wear warm clothing • Have heated shelters available • Cover tools' metal handles and bars with thermal insulation • Wear clothing according to the weather and the nature of tasks to perform (several layers, if necessary) and cover your head • Alternate between work periods and breaks to warm up • Reorganize the work to perform outdoor tasks during the warmest times of the day
	➢ Ultraviolet and infrared radiation (welding flash)	• Radiation burns	• Install radiation shields • Wear appropriate filtering lenses

No.	Hazards	Effects on Health and Safety	Means of Prevention
3	**Biological Hazards and Dangers**		
	➢ Infectious materials, bacteriological contaminants during work in sewers or dumps	• Tetanus	• Keep vaccination up-to-date • Carefully clean any wound, even small ones, with running water and mild soap • See a doctor if the wound is very dirty or deep, because the risk of contracting tetanus is greater if the vaccination was over five years ago • Wear gloves, boots, raincoats, work overalls, glasses, visors, masks • Clean tools and equipment after working in a contaminated environment
	➢ Toxic plants during brush cutting	• Skin irritations	• Wear work gloves • Cover the skin
	➢ Presence of insects	• Lyme disease and West Nile virus	• Protect yourself from insects and tics by applying DEET-based (maximum 30%) mosquito reShovelnt on uncovered skin
	➢ Presence of bees and wasps	• Serious allergic reactions	• Cover skin as much as possible (long sleeves and pants) and wear light-coloured clothing preferably • Wear short or tied back hair • Abstain from using scented products • Never approach a wasps' nest • Inform your supervisor so that he has the nest destroyed by experts, if applicable • Never drink directly from the can or bottle (a bee or wasp might be there and sting the worker on the throat, which could be fatal) • Have effective means of communication available
	➢ UV exposure	• Skin cancer • Sunburns	• Cover the skin • Use a sunscreen

No.	Hazards	Effects on Health and Safety	Means of Prevention
4	**Ergonomic Hazards and Dangers**		
	➢ Handling and moving heavy loads (robotic total station, etc.)	• Backache	• Use handling equipment • Know safe handling techniques
	➢ Repetitive gestures	• Tendinitis, bursitis	• Rotate tasks • Wear equipment in good condition and correctly adjusted • Adjust the brush cutter's safety harness strap adjustment buckles so that they are well secured to the body
	➢ Standing up for long periods ➢ Walking in difficult, rough terrain	• Foot pain • Muscular fatigue • Backache	• Adjust the height of instruments to the worker's tallness • Change position frequently
5	**Safety-related Hazards and Dangers**		
	➢ Falling when working at a height	• Multiple injuries • Death	• Put in place a protective system against falls from heights
	➢ Falling by tripping when working on rough terrain or other irregular surfaces	• Fractures, sprains, strains	• Do reconnaissance of work areas to detect holes and obstacles • Level the terrain • Pick up debris on the construction site • Wear appropriate safety shoes
	➢ Falling when working on a slippery or snowy surface	• Fractures, sprains, strains	• Wear appropriate safety shoes with anti-slip soles • Remove snow from work surfaces and de-ice them • Apply abrasives
	➢ Working on or near water bodies	• Drowning • Hypothermia	• Wear a safety harness and a life jacket to work on the shore line

No.	Hazards	Effects on Health and Safety	Means of Prevention
	➢ Moving vehicles and heavy machinery nearby ➢ Collision	• Being crushed • Death	• Place adequate signs marking the work area and interrupt road traffic • Wear a highly visible safety vest • Develop a traffic plan for the construction site • Place signs marking the work in accordance with Tome V, Chap. 4, of the manual *Traffic Control Devices* of the ministère des Transports du Québec
	➢ Using stud guns	• Explosion • Eye injuries • Deafness	• Do not use in an explosive atmosphere • Wear appropriate eye and ear protectors • Have operator training and certification • Be 18 years of age or over • Use low-velocity guns and according to manufacturer specifications • Unload the gun when unused
	➢ Using mechanical tools (brush cutter, chain-saw)	• Projection of foreign bodies in the eyes • Injuries to lower and upper limbs	• Wear a protective visor when cutting brush and crosscutting • Train workers in the use of tools
	➢ Superimposed work	• Injuries caused by objects or materials falling from a higher level	• Wear a hard hat • Delimit work areas and control their access • Prohibit simultaneous work in superimposed work areas, unless lower levels are protected against falling equipment, materials or other objects
	➢ Heavy objects falling on feet	• Bruises, being crushed, amputation	• Wear safety boots equipped with perforation-resistant soles and a class 1 toe cap

No.	Hazards	Effects on Health and Safety	Means of Prevention
	➢ Lightning while work takes place during a storm	• Electric shock • Electrocution	• Never stay under an isolated tree, along an area cleared of woods, in a clearing or on top of a hill • Move away from any high structure, such as a post, mast, crane or other metal structure • Move away from anything that conducts electricity, such as metal fences • As soon as a storm is imminent, find safe shelter, such as a vehicle or building, or at least seek refuge in a grotto, crevasse or under a cliff • In a forest, hide under dense vegetation of bushes or small trees • If lightning strikes before you have time to find shelter, crouch, forehead on knees, while making sure that neither hands nor clothing touch the ground • Do not lay on the ground, because that would increase contacts with charges conducted by humid ground • Take precautions even if the storm is not yet above yourself, because lightning can strike several kilometres from the cloud of origin • If 30 seconds or less pass between lightning and thunder, shelter must be sought, and it is recommended to remain there for 30 minutes after the last sound of thunder • If less than 5 seconds pass between lightning and thunder, shelter must be found immediately

No.	Hazards	Effects on Health and Safety	Means of Prevention
	➢ Aggression by wild animals or pets (black bears, dogs)	• Bites, scratches, lacerations, fractures • Rabies, tetanus, infections	• Avoid surprising the bear or dog • Keep the black bear or the dog at a respectable distance • Never feed a bear • Store food and garbage beyond its reach • Eliminate food and garbage odours by keeping food and garbage in sealed containers **If there is an encounter:** • Do not turn your back to the dog • Do not run, because the dog will pursue the person instinctively • Do not look the dog in the eyes • Stay calm and assess the situation • Do not scream or make sudden moves • Talk gently to the bear; wave your arms so it knows that it is in the presence of a human • Back up slowly toward secure shelter or make a detour to bypass the animal; if that is impossible, leave it an escape path, do not corner it, and leave it enough space to turn around • If the bear or dog approaches, do not run away, unless a secure location can be reached quickly enough; running away can encourage them to follow the person and see him as prey • Avoid looking the bear in the eyes, because it may perceive that as a threat • Continue backing up slowly to find a secure location, while keeping an eye on it • Wave your arms or throw objects to distract the bear • Do not play dead with the black bear; rather, remain attentive to the situation and be ready to face it in case it attacks

No.	Hazards	Effects on Health and Safety	Means of Prevention
			• If the bear attacks, defend yourself with anything at hand (rocks, stick, oar, axe, etc.) and impress it by raising your voice, screaming and gesturing • If the dog attacks, put an obstacle between it and yourself
	➢ Isolated work in woods	• No rescue after a serious accident	• Establish a regular monitoring procedure • Have effective means of communication
	➢ Working in peat bogs	• Getting stuck	• Evaluate the ground's bearing capacity • Mark out dangerous grounds
	➢ Ditch or excavation work	• Asphyxia • Being crushed • Being buried	• Ensure that the walls are strutted or pose no danger of sliding
	➢ Working in confined spaces in the presence of explosive gases	• Fire • Explosion	• Measure concentrations with a gas detector before entering the confined space • Ventilate the confined space to eliminate gases
6	**Psychosocial Hazards and Dangers** ➢ Psychological harassment ➢ Time constraints	• Depression, overwork • Stress • Backache • Insomnia	• Specify each worker's roles and tasks to help reduce ambiguity and role-related conflicts • Clarify each worker's roles, responsibilities and authority to reduce risks of role-related conflicts • Set precise goals and objectives to reduce risks of confusion and ambiguity • Define the various expectations clearly • Plan all stages of the work • Limit work done under pressure