Appendix 5

Project Cost Estimating Guidance

Prepared By:
Program Development Support Services
Transportation Planning and Policy Department
BC Ministry of Transportation

MINISTRY OF TRANSPORTATION

Project Management Support Services

Project Cost Estimating Guidance

PROJECT MANAGEMENT SUPPORT SERVICES

Project Cost Estimating Guidance

Project Management Support Services
5C • 940 Blanshard Street • Victoria BC • V9C 4L2
http://gww.th.gov.bc.ca/gwwimb

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Part 1

Project Cost Estimating Guidance

1. Introduction

This Guidance provides the principles and framework for project cost estimating within the Project Management Life Cycle, and can be applied to estimating all projects, regardless of size and complexity.

This Guidance is for program planners and project managers, and the estimators who support them in developing and implementing the Ministry's capital and rehabilitation program. It also assists with assuring sponsoring agencies and other partners (such as the Federal Government) that the Ministry's project cost estimates are prepared using sound practices.

It is intended to be an easy to follow, concise guide to Project Cost Estimating. It contains cross-references to the Ministry Project Management Manual where applicable. It is not intended to be a comprehensive document on the science of cost estimating, nor is it a user manual on how to use cost estimating systems. Readers may wish to pursue outside sources, such as published material or cost estimating courses, if they want to learn how to estimate. More information on such sources is available on the Project Management Support Services website.

1.1 Amendments to the Guidance

The guidance resides in the Project Management Support Services (PMSS) Branch. Any amendments, additions, or changes will be issued by PMSS. It is recognized that this guidance is dynamic. The procedures and principles herein are subject to ongoing review and continuous improvement.

Comments or questions can be addressed to:

Mike Hallas
Manager, Estimating Services
Project Management Support Services
Transportation Planning and Policy
Phone: 250-356-9328 Cell: 250-889-2733
Fax: 250-356-0897
E/mail: Mike.Hallas@gov.bc.ca

1.2 Cost Estimating Working Committee (CEWC)

A CEWC was established in October 2005 to provide leadership, consistency, and coordination in cost estimating within the Ministry. The CEWC consists of Ministry staff from all Regions of the Ministry. This Guidance has been reviewed and is endorsed by the CEWC.

The CEWC will continue to review and endorse any approved additions or changes to the Guidance in conjunction with the PMSS Branch.

Part 2

2. GOAL OF THE GUIDANCE

The goal of this Guidance is to provide a consistent, realistic, auditable, and appropriate approach to developing project budgets by offering definition to the expected composition of project cost estimates; and to lead the Ministry toward more stable cost estimates throughout the project life cycle. Specifically to ensure that project cost estimates:

- are done in collaboration with all areas of technical expertise;
- are meaningful and repeatable, with parameters which respect the quality and accuracy of the data available, the geographic area, and the point in the project life cycle;
- are derived in a consistent manner (comparable) at any point in the project life cycle;
- are provided for any size of project;
- are able to evolve with the project;
- provide an audit trail for the evolution of the cost estimate;
- support Value Analysis / Value Engineering uses; and
- address the needs of project change management processes.

2.1 Purpose of an Estimate

An objective within the Ministry of Transportation's Service Plan is to ensure that *available provincial investment dollars are used as effectively as possible*. A key strategy for achieving this objective is *completing projects on budget and on time*. This requires effective cost management of both the program development process and the Ministry's capital program.

The ministry's capital program budget is an aggregation of individual project budgets. The cost estimate is the foremost support document for building a project's budget and one of the most important factors against which the success of the project will be measured. **The primary purpose of any cost estimate is to provide the rationale for a project budget.** Estimates therefore must reflect the anticipated cost of the entire project in sufficient detail to define the future financial obligations of the ministry.

There is little doubt that an accurate estimate goes a long way toward supporting a successful project; while an incomplete or inaccurate estimate dramatically increases the likelihood of failure in delivering the project within the approved budget.

"....a project manager is only as good as the cost estimate...."

Quality cost estimates are also necessary in maintaining public confidence and trust throughout the life of a project. Estimates must therefore reflect an overall accuracy which is indicative of the level of information available when the estimate is developed. Cost increases over and above project budgets are a constant concern to ministry executive, senior management, as well as political leaders, and auditing agencies.

2.2 The "Project Cost Estimate"

In the past, the ministry emphasized the "pre-tender estimate" (often known as an engineer's estimate). The pre-tender estimate details the unit price construction costs for a project in preparation for tendering; and is generally developed from a potential bidder's perspective. While important for verifying costs prior to establishing a contractual commitment for construction, the pre-tender estimate is usually prepared too late in the project life-cycle to be useful for project budgeting.

This Guidance focuses instead on the "project cost estimate" which continuously evolves over the project lifecycle. **The "project cost estimate" is an estimate of the total cost of the project inclusive of all cost elements and their associated risks, required to deliver the entire project** (i.e. project management, planning, engineering, property, construction, environmental, and any and all other related project costs). It uses a consistent framework and format, and results in a series of successive, and therefore comparable, cost estimates. The project cost estimate is developed from an owner's perspective in terms of budget building and overall project cost management.

Developing realistic, representative, and therefore achievable project cost estimates during the early stages of project development is particularly important, not only to form a basis for comparison to each successive cost estimate, but also because it is often these early estimates upon which the project budget is based.

Part 3

3. PRINCIPLES OF PROJECT COST ESTIMATING

The following guiding principles have been established as the basis upon which all ministry project cost estimates should be developed.

3.1 Integrity

Project cost estimates must be prepared using a high standard of ethical and professional integrity.

As such project cost estimates must:

- be calculated through an open and transparent process;
- be presented in a manner that is understood by the public. The cost of a project is most often interpreted and most easily understood by the public to be dollars that are spent on the project. (e.g. any uncertainties or assumptions should be clearly and easily explained);
- avoid false precision and early optimism (this will go a long way in maintaining the public's trust, support and confidence in both the project and the project's expected cost, and will result in a more stable capital program);
- not be prepared by anyone who may be, or who may be perceived to be, in conflict of interest (particularly when using consultants to prepare estimates).

3.2 Contents

Project cost estimates must be comprehensive of all costs required to resource and deliver the project, regardless of when an estimate is created within the project life-cycle.

As such project cost estimates must:

- clearly and concisely document the scope of work that the project cost estimate is developed from;
- document any and all assumptions made by the estimator in the development of the estimate. This is particularly important in the

early stages of a project when much less information is known and the estimator must make assumptions about some cost elements and activities.

- clearly identify and allocate a cost to each work activity that can be accounted and budgeted;
- ensure that the costs reflect the value of direct resources (such as design, construction, and project management) as well as the value of costs and resources paid to others for work related to the project (such as utility adjustments and environmental mitigations). (Section 5 provides a comprehensive discussion of Cost Elements);
- identify whether or not project related costs attributed to pre-project planning and development are included in the estimate. (this decision will be made by the Ministry executive and/or project sponsor. Notwithstanding this decision to treat these costs as sunk costs or project costs, all costs attributable to the project must be maintained for future reference);
- calculate all costs in accordance with state-of-the-practice accounting methods; **[KEEP or TOSS – discuss with SVEIN]**

UNDER REVIEW

3.3 As Spent (Year-of-Expenditure) Dollars

The Ministry expresses project budgets in "as-spent" or year-of-expenditure dollars (i.e. the value represents the costs based on the year that the work is anticipated to be completed). Project cost estimates however, are generally initially developed in constant (current year) dollars (i.e. the value represents the costs based on doing all of the work in a given year - usually the current year at the time the estimate is prepared).

Therefore, the project cost estimate must be adjusted (using an escalation factor) to as-spent dollars based upon the expected timing of project delivery to support the anticipated budget requirements of the project.

Following is the basic approach for applying escalation:

- initially develop the estimate in constant year dollars, clearly indicating the amount and the year (i.e. Project Cost Estimate $2,000,000 in 2005 Dollars),

- then "cash flow" the estimate by assigning a dollar amount to each future year based upon the amount work anticipated to be completed in each future year as per the approved project delivery schedule (See Section 3.3.1 below),

- then adjust the "cash flowed" dollar amounts by assigning an inflation rate per year (See Section 3.3.2 below);

- specify the inflation rate used for each cost element and how it was applied; and

- clearly indicate the resulting estimate amount and that it is expressed in "as spent (year-of-expenditure) dollars".

3.3.1 Project Delivery Schedule and Schedule Changes

As part of project development process a project delivery schedule is developed (See PMM Project Definition - Develop Schedule Plan). If any changes to the project delivery schedule occur after the project budget has been confirmed, the remaining work can be rescheduled and compared to the original delivery schedule. Appropriate inflation rates can then be applied to the new schedule, and adjustments may then be made to the project budget. Externally mandated deviations from this schedule are treated as change requests and may result in greater or lesser funding requirements for the project. Anticipated changes in project expenditures resulting from schedule adjustments reflecting the management of the project shall be addressed through project contingency.

3.3.2 Inflation Rate

Inflation rate(s) vary depending upon many factors including the type of work, the geographic location and the general market situation. Consider multiple sources for determining the inflation rate, including nationwide and local references, as well as Treasury Board guidelines. Include consideration of any locality-specific cost factors that may reflect a growth rate significantly in excess of the inflation rate, such as land acquisition costs in highly active markets. **[Link Appendix 3 - UNDER REVIEW]**

3.4 Basis of a Project Cost Estimate

Project cost estimates should be based on good cost estimating practise, and prepared by qualified cost estimators. Each estimate must be based on the best information available, and the most comprehensive and current scope of work for the project.

As such project cost estimates must:

- be prepared by individuals with demonstrated knowledge, skill and experience in preparing cost estimates for similar projects;

- be prepared by applying expert judgment to both the estimate itself, and to the assumptions made during preparation of that estimate. *For example: A cost estimator choosing to use a bid based estimating approach must be mindful that this approach is only good if historic bid prices are for similar work, similar sized projects, and if the estimator believes the bids are indicative of future bids.*

- reflect both an accuracy and precision which, when combined, provide an upper and lower bound for anticipated project costs regardless of when the estimate is created within the project life cycle. The accuracy is indicative of the expertise of the estimator and available project and historical information, while the precision is reflective of the risks surrounding the individual components of the estimate as recognized by the estimator. **[UNDER REVIEW – ranges ?]**

- reflect the estimator's determination of the 'most probable' cost of completing each work activity.

- be revised at major milestone/submission points throughout the project life cycle. As a minimum, a project cost estimate should be prepared for each "Level of Estimate". This progressive elaboration will yield a series of estimates based upon the project information available at that stage. Each estimate should fall within the previous estimate range (See Section 4).

3.5 Risk and Uncertainty (Contingency)

Risk and uncertainty is captured in the project cost estimate as contingency. Contingency amounts are revised with each new cost estimate over the project's life cycle as the risks are revealed and uncertainty is reduced. The amount of contingency should be derived through an analysis of each item of work within the project, rather than the assignment of pre-determined percentages or dollar amounts against the entire cost estimate.

Risk is a reflection of the knowledge (or lack of knowledge) associated with a particular anticipated item of work or activity within a project. As each work activity is estimated, the individual risks associated with that work activity should be identified and quantified based on what is known (or not known) at the time.

Uncertainty is a reflection of both the accuracy and the completeness of the scope assumptions which form the overall project estimate. Firstly, in terms of accuracy, do the scope assumptions made for each Cost Element represent the work ultimately undertaken and, therefore result in a project estimate which represents the cost of the final product (ie. are the assumed Cost Elements of work accurate, if not, what uncertainty is associated with the assumptions which define the Cost Elements)? Secondly in terms of completeness, do the assumed Cost Elements reflect the complete scope of the final product? For example, an estimate may be developed for a four lane divided highway. The uncertainty associated with estimate accuracy would address whether the highway is ultimately built with a median or a concrete divider; while the uncertainty associated with the completeness would address whether enough interchanges were included in the original scope assumptions.

When establishing contingency, the project cost estimate must:

- express the contingency in terms that can be easily presented to and understood by the public;
- apply a disciplined and comprehensive method of assessing and reassessing both the project's risks and uncertainty as the project moves through the project life cycle (particularly important during the early project development stage);
- define and quantify a contingency amount for each potential risk element within each work activity;
- quantify a contingency amount for each Cost Element based on uncertainty within that Cost Element;
- identify a total project contingency amount which is a summation of all risk and uncertainty in the project;

Larger projects require special consideration of project risk and complexity in order to produce accurate estimates which reflect these issues. **(Link Risk Management Plans in PMM].**

3.6 Continual Documentation throughout Project Life Cycle

Project cost estimates should be tracked and reviewed continually to ensure they reflect the latest information on the project throughout the life of the project.

As such project cost estimates must:

- clearly and completely document all information forming the basis for an estimate, in particular the assumptions and constraints
- specifically identify what is in the estimate, and what is not in the estimate;
- be written in a form that can be easily understood, checked and verified;
- use the same project identification throughout to facilitate tracking projects;
- identify the "Level of Estimate" (See Section 4)
- be developed using an integrated approach to ensure there's a seamless progression of the cost estimate throughout the project life cycle. That is, ensure it's always clear how the newer more detailed breakdown was included in the previous, less-detailed estimate.
- clearly and completely document project scope changes by providing a cost estimate of the scope change and the risks to the project which may flow from the scope change itself.

3.7 Interdisciplinary Experts

Project cost estimates should be based on consultation and input from skilled, interdisciplinary experts and not be developed in a vacuum. This is particularly important when the project scope is least defined.

As such project cost estimates should:

- be developed using a team approach and consultation with personnel having expertise in the appropriate disciplines to obtain guidance and assistance in the development of the major components of the cost estimate. These components will likely include:
  - design engineers for design parameters;
  - properties personnel to review the probable cost for property acquisition and the value of 'risk' associated with property;
  - construction personnel to assist with the construction costs, contracting strategy, scheduling and risks; and
  - environment expertise to determine any potential impact.
- include a review of the project scope and objectives to ensure they are well defined and understood by the team of experts (include an evaluation of critical issues and risks);

- include a field review, with the interdisciplinary team of experts if possible, prior to preparing the estimate.
- involve consultation with outside agencies as may be appropriate, particularly for work that is unusual (e.g. buildings, railroads, mass transit, ferry boat docks, etc.).
- be communicated to the entire project team for review and input after the estimate's initial development to capture items or issues that may have been previously overlooked or unknown;

3.8 Review of Estimates

Project cost estimates should undergo periodic reviews by a competent disinterested party to validate the cost estimates.

Each estimate is based on the individual evaluation, views, and interpretation of a particular estimator. A second independent set of eyes reviewing the estimate will afford project managers and decision makers an opportunity to capture a different perspective (a second opinion), and provide assurances as to the quality of the estimate.

These reviews are important to ensure that any changes to the conditions and underlying assumptions for the original and subsequent estimates are reflected in the estimate. This is particularly applicable on larger projects where the estimates are very complex and often subject to significant scrutiny.

3.9 Release of Estimates and Estimating Information

Careful consideration must be given to the context surrounding the release and potential use for the information provided in the estimates. While estimates may have been developed for a specific and unique purpose, they may be subject to misuse by those who do not understand the applicable context.

As such project cost estimates:

- should not be used as the basis for project approval or released to the public until they have been thoroughly reviewed and found to be an accurate reflection of the project scope and associated project risks;
- should always be accompanied by documentation of the assumptions made in the development of the estimate to ensure that the context in which the estimate was developed is clearly understood. Estimates without such documentation, could lead to incorrect assumptions by those viewing the estimate.

Part 4

4. LEVEL OF ESTIMATES

The level, class, or category of an estimate is a simplified method of determining the degree of accuracy and precision of that estimate.

Estimates have often been described with using "letters" (ie. Class A, B, C, D, E). This approach implies a specified level of precision or accuracy. For example, if an estimate was "Class B" then it implied a degree of accuracy of +/- 20%. **The ministry has instead adopted an approach of categorizing estimates based on the stages of the project life cycle.**

This approach immediately identifies the point within the project continuum at which the estimate is prepared. It provides a more complete picture of the level of project information and knowledge that the estimate is based upon and the expected range of precision of that estimate.

Every project cost estimate must identify the "Level of Estimate" as follows:

Conceptual Level Estimate
An estimate based on completion of initial planning work and corridor studies. In many cases alternative solutions are still being considered at this stage, thus an independent estimate should be provided for each solution to assist cost comparison.

Planning Level Estimate
An estimate based on completion of all work necessary to undertake preliminary design. This estimate must be based on knowledge of site conditions adequate to enable the identification of site related risks and the development of corresponding contingency costs that are sufficient for making correct investment decisions.

Preliminary Level Estimate
An estimate based on all information available upon completion of preliminary design drawings. Upon acceptance, this estimate should become the basis for cost plans for project cost control during design.

Pre-Construction Level Estimate
An estimate based on all information upon completion of detailed design in preparation for tendering. This is a detailed estimate which the entire project team should be willing to commit to it.

Each level of estimate reflects a point within the lifecycle of the project. As a project evolves, the knowledge and information about that project increases. Therefore the number of assumptions that must be made in developing each project cost estimate should decrease as each successive level of estimate is prepared. For example, a project cost estimate classified as "Conceptual" will contain more assumptions than a project cost estimate classified as "Preliminary" because more information is available on the project following completion of the preliminary design.

This does not necessarily mean that the amount of the project cost estimate will change. It does mean that each successive "Level of Estimate" should indicate a greater level of confidence than the preceding estimate (See Table 4 below). Each subsequent estimate should be more accurate (closer to the final anticipated cost of the project) and more precise (the range around the anticipated cost should decrease). The result is a series of estimates where each subsequent estimate (range of estimated project costs) is a subset of the previous estimate.

For example, a project cost estimate may be initially developed as $100,000 (the accuracy) and a range of minus $25,000 and plus $75,000 (the precision) or an estimated project cost of $75,000 to $175,000. As a more detailed understanding of the project is confirmed, a subsequent estimate may then have an accuracy of $125,000 and a range of $115,000 to $155,000; and a more detailed estimate again may then have an accuracy of $130,000 with a range of $120,000 to $150,000. As previously stated, the progressive elaboration of the project should yield a series of estimates, each of which falls within the previous estimate.

TABLE 4

Estimate Level	Range of Precision	Project Phase	Data
Conceptual	**-25% to +75%**	Planning & corridor studies completed.	Historical costs.
Planning	**-15% to +50%**	Route studies completed.	Average unit costs for summary level activities on selected routes.
Preliminary	**-10% to +25%**	Preliminary design completed.	Preliminary design drawings & average unit costs for detailed activities.
Pre-Construction	**-5 % to +10%** **UNDER DISCUSSSION**	Detailed design completed, Pre-tender.	Final quantity (pre-tender) estimate, assessment of site conditions, and construction market evaluation.

5. COST ESTIMATING FRAMEWORK

The Cost Estimating Framework specifies the submission requirements for project cost estimates, and outlines the significant work categories (called "Cost Elements") defined by the Ministry of Transportation for developing project cost estimates.

5.1 Submission Requirements for Project Cost Estimates

5.1.1 Basic Header Information

- the Project Number;
- the Project Description;
- the date the estimate was prepared;
- the name of the individual (and/or firm) who prepared the estimate;
- the "Level of Estimate";
- specify "constant dollars" (i.e. 2006 dollars) or "as-spent dollars".

5.1.2 Scope Statement and Assumptions

- the scope statement from which the project cost estimate is developed;
- all assumptions made by the estimator in the development of the estimate. This is particularly important in Conceptual and Planning Level Estimates since the estimator must make more assumptions.

5.1.3 Cost Estimate – Summary Totals

- the estimated cost of each activity;
- the estimated cost of each cost element (excluding contingency) [i.e. sum of the activities];
- the total estimated cost of all cost elements (excluding contingency);
- the estimated contingency applied to each cost element;

- the total estimated contingency;
- the management reserve (if applicable); **----UNDER REVIEW**
- the total cost estimate (including contingency and management reserve);
- escalation (if applicable) **----UNDER REVIEW**
- the total cost estimate including escalation.

5.2 Cost Elements

The significant work categories defined by the Ministry of Transportation for developing project cost estimate are called (called "Cost Elements"). Each cost element consists of a number of activities. The project cost estimate should reflect the estimator's determination of the 'most probable' cost of completing each activity. The resulting activity estimates are summed to establish an estimate for each cost element. The cost element estimates are then totalled to result in the "Project Cost Estimate".

A description of each Cost Element and a list of the activities within are provided as Appendix 1 [Link to Appendix 1]. These elements and activities apply to the majority of the ministry's capital projects. The extent, size and complexity will vary from project to project.

When developing a project cost estimate, each Cost Element and its activities must be considered to ensure that all anticipated costs are captured. This analysis should be undertaken regardless of the size of the project, who delivers the element or activity (ministry or consultant) or who funds (ie. ministry, private sector, federal, municipal, developer) the element or activity.

If the estimator determines that there are no costs associated for a particular element, then the estimate should indicate a $0.00 for that element. This is often the case for smaller or less complex projects where elements and/or activities may be combined, however, the process of considering each cost element and activity, should still be undertaken. On larger projects each of these cost elements will likely be significant, and will have costs associated with each of the activities within each element.

ACTIVITY CODE	COST ELEMENT	ESTIMATE AMOUNT
2000	**PROJECT MANAGEMENT**	**$**
2500	**PLANNING**	**$**
	DESIGN	
3000	PRELIMINARY DESIGN	**$**
3500	DETAILED DESIGN	**$**
4000	**PROPERTY ACQUISITION**	**$**
		$
	CONSTRUCTION	**$**
5000	GRADE CONSTRUCTION	**$**
5200	ROADSIDE CONSTRUCTION	**$**
5300	OTHER CONSTRUCTION	**$**
5500	STRUCTURAL CONSTRUCTION	**$**
6000	PAVING CONSTRUCTION	**$**
6500	OPERATIONAL CONSTRUCTION	**$**
6700	UTILITY CONSTRUCTION	**$**
6800	CONSTRUCTION SUPERVISION	**$**
	CONSTRUCTION SUBTOTAL	**$**
9700	**CONTINGENCY**	**$**
9800	**MANAGEMENT RESERVE (use under review)**	**$**
9900	**ESCALATION (process under review)**	**$**
TOTAL	**PROJECT COST ESTIMATE**	**$**

Part 6

6. RECORDING AND MAINTAINING COPIES OF PROJECT COST ESTIMATES

6.1 Before a project is assigned to a Project Manager

- The program development manager (HQ or Regional) is responsible for maintaining cost estimates for potential projects.
- The program development manager and the estimator will keep an electronic record of all cost estimates (inclusive of the supporting materials, scope statements and assumptions).
- The completed project cost estimate which supports the Project Budget must be provided to Program Development and Monitoring Branch with the Capital Project Information Sheet (See Appendix 4) as part of the Business Case submission.

6.2 After the project is assigned to a Project Manager

- All cost estimates inclusive of the supporting materials, scope statements and assumptions, will be transferred to the respective Project Manager.
- The Project Manager is then responsible for maintaining the project cost estimate for the project.
- The Project Manager shall ensure that cost estimates are prepared in accordance with the Project Cost Estimate Guidelines.
- The Project Manager and the estimator will keep an electronic record of each project cost estimate (inclusive of the supporting materials, scope statements and assumptions).
- A copy of the most current completed project cost estimate must be provided to the Manager, Estimating Services upon request.

6.3 Project close out

- The Project Manager shall review the as-built costs or delivered value on the project along with outstanding items, like deficiency corrections and environmental monitoring as may be required as part of the project completion process.

- The Project Manager should complete a final cost report and compare it with the final version of the project cost estimate.
- A copy of the final project cost estimate shall be provided to the Manager, Estimating Services upon request for the cost estimate data archive.

7. AUDITING PROJECT COST ESTIMATES [TO BE DEVELOPED]

The intention is to conduct audits of project cost estimates on a sampling of projects each year.

The selection of projects will depend upon several factors such as the value of the project; the complexity of the project; actual costs exceeding budgets; and other issues that may warrant a review of the estimate.

These audits may or may not be conducted in conjunction with an overall project quality review/audit.

The estimates will be audited for compliance with the Project Cost Estimating Guidance; and for accuracy and completeness of the estimate.

8. RESOURCES

8.1 Cost Data

The ministry recognizes that historical cost data from projects (tenders data and actual costs) will assist estimators, cost consultants, planners, and engineering firms, with producing accurate and complete cost estimates for future ministry projects.

The cost data from construction tenders awarded by the ministry over the previous five calendar years has been compiled by the ministry, and is stored on excel spreadsheets on a contract-by-contract basis. The data is released under a specific set of "Business Rules" to ensure that the confidentiality of individual contractor unit prices is maintained.

The data is located on a webpage Historical Cost Data. Access is limited to those consultants contracted by the ministry to provide cost estimating/analysis services, and ministry staff.

Consulting firms must submit an email with proof of their current contract with the ministry for cost estimating services, their BCeID; and a signed Confidentiality Agreement. The consultant will then be sent the link to the webpage and the password. E/mail requests to: Mike.Hallas@gov.bc.ca

Notifications of updates to the data are sent to all engineering, planning, project management and cost estimating firms registered in RISP informing them about access to this data.

8.2 Warehouse of Completed Project Cost Estimates

Project Management Support Services Branch will maintain a warehouse of completed project cost estimates.

The project cost estimates will be stored electronically by the Manager, Estimating Services.

The warehouse will be maintained for projects on the ministry's capital plan from the previous three calendar years.

8.3 Websites [currently under construction]

Project Management Support Services Branch will maintain an intranet webpage on Cost Estimating for use by Ministry staff.

The site provides update information on cost estimating initiatives, links to tools and resources, as well as templates to assist ministry staff with contracting for cost estimators.

Website: http://gww.th.gov.bc.ca/gwwimb/Content/costestimating/underconstruction.asp

8.4 Estimating Methods and Systems (UNDER REVIEW)

8.4.1 Elemental Parametric Estimating Approach

This approach to estimating builds up the estimate of a project from the expected cost of its elements and its *parameters*. The elements are the building blocks, such as the design, the land acquisition, and construction elements including grade, structural, paving, and utilities, and so on. The parameters are the variables which need to be defined, such as, number of lanes, lane widths, depth of materials, number of culverts per kilometre for drainage, tunnel width and height, and so on. Elemental Parametric Estimating is the combination of *elements, parameters* and predefined activities within each element. It does *not* provide a breakdown of traditional labour, equipment and materials; however it does provide a consistent and increasingly detailed breakdown for decision-making over the project life cycle

It would appear from the foregoing that a parametric estimate cannot be developed until a project is being designed in detail, so all the parameters are known and can be priced. In fact, parametric estimating can be used for the earliest estimates; by simply entering the relatively few known parameters, and using assumptions for the rest. The result is a complete, workable estimate for early planning and budgeting. Later, as assumptions are gradually replaced with known quantities, the parametric estimate becomes more defined and can be compared to the original estimate.

The Ministry recognizes and supports the use of elemental parametric estimating as a method of developing project cost estimates.

The Ministry recommends use of the elemental parametric estimating method for larger projects and entire program estimating. This approach is particularly effective for projects requiring significant option analysis and for comparison purposes.

8.4.2 Estimating Systems

The Ministry recognizes the following tools to assist its cost estimating:

i. Kneeshaw
   User manual
   Sample Spreadsheet

ii. Wolski
   User Manual
   Sample Spreadsheets

iii. Other

8.5 Obtaining a Qualified Estimator

8.5.1 Terms of Reference for Cost Estimating Assignments

A "Cost Estimating Terms of Reference for Consultant Assignments" document has been prepared to provide estimators, cost consultants, planners and engineering firms with a framework for submission of project cost estimates, and to provide the Ministry with more consistent cost estimates in terms of content, format and approach.

These "Terms of Reference" shall be used on consulting assignments for cost estimating services and design/planning assignments that include a cost estimating component.

The document is attached as **Appendix XX [insert link]** to this Guidance), and is also available on the Project Management Support Services Branch website: http://gww.th.gov.bc.ca/gwwimb/Content/Home/Home.asp

8.5.2 RISP

The Ministry of Transportation uses a system called RISP (Registration, Identification, Selection and Performance Evaluation) to assist in the selection of consultants for engineering and technical contracts of a value less than $1 million. The online computer system supporting RISP is called eRISP.

There are two categories in RISP for cost estimating: Cost Estimating Services and Coast Estimating Audit Services. Each category is divided into sub-categories for small, medium and large projects.

Consultants can apply to meet the evaluation criteria for each category. Four evaluation criteria for cost estimating are: demonstrated experience,

relevance of experience, type of assignment experience, and currency of experience.

Once approved, Consultants are then registered to be selected for cost estimating assignments within that category.

8.5.3 Sample RFP for Cost Estimating and Cost Estimating Audit Services

To be developed

9. TRAINING OPPORTUNITIES

9.1 In-house Training Plan

The ministry has developed an in-house training plan for developing cost estimators and fostering ongoing cost estimating expertise.

The Plan is primarily designed for Ministry staff and/or consultants already working in transportation project management, construction and/or design (any discipline: structural, civil, highway or geotechnical).

The program is comprehensive, one-on-one training on the parametric elemental estimating.

The training plan document is attached as Appendix XX [insert link] to this Guidance, and is also available on the Project Management Support Services Branch website: http://gww.th.gov.bc.ca/gwwimb/Content/Home/Home.asp.

9.2 Other recognized training

To be researched. Insert links to other training programs in estimating.

APPENDICES

APPENDIX 1

Cost Elements and Activity Descriptions

2000 PROJECT MANAGEMENT

This is the cost to manage the overall project. It includes all administration and management costs of both the ministry and any consultants involved in managing the project. It also includes legal and insurance costs associated with managing the project, as well as communications costs such as public open houses, information meetings, news releases, publications and brochures, opening ceremonies, etc. Communications costs for larger projects may also include information offices, and traffic information plans for motorists.

Activities:

- salaries of staff managing the project,
- office (building rent, equipment, furniture etc.)
- administration, printing and consumable supplies
- travel expenses,
- information systems,
- legal (legal counsel and expenses),
- insurance (project insurance premiums and associated costs),
- communications and public relations costs; and
- any other costs associated with managing a project.

2500 PLANNING (confirm with project sponsor whether to include in project estimate):

This is the cost for planning and project development; and also may include pre-project planning and development costs and project identification. These costs may be considered ‘sunk’ or past costs. Project managers should carefully consider these costs to clearly determine whether they will, or will not, be included in the total project cost. The decision on whether to include these costs should be made during the development of the scope of the work for the project, and will likely be decided by the Ministry executive and/or project sponsor.

Activities:

- transportation planning studies,
- corridor studies,
- functional planning studies,
- project identification, and
- any general costs associated with planning and project development.

DESIGN:

This is the cost of designing the project (preliminary, detailed). It includes all engineering costs, as well as field investigation, testing and administration of the design work, and costs to prepare the construction documents. It also includes the cost of environmental investigation and other environmental documentation. Design consists of the following sub-elements:

3000 PRELIMINARY DESIGN

This is the cost of all design work required up to the point of detailed design. It includes both preliminary and functional design costs.

Activities:

- aerial mapping and control survey,
- preliminary design,
- functional design,
- geotechnical investigation, and
- environmental impact assessments and investigation.

3500 DETAILED DESIGN

This is the cost of all detailed design work. It includes the development of construction drawings and technical specifications and any and all construction details necessary to construct the project.

Activities:

- detailed design of all disciplines necessary to complete the Construction Cost Elements,
- environmental pre-construction assessments, enhancements and approvals,
- development of construction drawings and specifications
- design services during construction,

- usually expressed as a percentage of each Construction Cost Element

4000 PROPERTY ACQUISITION:

This is the cost to research and acquire right-of-way for the project, including right-of-way costs for work outside the roadway prism. It also includes easements, contractual obligations with property owners, the cost of any required relocation of residents and businesses, as well as the administration costs of right-of-way activities.

Activities:

- purchase price of land (residential, commercial, and right-of-way property)
- associated costs including:
  - land improvements,
  - property management,
  - administration,
  - acquisition fees,
  - demolition,
  - legal survey, and
  - owner's costs,
- all other costs incurred to research, acquire property, and manage the acquisition process.

CONSTRUCTION:

This is the cost of physically constructing the project in the time required based on current costs for labour, materials, equipment, mobilization, bonds and insurance, and profit. Construction consists of the following sub-elements:

5000 GRADE CONSTRUCTION

This is the cost to prepare, excavate, construct, and finish the roadway to grade (excluding structures).

Activities:

- site preparation (clearing and grubbing),
- excavate, supply, haul, place, and compact all types of material for road bed (includes rock blasting and drilling),
- drainage, pipes, culverts, and multiplates (under 3 meters in diameter) including excavation and backfill,

- granular materials (SGSB, CBC) (produce, place and compact)
- finishing work, landscaping (hydroseeding), fencing, barriers, sidewalks, curb and gutter,
- temporary works, traffic control, detours, any other items to handle traffic during construction,
- mobilization, and
- water, sanitary, storm associated with Grade construction.

5200 ROADSIDE CONSTRUCTION

This is the cost to construct roadside works located off the travelled roadway. It includes the cost of all buildings, parking, access and exit roads, lighting, utilities etc.

Activities:

- weigh scales,
- tourist info centers,
- safety rest stops,
- viewpoint areas,
- mobilization, and
- water, sanitary and storm, associated with Roadside construction

5400 OTHER CONSTRUCTION

This is the cost to construct items of work peripheral to the roadway which are required for the project. It includes the cost of all items of work for each activity.

Activities:

- environmental mitigation (all work specifically required to protect the environment),
- railroad lines, spurs, and crossings,
- marine work (both temporary and permanent),
- mobilization, and
- water, sanitary and storm, associated with Other construction

5500 STRUCTURAL CONSTRUCTION

This is the cost to construct any and all structures on the project. Each structure is independently estimated. All structures are summed to determine the total structural construction cost.

Activities:

- site preparation

- bridge construction
  - piers
  - abutments
  - decks, and
  - site works
- retaining walls
- multiplates, pipes and culverts greater than 3 meters in diameter,
- tunnels and snow sheds
- mobilization , and
- water, sanitary and storm associated with structural construction.

6000 PAVING CONSTRUCTION

This is the cost of surfacing the roadway. It includes the supply, install, removal, disposal, and modification of any and all surface materials.

Activities:

- machine paving - asphalt and/or concrete,
- hot re-profiling of existing pavement (heat scarification),
- shoulder paving,
- pavement finishing (intersection islands, median, driveways and handwork),
- sealcoating, and
- mobilization

6500 OPERATIONAL CONSTRUCTION

This is the cost to construct (remove, dispose, modify) work required to make the project operational.

Activities:

- lighting,
- signals,
- signing,
- guardrail / median and roadside safety barriers,
- pavement markings (paint, thermoplastic, and reflectors) both temporary and permanent, and
- mobilization

6700 UTILITY AND THIRD PARTY CONSTRUCTION:

This is the cost to supply, remove, or relocate existing utilities such as hydro power, telephone, and gas. These are costs incurred by third parties and utility companies that will be paid by the ministry. These costs are perhaps the most difficult costs to estimate since third party requirements have a high potential for risk and change, particularly on projects located in urban areas with a high concentration of existing utilities.

Activities:

- hydro transmission lines (overhead and underground),
- telephone lines (overhead and underground),
- oil or gas pipelines (new or temporary),
- telecommunications such as cable, fibre optics, or other communications lines or antennas,
- transit for bus shelters, stops, and benches etc.
- inspection costs for third parties (municipalities and other agencies), and
- any other miscellaneous utility or third party costs,

6800 CONSTRUCTION SUPERVISION

This is the cost to supervise, administer and oversee the construction on site. This cost should be adjusted to meet the project's requirements and delivery model. Construction Supervision is often expressed on the estimate as a percent of each Construction Cost Element above.

Activities:

- general site supervision (either ministry or consultant) and security,
- surveying for measurement of pay items,
- administrative oversight during construction
- plant inspections and materials testing,
- quality assurance, and
- environmental monitoring,

9700 CONTINGENCY

This is an amount provided for the risk and uncertainty associated with each Cost Element within the scope of work for the project.

- risk contingency is derived from assigning a dollar amount to each identified risk for each activity based on the probability of that activity being completed as planned, and the impact if it's not,

- the contingency for each Cost Element generally results from a summation of the risk contingency amounts for each activity, and an overall assessment of the uncertainty associated with that Cost Element (usually expressed on the estimate as a percent of the base estimate for each Cost Element - the percent will vary depending upon the nature of the Cost Element);
- the Total Project Contingency generally results from the summation of the Cost Element contingency amounts (usually expressed on the estimate as a percent of the base estimate).

9800 MANAGEMENT RESERVE (optional) UNDER REVIEW

Management reserve may be appropriate for high risk projects and projects that are sensitive to changing politics and management. The reserve is a provision for risks associated with scope changes, or other additions which management feels should be included in the project but which are specifically outside the scope of the project. Management reserve, when used, is usually expressed as a percent of the total cost estimate.

9900 ESCALATION (application of escalation is UNDER REVIEW)

This is the amount included in the cost estimate to account for the changing value of money over time.

- typically the cost estimate is developed in constant (current) year dollars (i.e. the value represents the cost of doing all of the work in a certain year – 2006 Dollars).
- the ministry requires that the cost estimate be submitted in 'as-spent' or year-of-expenditure dollars (i.e. the value represents the costs based on the year that the work is anticipated to be completed),
- after the cost estimate is prepared it must be adjusted by assigning an inflation rate per year based upon the amount of work anticipated to be completed in each future year,
- inflation rate(s) vary depending upon many factors including the type of work, the geographic location and the general market situation,
- the cost estimate must clearly specify how inflation is considered in the estimate, what inflation rate is used for each cost element, and
- must clearly state that the estimate is expressed in year-of-expenditure dollars.

Appendix 2

Sample Cost Estimates

[to be inserted]

Appendix 3

Terms of Reference for Consulting Assignments

[to be inserted]

new CE ToR for Consulting Assi...

Appendix 4

Capital Project Information Sheet

W:\PMSS\!ARCS\Estimating\Manual Development\Samples and background info

Appendix 5

Escalation Process and Rates

Under development – to be inserted

Appendix 6

Special Considerations [Under development]

Property Costs:
If the extent of the right-of-way acquisition is not known, then a contingency should be added based upon historical settlements and awards for condemnation cases, which must include costs for attorneys, engineering research, witness research, survey, and staff time. Also, the right-of-way acquisition schedule needs to be considered. Right-of-way acquisition costs will increase quickly in rapidly developing areas. Costs must include relocation assistance and benefits for displaced individuals, families, businesses, governments, and non-profit organizations. Special acquisitions, such as those from government sites can be time consuming and costly. Note that the user of right-of-way estimates always must recognize that the estimates are very dependent upon the accuracy and reliability of information concerning the location of the right-of-way limits on a project. A very small change in the location of the right-of-way line, or a change in access control or drainage retention placement, particularly in commercial areas, can affect the right-of-way cost estimate by many millions of dollars because of required damage payments such as severance or business damages.

Ministry Capital Program: (Do we wish a comment on this?)
For planning/development purposes, the timeframe in which a project will be implemented plays a key role in the level of precision of the project's initial cost estimate. For example, a project included in the first couple of years of the Ministry's long-range Capital Plan should be based on more precise cost estimate information than a project reflected in the latter years of the Capital Plan. This is particularly important for committing funding for a project and managing to a fixed level of funding within the overall Capital Program.

Environmental Work: (Do we wish a comment on this?)
Although the intent of a project may be to avoid environmentally sensitive resources, some degree of environmental consideration and analysis is required for all projects. Any additional environmental avoidance, minimization, mitigation, remediation, and enhancement costs must also be included in the cost estimate. Costs to mitigate impacts to natural resources, cultural resources, neighborhoods, etc.,

must either be individually estimated or included in a contingency amount. Although large contingencies may be appropriate if no resource surveys have been conducted, resource surveys conducted as part of the CEAA process provide valuable information for refining cost estimates. Additionally, some large projects may have enhancement work that is not directly related to the project. These costs must be captured and included in the cost estimate. A project that has a potentially significant effect or impacts on environmental resources or has opposition from environmental or community groups or regulatory agencies, tends to include more environmental mitigation which results in higher costs than those projects with relatively little impact or oppositions.

Project Funding

Consider how projects will be funded. Some projects may be completely funded when construction begins; while others, as is the case for many larger projects, may have limited funding or be funded in phases (e.g. corridors). This will certainly affect the costs due to the demands on the accuracy of the "timing of project delivery" risks, and due to inflation. **[KEEP or TOSS ? – MJH]**

CONSTRUCTION COST CONSIDERATIONS:

The following should be considered when preparing the construction cost estimate. These issues are of particular significance on larger projects:

Contracting Method

Innovative contracting techniques such as Design-Build, partnership and concession agreements, cost-plus-time bidding, etc. should be taken into consideration when preparing the estimate. Design-Build contracts and contracts with performance-based specifications or warranties impose a higher risk on the Contractor and may increase a Contractor's bid. Any stipend costs should be included in the estimate.

Acquisition Strategy Analysis

A separate Value Analysis (insert link to VE site) on the project should be considered to determine the most economical and advantageous way of packaging the contracts for advertisement. A Value Analysis is a systematic approach by a multi-disciplined team to identify functions of a project, establish a worth for each function, and generate alternatives that satisfy each function at the lowest life-cycle cost.

Surety Issues

Obtaining bid and performance bonds for some projects are difficult, especially for smaller contractors. If bonding requirements are not reduced, then an increased amount for obtaining bonds should be included in the cost estimate.

Bidding Climate Impact

Cost estimates should consider the economic impact of the project on the local geographical area. For example, material manufacturers that would normally compete with one another may need to combine resources in order to meet the demand of the project. Extremely large construction packages also have the potential to reduce the number of contractors that have the capacity or capability to do the work, and may need to be split up into smaller contracts to attract additional competition. Cost estimates should take into account market conditions. If the economy is experiencing a downturn and there is more competition for projects, contractors will bid with less profit. Conversely, if the market is healthy and more projects are advertised, contractors will bid projects with higher markups. In addition, the timing of the bid solicitations can also have an affect on the cost since contractors may be more competitive during the winter months when trying to build some inventory. Cost estimates should also consider controls on the use of labor.

Industry Capacity

The number of potential qualified contractors that are able to bid on projects are limited to those that have the capacity to construct the project. Contractors who bid on projects often bid on projects throughout the country. If other projects are being advertised concurrently, this may have a limiting effect of competition and would result in higher bids. If possible, rescheduling advertisement dates may be appropriate.

Highly Specialized Designs and Technology

Cost estimates should consider the impact of any requirement to use first-of-a-kind technology, new materials, or methods of construction.

Context Sensitive Solutions

The implementation of context sensitive solutions into a project may have an impact on the project cost estimate. (Not sure what this means?)

Construction Time

The impacts of construction activities (e.g. sequencing, traffic control, haul routes, accessibility, geographic locations, repair work to roads damaged by construction equipment, and for ponds that may be silted as part of construction) should be considered when developing cost estimates. Also, costs associated with rush hour restrictions and night work must be considered.

Construction Incentives

The cost for the contractor to meet quality/material and performance incentives must be included in the cost estimate.

Construction Contingencies:

To allow for the likelihood that additional construction work will be identified after the design has been completed and the project awarded, a contingency for cost growth during construction should be included. This is normally around 5 to 10%. However, some projects where the potential for scope creep and changes during construction is high have used a contingency factor approaching 15%. The following may also have an impact on this percentage:

Design-Build Contracts

Design-Build contracting on major projects has thus far shown very little increase from the negotiated contract amount to the final project completion and therefore may require a smaller construction contingency since the number of construction claims due to design errors is substantially reduced.

Number of Concurrent Contracts and Contract Interfaces

On projects where multiple construction contracts are underway at the same time, close coordination of construction activities and schedules may be required. The potential for one contractor to impact another contractor's activities is higher and may result in additional delay or coordination costs during construction.

Contractor Proposed Construction Changes

Construction contracts should include specifications to allow the contractor to propose construction changes that result in benefits to the contractor and the owner. These are sometimes referred to as Value Engineering Change Proposals. **(Do we still have these in our construction contracts?)** Contracts that restrict the opportunity for contractors to make changes may limit the ability to contain costs once construction starts. An increased construction contingency may be appropriate in these situations.

Construction Time

For longer duration projects, there is a greater risk for impacts to the construction schedule and therefore, the contingency amount should be higher. Construction scheduled in winter or rainy seasons should be accounted for appropriately in the contingency amount, since there may be a higher risk in meeting construction schedules due to unforeseen weather delays. When a project consists of two or more phases by different Contractors that are interdependent, a higher than normal contingency may be necessary. Also, compressed or accelerated construction schedules could potentially increase costs.

Protection of the Traveling Public

Some projects have complex construction traffic control and may have multiple construction contracts underway at the same time. This results in a potential for unanticipated costs once construction begins. Costs may also include incident management, public information and communication efforts, transit demand management and improvements to the local area network, which help improve safety and traffic flow through the project during construction.

Environmental Impacts

Projects may involve work within environmentally sensitive areas. In some cases projects must go through a thorough CEAA process (Canadian Environmental Assessment Agency – link to CEAA: http://www.ceaa-acee.gc.ca). This will lead to greater public and resources agency scrutiny during construction. As a result, environmental related work may be added during construction.

Other Factors

A few of the potential impacts to the construction contingency are the risks of encountering underground utilities and other obstructions, differing site conditions, contaminated soil, multi-agency involvement, etc.

Appendix 7

TRAINING PLAN FOR PROJECT COST ESTIMATING

Purpose:

The ministry is committed to improving the accuracy of its project cost estimates.

The purpose of this training is to support that objective by providing training in cost estimating using the elemental parametric method.

Candidates are expected to be committed to the program for up to a year (may vary depending on full/part basis).

Successful completion of the training will result in recognition by the ministry as a qualified project cost estimator.

Approach:

The ministry will partner with a private sector cost estimator to deliver a comprehensive training program. The lead trainer will be Ernest Wolski.

Individuals will work "hands-on" with Ernest Wolski to prepare cost estimates using the "Wolski method of estimating". The training will begin on sample projects; but will evolve to preparing "live" cost estimates for actual ministry projects. The training will also involve consultation/discussion with ministry business area experts and project teams to provide candidates with direct access to information and insights valuable for developing accurate cost estimates.

The training will generally follow the "Training Program Phases" below.

Qualifications:

Preference will be given to candidates with:

- experience (approx. three years) in transportation project management, construction and/or design (any discipline: structural, civil, highway, or geotechnical); See also the *"Experience-on-the-Go" approach*, attached

- good working knowledge of excel spreadsheets; and,
- some knowledge or experience in cost estimating or quantity surveying (i.e. takeoff of materials/pricing - Schedule 7)

The depth and focus of the training may vary depending upon the experience and knowledge of the individuals in the program.

Location and Materials:

Candidates will be required to spend time in Victoria at E. Wolski Consulting offices, but can also complete portions of the program at their own work location. Candidates may also be required to visit project sites throughout the Province. All travel costs are the responsibility of the candidate's business unit.

Candidates may require use of a laptop computer with Excel, and various miscellaneous supplies (pens, paper, etc.).

Training Program Phases

Phase 1: Project Cost Estimating Overview approx. 2 days

- What is elemental parametric estimating ?
- Types (classes) of estimates within the project life cycle;
- Manual overview and assigned reading

Phase 2: Estimating and Work Breakdown Structure approx. 3 months

- Part A: Understanding composite unit prices & activity codes
  - Understanding activity codes and definitions;
  - Assign activity codes to Schedule 7 pay items
  - Re-sort pay items to develop database of information
  - Evaluation to determine composite unit costs for pertinent items:
    - cost per lm for base
    - cost per m2 of asphalt;
    - cost per m2 of bridge deck;
    - cost per m2 for retaining walls.....etc.
- Part B: Learning the Structure of the Spreadsheet
  - Steps of Estimating (the "big picture")
  - Work Breakdown Structure of the Estimate
  - Elements and Components
  - Activity Line items (lowest level of detail)
  - Parameters
- Part C: Working with Elements and Parameters
  - How each Element is developed
  - How changes in Project Parameters effect cost of elements
  - How Parameters help define project scope

Phase 3 – Preparing Project Cost Estimates *approx. 8 months*

- Preparing estimates (approx. 8 – 10) for different projects:
  - Interchanges
  - Grade separation (Bridge or underpass etc.)
  - Basic road (4 lane and 2 lane etc.)
  - Adding to an existing roadway
- Organization of Estimates
- Documentation of assumptions

Phase 4 – Post Estimate Review *approx. 1 week*

- Tracking completed projects
- Review estimates against final costs
- How to apply "Post-estimate review" to future estimates

"Experience on the Go" Approach

UNDER DEVELOPMENT

Candidates entering the training program without the necessary foundation of experience and knowledge in a particular business area can develop their knowledge and gain valuable exposure to these disciplines as they proceed through the training program.

The ministry has arranged for business area champions to mentor candidates, by conducting information sharing sessions, and one-on-one discussions on the key business elements of transportation projects.

The primary focus will be on highway and structural construction and design, however candidates will also have the opportunity to discuss issues and learn key pieces of information regarding property acquisition, environment, project management etc.

Candidates will receive information sessions on the key business areas to assist in producing complete project cost estimates:

Construction:
-

Design:
-

Property:
-

Environment:
-

Project management:
-