Quality Assurance Guidelines: Predictive Ecosystem Mapping (PEM)

Draft

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for the

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Preface

The Government of British Columbia provides funding for the work of the Resources Information Standards Committee (RISC), including the preparation of this document. To support the effective, timely and integrated use of land and resource information for planning and decision-making, RISC develops and delivers focussed, cost-effective, common provincial standards and procedures for information collection, management and analysis. Representatives on the Committee and its Task Forces are drawn from the ministries and agencies of the Canadian and British Columbia governments, as well as academic, industry and First Nations stakeholders.

RISC evolved from the Resources Inventory Committee (RIC), which received funding from the Canada-British Columbia Partnership Agreement on Forest Resource Development (FRDA II), the Corporate Resource Inventory Initiative (CRII), and Forest Renewal BC (FRBC). RIC addressed concerns of the 1991 Forest Resources Commission.

For further information about RISC, please access the RISC website at: *http://srmwww.gov.bc.ca/risc/*.

Acknowledgements

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1. Introduction

1.1. General Approach

A general approach to quality assurance (QA) on ecological data-collection projects is described in the document *Introduction to Quality Assurance Procedures*.

1.2. Scope

These PEM QA guidelines outline the procedures for completing a QA review of a PEM project.

This document does not provide detailed QA review procedures for all stages of the PEM process. It must be used in conjunction with other QA guideline documents and RISC standards, as shown in the following table:

QA Guideline*	RISC Inventory Standard	Required for…
Intro QA		Background and general guidelines for QA
DTEIF QA,	*Manual for Describing Terrestrial Ecosystems in the Field* (1998)	Reviews of field data
PEM QA	*Standard for Predictive Ecosystem Mapping in British Columbia, version 1* (1999)	Reviews of PEM projects
PEM-DDC QA	*Standards for Predictive Ecosystems Mapping - Digital Capture in BC* (2000)	Reviews of spatial and non-spatial PEM databases
TEM QA	*Standard for Terrestrial Ecosystem Mapping in British Columbia, version 1* (1999)	Reviews of TEM projects & TEM attributes collected as an input for PEM
TEM-DDC QA	*Standards for Terrestrial Ecosystems Mapping - Digital Capture in BC* (2000)	Reviews of spatial and non-spatial TEM databases
WHR QA	*BC Wildlife Habitat Rating Standards, version 2* (1999)	Reviews of PEM projects with a Wildlife Habitat Ratings component
PEM QA	*Standard for Predictive Ecosystem Mapping in British Columbia* (1999) & *Standard and Procedures for Integration of Terrestrial Ecosystem Mapping (TEM) and Vegetation Resources Inventory (VRI) in British Columbia Version 1.0*	Reviews of PEM projects completed in conjunction with VRI (VRI QA review to be completed according to RISC standards)

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*For abbreviations, see Introduction to QA Procedures, section 1.2 Scope.

This document also does not cover the procedures for reliability/accuracy assessments of PEM. Further information regarding PEM reliability/accuracy assessments is provided in the *Introduction to Quality Assurance Procedures,* section 1.2.2, Accuracy Assessments (TEM and PEM).

2. Quality Assurance Procedures for PEM

This section provides specific guidelines for PEM QA. These guidelines are in addition to the general QA guidelines outlined in the *Introduction to Quality Assurance Procedures*. There is also a generic guideline for the development of PEM QA contracts included in Appendix A. This contract guideline only includes the standard PEM QA requirements and should be modified to suite specific project objectives.

2.1. QA Procedures – Review Stages

The following review stages outline the QA procedures common to all PEM projects. Where other RISC standard attributes are included as a component of PEM, the applicable QA guidelines should be followed (See section 1.2 Scope).

1. Review of Input Data Quality Assessment

In this review stage, the QA team should determine whether the PEM practitioner has adequately documented the methods and procedures for collecting, evaluating and compiling input data quality (IDQ). They should also identify and explain the potential strengths and weaknesses of input data relative to the final PEM outputs. The QA team should ensure that the IDQ report includes adequate documentation of the procedures used in the preparation, derivation, extraction and quality control of the input data during the predictive process. For further information on IDQ reporting please see the paper, "Input Data Quality and PEM Procedures Reports" by D. Moon.

Deliverable: Form #P1.

2. Review of Knowledge Base Documentation

During this review stage the QA team should ensure that the knowledge base documentation includes full definitions for the entities predicted by the PEM process, full definitions for all input attributes used to describe, characterize, or infer PEM entities, and detailed descriptions of the logic or inference algorithms used. Ultimately the review of the knowledge base documentation should focus on the requirements outlined in section 4.7.3 of the *Standard for PEM Inventory* (RIC 1999).

The QA team should also review the validation procedures and results used in the creation and refinement of the PEM knowledge base. All of the validation procedures and results must be adequately documented and in accordance with section 4.6.1 of the PEM inventory standard (RIC 1999). The QA team must ensure that the validation data set includes the minimum set of attributes, as defined by the set of attributes used in the PEM knowledge base procedures and in the field identification of the mapping entities. This data set must not have been used in the development of the knowledge base.

Note: An independent (third-party) accuracy assessment of the knowledge base and related PEM outputs may also be undertaken, if requested by the client. This step is independent of the final QA of PEM deliverables. See section 1.2.2 of the *Introduction to Quality Assurance Procedures* (RISC 2003).

Deliverable: Form #P2.

3. Review of Structural Stage Layer

In this stage, the QA team should ensure that the structural stage layer documentation includes full definitions of the structural stages being mapped, full definitions for all input attributes used to describe, characterize, or infer structural stages and if applicable, detailed descriptions of the logic or inference algorithms used to predict the structural stages. The QA team should also ensure that the methods and procedures used in the development of the structural stage layer are documented in detail, along with any quality control procedures and results, if available.

All of the general questions listed in the QA form should be addressed and any specific examples and/or recommendations should be included in the comments field provided on the form. All review comments should be included in the QA report.

Note: An independent (third-party) accuracy assessment of the structural stage knowledge base and related PEM outputs may also be undertaken, if requested by the client. This step is independent of the final QA of PEM deliverables. See section 1.2.2 of the *Introduction to Quality Assurance Procedures* (RISC 2003).

Deliverable: Form #P3 .

4. Review of Internal QA Procedures and Results

The intent of this review stage is to ensure that the PEM practitioner has completed a statistically unbiased assessment of their ecosystem map accuracy or acceptability, in terms of thematic content. The QA team should ensure that the accuracy assessment methods, procedures and results are clearly documented and are in accordance with the *Protocol for Quality Assurance and Accuracy Assessment of Ecosystem Maps* (Meidinger, 2000), as outlined in section 4.6.2 of the PEM inventory standard (1999).

All of the general questions listed in the QA form should be addressed and any specific examples and/or recommendations should be included in the comments field provided on the form. All review comments should be included in the QA report.

Note: an independent (third-party) accuracy assessment of the knowledge base and related PEM outputs may also be undertaken, if requested by the client. This step is independent of the final QA of PEM deliverables. See section 1.2.2 of the *Introduction to Quality Assurance Procedures* (RISC 2003).

Deliverable: Form #P4.

5. Review of Digital PEM data (spatial and non-spatial)

This purpose of this stage of PEM QA is to ensure that the data being submitted is in the correct format and meets the *Standards for Predictive Ecosystem Mapping (PEM) - Digital Data Capture,* v. 1.0 (RIC, 2000).

The database associated with terrestrial ecosystem mapping is called the TEM Data Capture (DC) Tool. This data-entry tool is also applicable for PEM data capture of non-spatial attributes. The TEM DC tool is structured to include built-in error detection for most attributes. Typically, errors are detected upon data entry however some errors can only be detected through batch routines run on the complete data set.

The spatial data for PEM must be submitted according to the data structure outlined in the PEM-DDC standard (RIC, 2000). Please see the PEM-DDC QA document for a detailed description of the non-spatial data QA procedures.

Note: The complex nature of the data collected for PEM makes it difficult for the automated data capture tools to detect every possible error. These tools are unable to detect potential errors that fall within acceptable ranges or are subjective by both definition and application. Recognizing this, the QA team must also review the digital data by using sorts and spot checks to find errors and omissions that are beyond the capability of these tools. Note that in addition to the TEM DC Tool and VENUS, additional tools are being developed to assist in the overall QA process. The QA team should inform the provincial specialists of any common errors or misconceptions that are not captured by these tools via the change management process on the TEM website.

As outlined in the PEM inventory standard, any field data for PEM validation must be collected according the DTEIF standards (RIC, 1999), or according to the applicable standard under which the input data were originally collected, and be made available in digital format. The VENUS program is used to store field data collected for full plots and ground inspection plots. VENUS has it own internal set of validation rules which, when turned on, only allow standard DTEIF codes to be entered in the appropriate fields. For a detailed description of field data QA procedures, please see the *QA Guidelines for DTEIF* (RISC 2003).

Deliverables: Completed checklists and sign-off forms from the QA guidelines for DTEIF and the QA guidelines for PEM-DDC.

6. Review of Final Mapping Deliverables

Upon project completion, all final deliverables should be reviewed and signed off if acceptable. This stage of review must involve the entire QA team. Deliverables typically include complete PEM databases, the final reports, and final maps. Optional deliverables may include field data in VENUS, and a complete set of air photos for new PEM inputs. The QA team must consult the original PEM contract to determine the complete description of project deliverables. The intent of QA at this stage is to ensure all data products are provided in the standard formats required for loading into the provincial database. The QA team should ensure that comments and feedback from preceding stages of QA have all been adequately addressed. There will be a zero tolerance for errors in data submitted to the province. For more detailed review procedures please refer to the PEM-DDC QA document. The final project report should be thoroughly reviewed by each QA team to ensure that it is correct and complete (i.e., includes all necessary sections) for each area of expertise.

Deliverable: Form #P5 and #P6

2.2. QA Deliverables

The final QA deliverables must be submitted as described in *Introduction to Quality Assurance Procedures,* section 1.3 How to Use These Guidelines. The final QA deliverables include all PEM QA sign off forms and any applicable sign off forms from other QA guidelines. It is the responsibility of the client to deliver all final PEM QA data to the province via the following ftp site: ftp://env.gov.bc.ca/pub/incoming/PEM

The final PEM QA Report should include:

- All completed review and sign-off forms (Form #P1-P6) – either signed off by a third party QA contractor or by the data collection contractor;

- All additional review and sign-off forms from other QA Guidelines - either signed off by a third party QA contractor or by the data collection contractor;

- (if applicable) All e-mail messages from the QA specialists' to the client or from the data collection contractor to the client, in place of hardcopy signatures; and

- Any additional review documentation, comments and/or concerns

3. QA Forms

QA forms, complete with project information fields, checklists, review questions and sign-off, are provided in the following this section. They and are to be used to document all QA correspondence for each review stage. Separate forms should be filled out for multiple submissions of a particular stage (e.g., if it takes three submissions to pass review stage 2 then three P2 forms should be filled out).

The top of each form includes the form number and title followed by several fields for general project information including submission number, date of the review, project name, and the names of the QA contractors and the mappers. The second section is a checklist that lists all of the materials to be submitted by the mapping contractor to the QA contractors for each review stage. The third section on the forms is a list of QA questions intended to guide the review process. Some require specific information, such as the number of air photos reviewed (e.g., 14) or air photo numbers (e.g., BCB 985764#103). Others are yes/no review questions that should be supplemented with comments and recommendations, including the following information:

- An explanation of errors and omissions with specific examples from the mapping project, where appropriate;
- An indication of the extent of an error, expressed either qualitatively (e.g., several, few, minor, major, etc.) or quantitatively (e.g., three out of the 60 polygons reviewed);
- Recommendations on how to correct the error.

A field is provided under each question for these comments. Additional space can be added as required. Additional questions can be added to the end of the list. All polygon-specific comments and recommendations should be recorded in a separate PDF or Word file and submitted as part of the final QA report (please see section 1.3.2 of the *Introduction to Quality Assurance*). Where no polygon numbers are available, it is recommended that each comment be numbered and/or indicated on the airphoto or mapsheet .It is critical that the QA comments clearly indicate any / or all corrections that are required for successful completion of the mapping process.

The final section on each of the forms is for sign-off Each QA contractor must indicate whether or not the particular submission meets the RISC standard in their area of expertise. A stage of review is only considered to be signed-off once each of the required QA contractors have checked the 'yes' box under 'Acceptable?' and signed their name(s). In situations where the QA of a given stage was not completed, the mapping contractor must provide sign off for the particular map deliverable. In addition to the QA forms provided for each of the review stages there is also a PEM QA summary sign-off form (Form # P6). This summary form includes a field to indicate the total number of submissions that were required before the completion and sign-off of each review stage. The summary sign-off form should be kept up to date and used as a method of tracking project status. Note that these forms must be submitted electronically as part of the QA report (please see section 1.3.2 of the *Introduction to Quality Assurance* for further QA reporting details).

It is recommended that prior to to the detailed review of any mapping stage, the QA contractors familiarize themselves with the structure and content of the individual QA forms, in particular the QA questions. These review questions are general in nature and are meant to stimulate thought in terms of the common errors and trends with respect to the material being reviewed. Therefore, it is essential that the QA contractors review these generic questions before they begin

their detailed review. Once the QA contractors are satisfied with the extent of their review, the general QA questions should be addressed. Any examples that are applicable to a specific question should be provided along with the review comments and recommendations.

These It is recommended that mapping contractors used these forms   to perform internal quality control prior to the by mapping contractors submission of any project materials.

The following forms are included for these guidelines:

- Form P1: Review of Input Data Quality Assessment
- Form P2: Review of Knowledge Base
- Form P3: Review Structural Stage Layer
- Form P4: Review Internal QA Procedures and Results
- Form P5: Review Final Mapping Deliverables
- Form P6: QA Summary and Sign-off

Form P1: Review of Input Data Quality Assessment

Submission #	**Date of Submission**
Project Name	
QA Ecologist	
QA Bioterrain specialist	
QA GIS specialist	
PEM Practitioner(s)	

Materials to be submitted:

❑ Input Data Quality assessment file(s)

❑ Field data if available (in VENUS or another acceptable electronic format such as Excel or Access)

❑ List of mapping entities for each BGC subzone

Input Data Quality Review:

Field Data QA Review Questions:

1. Has the purpose(s) for which the field data is being collected been described (i.e. to develop and validate the knowledge base or to determine the quality of specific input layers)? ❑Yes ❑No

    Comments/Recommendations:

2. Has the entity characterized by the field data been described appropriately (i.e. an ecosystem unit or terrain unit)? ❑Yes ❑No

    Comments/Recommendations:

3. Has the sampling design and sampling strategy been adequately identified? Documentation should include stratification criteria for stratified sampling and selection criteria for selective sampling. ❑Yes ❑No

    Comments/Recommendations:

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4. Have the procedures and results, relative to an assessment of the positional accuracy of the plot data, been documented appropriately? For example if GPS has been used to identify sample plot locations, the type of GPS system and the calibration and correction procedures used, should be documented. ❑Yes ❑No

Comments/Recommendations:

5. Have the procedures, and subsequent results, been documented relative to any validation or evaluation of the field data quality? ❑Yes ❑No

Comments/Recommendations:

Map Entities QA Review Questions:

1. Have the mapping entities been described appropriately, including the characteristics used to recognize the entity type and the criteria used to identify its area extent? ❑Yes ❑No

Comments/Recommendations:

2. Is there an adequate description of how the polygons relate to the mapping entities? For example, are the polygons representations of single mapping entities or groups of mapping entities, or the likelihood of occurence of several possible mapping entities? If a group of mapping entities, is their pattern of distribution part of the attribution of the polygon or inferable from the label? ❑Yes ❑No

Comments/Recommendations:

3. Have the knowledge base input attributes been described appropriately? ❑Yes ❑No

Comments/Recommendations:

4. Have the notation conventions used in field typing and map production been described adequately (i.e., placement of attributes, mapping entities or class designations, modifiers, distribution or composition, etc.)? ❑Yes ❑No

Comments/Recommendations:

Inventory Procedures QA Review Questions:

1. Have the optional field inventory methods and procedures been adequately described and/or referenced? ❑Yes ❑No

Comments/Recommendations:

_____

2. Have the methods and procedures used to delineate map polygons been described, including descriptions of the media used and the rectification methods and standards? ❑Yes ❑No

Comments/Recommendations:

_____

3. Have the procedures used for quality control been documented, including frequency and type of quality control, the attributes or entities checked, and the criteria used to ascertain quality? ❑Yes ❑No

Comments/Recommendations:

_____

4. Have the procedures used for internal quality assurance (accuracy assessment) been documented, including frequency and type of quality control, the attributes or entities checked, and the criteria used to ascertain quality? ❑Yes ❑No

Comments/Recommendations:

_____

_____

Input Data Processing:

1. Have the methods and quality control procedures used to rectify all input layers been documented appropriately? ❑Yes ❑No

Comments/Recommendations:

_____

2. Have the overlay procedures, used to create and attribute the entities predicted by the PEM process, been documented? ❑Yes ❑No

Comments/Recommendations:

_____

3. Have the logic and procedures used to extract, calculate, or derive each attribute for the knowledge base, been documented to level of detail that will allow a subsequent user to duplicate the process? ❑Yes ❑No

Comments/Recommendations:

_____

4. Have the quality control procedures, used to ensure that all data processing adheres to the intended methodology, been outlined? ❑Yes ❑No

Comments/Recommendations:

_____

5. Have the procedures used to estimate or demonstrate the accuracy of the knowledge base attributes been documented? ❑Yes ❑No

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Comments/Recommendations: _____

_____

QA Sign Off: (Please Print)

Name QA Contractor(s)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	
		❑Yes ❑No	
		❑Yes ❑No	

Form P2: Review of Knowledge Base Documentation

Submission #		**Date of Submission**

Project Name

QA Ecologist

QA Bioterrain specialist

QA GIS specialist

PEM Practitioner(s)

Materials to be submitted:

- ❑ Knowledge base documentation and associated tables
- ❑ Field data (xls, dbf or Venus database) if applicable
- ❑ List of mapping entities for each BGC unit

Knowledge Base QA Review Questions:

1. Have all of the entities predicted by the PEM process been fully defined and documented? ❑Yes ❑No

   Comments/Recommendations:

2. Have all of the knowledge base input attributes used in the PEM process been fully defined? Note, attributes to be described must include both those extracted directly and those that have been derived from thematic input data. ❑Yes ❑No

   Comments/Recommendations:

3. Have all of the rules and definitions associated with the knowledge base been documented in detail? All documentation for rule based systems must include all of the information outlined in section 4.7.3.3 of the PEM standard. All documentation for belief matrices must follow the guidelines outlined in section 4.7.3.4 of the PEM standard. ❑Yes ❑No

   Comments/Recommendations:

4. For rule-based systems, is the output from the system compatible with that required in section 4.7.3.3.of the PEM standard? Are the operators consistent with those required by the standard or are they at least defined under the same terms as listed in the PEM standard? ❑Yes ❑No

Comments/Recommendations:

_____

5. For belief matrices, have all of the attribute values and condition sets been clearly   ❏Yes ❏No
    defined? Have all of the assumptions that guided the assignment of attribute
    values to map entities been clearly documented, including any inference
    algorithms used to assignment of condition sets.

    Comments/Recommendations:

    _____

6.   Have the knowledge base and algorithms been validated in accordance with   ❏Yes ❏No
    section 4.6.1 of the PEM standard?

    Comments/Recommendations:

    _____

7.   Have the knowledge base and algorithm validation procedures been documented in   ❏Yes ❏No
    detail? Does the validation data set represent a separate set of data from that used
    in the development of the knowledge base?

    Comments/Recommendations:

    _____

8.   Have the results of the knowledge base and algorithm validation been documented   ❏Yes ❏No
    as indicated in section 4.6.1.2 of the PEM standard? Note the results must include a
    table showing the sample plot number, the predicted class, the observed class, and
    the result.

    Comments/Recommendations:

    _____

Ecosystem Unit QA Review Questions:

Assess each proposed new ecosystem unit relative to the following criteria:

1. Is the proposed new unit supported by field data?   ❏Yes ❏No
2. Given the scale of mapping, is the proposed unit mappable?   ❏Yes ❏No
3.   Can the proposed new unit be represented by any existing units?   ❏Yes ❏No
4.   Is the proposed new mapcode unique within the given subzone (see provincial   ❏Yes ❏No
    mapcodes list)?
5.   Does the proposed new mapcode duplicate any of the sparsely vegetated, non-   ❏Yes ❏No
    vegetated, anthropogenic or generic small scale map units (see provincial mapcodes
    list)?

BGC subzone	Mapcode	Ecosystem Name	Acceptable?	Comments/Recommendations
			❑Yes ❑No	
			❑Yes ❑No	

6. Have all of the new PEM mapping entities units, listed above, been approved by the regional ecologist? This includes any existing site series that have been lumped together for mapping purposes.   ❑Yes ❑No

   Comments/Recommendations:

7. Have all of the new mapcodes, listed above, been approved by the provincial ecologist? This includes any existing site series that have been lumped together for mapping purposes.   ❑Yes ❑No

   Comments/Recommendations:

8. Other: ❑Yes ❑No

   Comments/Recommendations:

QA Sign Off: (Please Print)

Name QA Contractor(s)	Signature	Acceptable?	Review Date
		❑Yes ❑No	
		❑Yes ❑No	
		❑Yes ❑No	

Form P3: Review of Structural Stage Layer

Submission #   **Date of Submission**

Project Name

QA Ecologist

QA Bioterrain specialist

QA GIS specialist

PEM Practitioner(s)

Materials to be submitted by the PEM practitioner:

- ❑ Structural stage knowledge base, input attribute and process documentation and associated tables
- ❑ Structural stage layer spatial file

Structural Stage Layer QA Review Questions:

1. Have all of the structural stages been fully defined and documented?   ❑Yes ❑No

   Comments/Recommendations:

2. Have all of the attributes to describe, characterize, or infer structural stages, been fully defined? Note, attributes to be described must include both those extracted directly and those that have been derived from thematic input data.   ❑Yes ❑No

   Comments/Recommendations:

3. If applicable, have all of the rules and definitions associated with the inference of structural stages, been documented in detail? Any rule based systems or belief matrices associated with the development of the structural stage layer must also be documented in full.   ❑Yes ❑No

   Comments/Recommendations:

4. Have the methods and procedures used in the development of the structural stage layer been documented, along with any quality control procedures and results, if available?   ❑Yes ❑No

   Comments/Recommendations:

5. If applicable, have the logic or inference algorithms used to predict the structural stages, been documented? ❑Yes ❑No

    Comments/Recommendations:

6. Have the structural stage quality control procedures and results, including any validation procedures if applicable, been documented in detail? ❑Yes ❑No

    Comments/Recommendations:

QA Sign Off: (Please Print)

Name QA Contractor(s)	Signature	Acceptable?	Review Date
		❑Yes ❑No	
		❑Yes ❑No	
		❑Yes ❑No	

Form P4: Review of Internal QA Procedures and Results

Submission #		**Date of Submission**	
Project Name			
QA Ecologist			
QA Bioterrain specialist			
QA GIS specialist			
PEM Practitioner(s)			

Materials to be submitted by the PEM practitioner:

❑   QA documentation and associated tables

Internal QA Procedures and Results Review Questions:

2.   Have the QA methods, procedures and results been clearly documented and do they follow the Protocol for Quality Assurance and Accuracy Assessment of Ecosystem Maps (Meidinger, 1999), as outlined in section 4.6.2 of the PEM standard (1999)? Ensure the minimum of a level 1 protocol has been applied to the project area?   ❑Yes ❑No

Comments/Recommendations:

3.   Was the assessment completed after the mapping was completed?   ❑Yes ❑No

Comments/Recommendations:

4   Does the QA sample data set represent a random sample?   ❑Yes ❑No

Comments/Recommendations:

5.   Was the QA sample data set used in the PEM process (i.e., creation of the polygons or their attributes)?   ❑Yes ❑No

Comments/Recommendations:

6.   Do the QA results include a chi-square test of proportions for each of the PEM entities that were assessed?   ❑Yes ❑No

Comments/Recommendations:

7. Do the QA results include an assessment of the percent dominant correct for each of the PEM entities? ❑Yes ❑No

    Comments/Recommendations: _____

    _____

8. Do the QA results include an assessment of the percent overlap for each of the PEM entities? ❑Yes ❑No

    Comments/Recommendations: _____

    _____

9. Do the QA results include an assessment of the percent acceptable overlap for each of the PEM entities? ❑Yes ❑No

    Comments/Recommendations: _____

    _____

QA Sign Off: (Please Print)

Name QA Contractor(s)	Signature	Acceptable?	Review Date
		❑Yes ❑No	
		❑Yes ❑No	
		❑Yes ❑No	

Form P5: Review of Final Deliverables

Submission #   **Date of Submission**

Project Name

QA Ecologist

QA Bioterrain specialist

QA GIS specialist

PEM Practitioner(s)

Materials to be submitted by the PEM practitioner:

☐ Final PEM spatial and nonspatial data in standard format, including spatial plot location files, if applicable.

☐ This is part of the knowledge base metadata required in the next required item

☐ Final typed air photos (if applicable)

☐ Final report, including input data quality assessment, knowledge base, and structural stage documentation

☐ Final VENUS database for GIF and FS882 field plots (field data for visual plots can either be submitted in VENUS format or as a separate Excel file)(if applicable)

☐ Final PEM structural stage layer, knowledge base and documentation

☐ Final PEM knowledge base tables and documentation

☐ Final PEM input data quality assessment documentation

Final Deliverables QA Review Questions:

1. Does the spatial data meet the standards? See the *Quality Assurance guidelines for Predictive Ecosystem Mapping Digital Data capture in B.C. (2001).* ❑Yes ❑No

   Comments/Recommendations:

2. Does the nonspatial data meet the standards? See the *Quality Assurance guidelines for Predictive Ecosystem Mapping Digital Datacapture in B.C. (2001).* ❑Yes ❑No

   Comments/Recommendations:

3. Has all the required plot data been entered into VENUS? Does it pass validation?   ❑Yes   ❑No

    Comments/Recommendations:

4. Have all of the original field plot cards (or copies) been submitted?   ❑Yes   ❑No

    Comments/Recommendations:

5. Have all of the airphotos been submitted (if applicable)?   ❑Yes   ❑No

    Comments/Recommendations:

6. Has the final input data quality assessment report been submitted? Is it acceptable?   ❑Yes   ❑No

    Comments/Recommendations:

7. Has the final report been submitted? Is it acceptable?   ❑Yes   ❑No

    Comments/Recommendations:

8. Has the final knowledge base been submitted, including all relevant documentation? Is it acceptable?   ❑Yes   ❑No

    Comments/Recommendations:

9. Has the final structural stage layer been submitted, including all relevant documentation? Is it acceptable?   ❑Yes   ❑No

    Comments/Recommendations:

Other: ❑Yes   ❑No

    Comments/Recommendations:

QA Sign Off: (Please Print)

Name QA Contractor(s)	Signature	Acceptable?	Review Date
		❑Yes ❑No	
		❑Yes ❑No	
		❑Yes ❑No	

Form P6: QA Summary and Sign-off

This section is intended to track project status relative to the final sign-off of each stage of review. If a hardcopy of this form is maintained, the QA contractor(s) must provide a date and signature once a particular review stage has been deemed complete and acceptable. If this form is submitted electronically, an email message stating acceptance of a particular stage of mapping, must be sent from the QA contractor to the client in lieu of a hardcopy signature. Any additional comments not covered in the forms above should be included at this time. Also, please record the total number of submissions reviewed for each of QA stages in the space provided. Note this form must be submitted in electronic format as part of the QA report (see QA deliverables section) and include any additional sign-off documentation.

Review of Input Data Quality Assessment:

The Input data quality assessment report has been completed to an acceptable standard.

Print Name QA Contractor(s)	Signature	Date
Additional Comments/Recommendations:		

Review of Localized Biogeoclimatic Unit layer:

Typed photos (if applicable), rule sets, spatial databases and associated polygon data base, graphics files of intermediate coverages.

Print Name QA Contractor(s)	Signature	Date
Additional Comments/Recommendations:		

❑ This represents the final signoff, and represents submission number ___of___ submissions received for the localized BGC review stage.

Review of Knowledge Base:

Print Name QA Contractor(s)	Signature	Date
Additional Comments/Recommendations:		

❑ This represents the final signoff, and represents submission number ___of___ submissions received for the knowledge base stage.

Review of Structural Stage Layer:

Print Name QA Contractor(s)	Signature	Date
Additional Comments/Recommendations:		

❑ This represents the final signoff, and represents submission number ___of___ submissions received for the structural stage layer and associated knowledge base.

Review of Digital PEM Data (spatial and non-spatial):

The spatial and non-spatial data stage has been completed to an acceptable standard.

Print Name QA Contractor(s)	Signature	Date
Additional Comments/Recommendations:		

❑ This represents the final signoff, and represents submission number ___of___ submissions received for the review of the digital PEM data (spatial and non-spatial).

Review of Final Deliverables:

The project metadata stage has been completed to an acceptable standard.

Print Name QA Contractor(s)	Signature	Date
Additional Comments/Recommendations:	

❑ This represents the final signoff, and represents submission number ___of___ submissions received for the review of the final PEM deliverables.

Appendix A: Guideline for Contract Development – PEM QA

MEMORANDUM OF AGREEMENT
Made *month/day/year*

BETWEEN

<organization receiving final deliverables - paying for services>, hereafter referred to as the **"Client or Client Group"**

AND

<organization completing Quality Assurance of PEM final deliverables)>, hereafter collectively referred to as the **"QA Group"**

Whereas the Client requires Quality Assurance (not an Accuracy Assessment) of their project "Predictive Ecosystem Mapping", which is being completed by *<the mapping contractor hired by Client Group>*, hereafter referred to as the "**Consultant**".

Whereas the QA Group has the responsibility of reviewing the quality of data to be warehoused by the Province.

Now, therefore, this Agreement witnesses that in consideration of the mutual promises hereafter set out, the Parties agree as follows:

1. PURPOSE

The predictive ecosystem map displays a hierarchy of ecosystem units including: Ecosections, Biogeoclimatic Subzone/Variant, Site Series, certain Site Modifiers, and (optionally) Terrain Attributes. Application of prescribed standards results in ecosystem spatial data linked to a polygon database, a separate structural stage spatial database linked to its polygon database, and for point locations of ground samples, a spatial database linked to its point attribute database. This is supported by extensive meta data on the input data sets, the 'knowledge base" (KB), the algorithm (inferencing element) that applies the KB to the assembled input inventories to derive the ecosystem outputs. The expertise required for this project includes a plant ecologist and a GIS/data base specialist. If bioterrain or select terrain attributes are used as an input, a bioterrain specialist is required to participate in the QA process, and where Wildlife Habitat Ratings are derived a wildlife biologist is required. A review procedure is required for Bioterrain, Predictive Ecosystem Mapping (PEM), Terrestrial Ecosystem Mapping (TEM) and for Wildlife Habitat Rating (WHR) components of the project. This agreement outlines the requirements for conducting Quality Assurance of those components.

2. OBLIGATIONS OF THE PARTIES

Obligations of the Client

The Client will provide funding to enable the QA Group to proceed with Quality Assurance (QA) of the Predictive Ecosystem Mapping for the study area: *<study area and project boundary>* This agreement may include the wages and benefits of staff, and consulting fees, where aspects of the work are sub-contracted by the QA Group. Funds will be limited to a maximum of *$<total dollar amount of agreement>*. The Client has provided direction to the Consultant *<<the mapping contractor hired by Client Group>*. on the schedule for deliverables. Further details on QA services, QA reports, and payments are outlined in Schedules A and B below.

The Client will ensure that the Consultant will complete the PEM work and will provide the deliverables to the QA Group in a timely fashion, according to a schedule agreed upon by the Client and Consultant. The Client will notify the QA Group of any changes to the delivery schedule. Deliverables will include:

- PEM Mapping Entities (proposed new site units or lumped units);

- Initial PEM Input Data Quality (IDQ) Assessment Report;

- Initial PEM Knowledge Base (first iteration) for review;

- Initial PEM Map Entities (Site Mapcodes);

- Initial PEM Structural Stage Knowledge Base;

- Initial PEM Localized BGC Input Data Preparation and Evaluation

- Final PEM Project Meta Data and final IDQ report;

- Final PEM Additional Meta Data (non-R.I.C. data, if required);

- Final PEM Knowledge Base, including list of Final Map and Mapping Entities;

- Final PEM Attribute Database(s);

- Final PEM Spatial File(s);

- Final PEM Structural Stage Knowledge Base;

- Final PEM Structural Stage Attribute database(s);

- Final PEM Structural Stage Spatial File(s);

- Final Sample Point Data Files (VENUS or GRAVITI or .xls);

- Final Sample Point Data Spatial Files; and

- *< add additional project specific deliverables>*

Obligations of the QA Group

The QA Group will undertake Quality Assurance of all relevant stages of the project, and will ensure a timely delivery of all reviews, as outlined in Schedule A "Terms of Work". The QA Group agrees to report on each Quality Review within *15 working days* of receipt of a given set of deliverables.

3.   ACTIVITIES TO BE UNDERTAKEN BY THE QA GROUP

Schedule A describes the activities to be undertaken by the QA Group in detail. Schedule B sets out financial considerations.

4.   DURATION

This Agreement shall bind the Parties for the period beginning on the date of signing and ending on *<mmm-dd-yyyy>*

5.   TERMINATION

Either the Client or the QA Group may terminate this Agreement on one (1) month written notice to the other Parties to this Agreement.

6.   AMENDMENTS

This Agreement may be amended. Any amendment to this Agreement shall be in writing and signed by all Parties. Any significant changes in the project (I.e. cost, scope, timing, etc…) must be made through formal amendment to this Agreement.

7.   ENTIRE AGREEMENT

This Memorandum of Agreement, along with the Terms of Work for the Client's PEM and the any other schedules and appendices to this agreement, shall constitute the entire and sole Agreement between the Parties and shall supersede all other communications, negotiations, arrangements and agreements of any nature between them prior to the date of this Agreement.

IN WITNESS WHEREOF the Parties have executed this Agreement on the day of the completion of signing of the Agreement.

FOR: *< organization receiving final deliverables - paying for services>* **(Client Group)**

FOR: *< organization receiving final deliverables - paying for services>* **(Client Group)**

_____

Signature

_____

Signature

_____

Date (mon-dd-yyyy)

_____

Witness

Date (mon-dd-yyyy) _____

Witness _____

FOR: *<organization completing Quality Assurance of PEM final deliverables)>,*

FOR: *<organization completing Quality Assurance of PEM final deliverables)>,*

_____

Signature

_____

Signature

_____

Date (mon-dd-yyyy)

_____

Date (mon-dd-yyyy)

_____

Witness

_____

Witness

SCHEDULE A:

PREDICTIVE ECOSYSTEM MAPPING QUALITY ASSURANCE - TERMS OF WORK

DEFINITIONS

In this document, acronyms and words have the following meanings:

(a) **BEC** means Biogeoclimatic Ecosystem Classification
(b) **Bioterrain** means terrain mapping to support PEM
(c) **BGC** means Biogeoclimatic (subzone, variant, phase)
(d) **Client** means *<organization receiving final deliverables - paying for services>* (Client Group)
(e) **Consultant** means the mapping contractor hired by *Client Group.*
(f) **GIS** means Geographic Information System
(g) **KB** means knowledge base
(h) **Location** means the *<area of study and project boundary>*
(i) **MSRM** means Ministry of Sustainable Resource Management
(j) **MoF** means Ministry of Forests
(k) **PEM** means Predictive Ecosystem Mapping
(l) **Province** means Ministry of Sustainable Resource Management and/or Ministry of Forests
(m) **QA** means Quality Assurance
(n) **QA Group** means *<organization completing Quality Assurance of PEM final deliverables)>*
(o) **QA Guidelines** refers to the Quality Assurance Guidelines for PEM and PEM Digital Data Capture, as well as all other associated QA guideline documentation
(p) **RIC** means Resources Inventory Committee
(q) **TEM** means Terrestrial Ecosystem Mapping
(r) **TIB** means Terrestrial Information Branch
(s) **TRIM** means Terrain Resource Information Management
(t) **WHR** means Wildlife Habitat Ratings

OVERVIEW OF SERVICES

Upon completion of each Quality Review, the responsible agency will prepare and deliver a QA summary report to the Client and Consultant, as outlined in the QA Guidelines.

a) QA Group *(QA Ecologist <if necessary add additional project specific QA specialists {for example bioterrain}>)* will undertake Quality Review #1 – Input Data Quality Assessment Report;

b) QA Group *(QA Ecologist)* to coordinate the MoF *(Regional Ecologist)* Quality Review #2a – Localized BGC and #2b – Mapping Entities, and ensure MoF approval;

c) QA Group *(QA Ecologist)* to coordinate the MSRM *(Provincial Correlator)* Quality Review #3 – Map Entities (Site Mapcode), and ensure MSRM approval;

d)   QA Group *(QA Ecologist)* to coordinate the MoF *(Regional Ecologist)* Quality Review #4 - Proposed knowledge base and preliminary KB reliability report, and ensure MoF approval;

e)   QA Group *(Ecologist / GIS QA)* will undertake Quality Review #5 – Project Completion (metadata, final report and final project spatial and non-spatial data - including field data/plots); and

The QA Group shall:

1.   Provide Quality Assurance review following the Quality Assurance procedures outlined in the Quality Assurance Guidelines. See the **<(location to be determined or attach as schedule ##)>**

2.   Ensure that the Services are carried out in accordance with the technical standards set out in the edition of the following documents and that was the most up-to-date at the time the contract between the Client and the Consultant was signed:

- *Standards For Predictive Ecosystem Mapping – Inventory Standard* (1999) RIC, Terrestrial Ecosystems Mapping Alternatives Task Force;

- *Standards For Predictive Ecosystem Mapping – Digital Data Capture In British Columbia.* Version 1.0 (2000) RIC, Terrestrial Ecosystems Mapping Alternatives Task Force;

- *Standard for Terrestrial Ecosystem Mapping in British Columbia.* Ecosystems Working group, Terrestrial Ecosystems Task Force, Resources Inventory Committee, May 1998;

- *Standards For Terrestrial Ecosystem Mapping – Digital Data Capture In British Columbia.* Version 3.0. 2000. RIC, Ecosystems Working Group;

- *Digital Terrestrial Ecosystem Mapping (TEM) and Wildlife Habitat Ratings (WHR) Data Capture in (DC) User's Guide.* 1999 RIC, Ecosystem Working Group;

- *Digital Terrestrial Ecosystem Mapping (TEM) and Wildlife Habitat Ratings (WHR) Data Capture and Ratings Table* Application;

- *Standard for Digital Terrain Data Capture in British Columbia.* Terrain Technical Standard & Database Manual. June, 1998 Version 1. Resources Inventory Committee;

- Howes, D.E. and E. Kenk. 1997. *Terrain Classification System for British Columbia. Revised Edition.* Manual 10. B.C. Ministry of Environment, Lands, and Parks. Victoria, B.C.;

- *Ecosystem Field Forms* FS882 (1-7). 1998. Province of B.C;

- VENUS Version 5.0. (2001). RIC Ecosystems Working Group;

- *Provincial Site Series Mapping Codes and Typical Environmental Conditions.* RIC, Ecosystems Working Group;

- *Field Manual for Describing Terrestrial Ecosystems.* 1998. Land Management Handbook No. 25. BC Ministry of Environment, Lands, and Parks and Ministry of Forests. Victoria, B.C.;

- Douglas, G.W., G.B. Straley, and D. Meidinger. 1989, 90, 91, 94. *The Vascular Plants of British Columbia.* Parts 1-4. Special Report Series Nos. 1-4. Research Branch, B.C. Ministry of Forests. Victoria, B.C.;

- *British Columbia Wildlife Habitat Rating Standards.* Version 2.0 1999. RIC Ecosystems Working Group;

- [Standard for Wildlife Habitat Rating (WHR) Digital Data Capture in British Columbia –](http://) *Digital Data Capture In British Columbia.* [Version 1.0](http://). 2000. Wildlife Interpretations Subcommittee, Resources Inventory Committee; and

- *Wildlife Habitat Ratings (WHR)* Mapping Tool (WHR103.avx).

    Note: RIC documents are available in regional Ministry libraries and on the RIC website (http://www.for.gov.bc.ca/ric/standards.htm).

Predictive Ecosystem Mapping documents are available through the TEM alternatives website (http://www.for.gov.bc.ca/research/temalt/).

Ministry of Forests publications are available through Ministry of Forests representatives and, in some cases, on the Ministry of Forests website. (http://www.for.gov.bc.ca/).

Terrestrial Ecosystem Mapping documents and support tools are available through the TEM website (http://www.elp.gov.bc.ca/rib/wis/tem)

Wildlife Habitat Ratings documents and support tools are available through the TEM website (http://www.elp.gov.bc.ca/rib/wis/whr)

All other listed materials are available through the regional MSRM library.

DELIVERABLES

The QA Group shall deliver **2 copies** of the following to the Client (required documentation is outlined in QA guidelines):

1. A report on the quality of the Consultant's Input data quality assessment report. The Consultant's preliminary deliverable to the Client (IND.RTF) will be included in the final INP.RTF file.

2. A report on the quality of the Consultant's spatial and database files of Biogeoclimatic linework and intermediate coverages that were required to produce that linework (BGC.e00), the associated polygon attributes (BGC.CSV) and the rule sets (Knowledge Base) that was used to generate that linework (BGC.RTF) AND a report on the quality of the preliminary listing of the mapping entities to be predicted, including proposed project-specific entities.

3. A report on the proposed Map Entities (Site Mapcodes)

4. A report on the first iteration of the knowledge base. This interim deliverable (KBD.RTF) from the Consultant will be included in the final KNB.RTF file.

5. A report on the quality of the final deliverables for the Predictive Ecosystem Mapping and Terrestrial Ecosystem Mapping projects – including: project metadata database file(s), attribute database(s), spatial file(s), plot locations and a final project reports from the Consultant that should include a description of the study area and the project objectives.

6. *<if necessary add additional project specific deliverables>*

Upon acceptance of the final PEM deliverables from the Consultant, the QA Group will delivery all final QA reports, as per the QA Guidelines, to the Client. The Client will then delivery all final PEM and PEM QA deliverables, in standard format, to the province. The province will post all project files, including both PEM and PEM QA deliverables, to the Provincial Data Warehouse and associated FTP site.

SCHEDULE B

This Agreement is subject to the terms agreed upon between the Client and the QA Group.

1) The Client agrees, subject to the terms and conditions of this Agreement, to pay all eligible costs that are incurred by the QA Group for the activities described in this Agreement, up to a maximum of *$ (excluding GST) - $ (QA cost) and $ (contingency)*.

2) The payment schedule will be based upon the agreed upon figures below and payments made upon completion of significant milestones as outlined below.

The QA Group: *<total # person days>*, *$<dollar amount>*.

> QA Ecologist: *<# person days>*, *$<dollar amount>*.
> *<other QA specialist>: <# person days>*, *$<dollar amount>*.
>> Quality Review #1 – Input Data Quality Assessment Report;
>
> QA Ecologist: *<# person days>*, *$<dollar amount>*.
>> coordinate Quality Review #2a – Localized BGC and #2b – Map and Mapping Entities, and ensure MoF approval;
>
> QA Ecologist: *<# person days>*, *$<dollar amount>*.
>> coordinate Quality Review #3 – Map Entities (Site Mapcode), and ensure MSRM approval;
>
> QA Ecologist: *<# person days>*, *$<dollar amount>*.
>> coordinate Quality Review #4 - Proposed knowledge base, and ensure MoF approval;
>
> Ecologist : *<# person days>*, *$<dollar amount>*.
> GIS QA: *<# person days>*, *$<dollar amount>*.
> *<other QA specialist>: <# person days>*, *$<dollar amount>*.
>> Quality Review #5 – Project Completion (metadata, final report and final project spatial and non-spatial data - including field data/plots); and

NOTE: Additional funds required for **travel for field QA** or **Accuracy Assessment** are **not** recorded in this document. Contact Client Project Monitor for this information. Add applicable QA specialists for additional project specific deliverables.

3) Contingency funds for the project limited to *$<dollar amount>*

4) The QA Group agrees that the payments referred to above shall be applied to the following expenditures:
- Salaries and professional services contracts;

5) The QA Group shall provide with claim for payment, a report outlining expenses incurred and a progress report.

6) Within the limits of the aforementioned terms, the Client agrees to pay the QA Group as follows:
- Invoices from the QA Group must be accompanied by notification of successful completion of Quality Review reports 1 through 5.
- Quality Review reports will be communicated to the Client upon completion of each review.
- Payment to the QA Group should be addressed to:

  <organization>

  <address>

  <city, province>

  <postal code>

  <phone>

  <fax>

  <e-mail>

- Cheques are to be made payable to the *<organization completing Quality Assurance of PEM final deliverables)>,*

7) All invoices or requests for payment should be sent to:

  Client Project Monitor:

  <organization>

  <address>

  <city, province>

  <postal code>

  <phone>

  <fax>

  <e-mail>

8) The QA Group agrees to keep proper accounts and records of the revenues and expenditures for the subject matter of the Agreement:

9) The QA Group shall provide the Quality Assurance Services within **15 working days** of receipt of the Consultant's deliverables or within **15 working days** of agreed upon delivery date (as per schedule outlined below).

10) If the QA work is not completed within **15 working days** of receiving deliverables, the Client reserves the right to withhold part of or all of the relevant payment in Schedule B.

11) If the QA work is not completed within **15 working days** of receiving deliverables, due to the Consultant failing to produce satisfactory products, it is the responsibility of the QA Group to notify the client of the problem. The QA Group will not be held responsible and all of the relevant payment outlined in Schedule B would be due, unless otherwise agreed to.

It is the Client 's responsibility to notify the QA Group of any deviations from the following schedule (Table II):

Table II: Submission Schedule

Service/Deliverable	Delivered by:
Localized BGC units	mmm-dd-yyyy
Initial Input data quality assessment report, including plots of spatial feature control shift	mmm-dd-yyyy
Proposed Mapping Entities	mmm-dd-yyyy
Initial Knowledge Base and its reliability report, including required revisions to procedures and schedule	mmm-dd-yyyy
Proposed Map Entities (Site Mapcodes)	mmm-dd-yyyy
Final Knowledge Base	mmm-dd-yyyy
Final Structural Stage: Knowledge Base and Attribute and Spatial file(s)	mmm-dd-yyyy
Final Input Data Quality Report and Database	mmm-dd-yyyy
Final Metadata (standard and non-standard) Report(s) and Database(s)	mmm-dd-yyyy
Final Attribute and Spatial file(s)	mmm-dd-yyyy

The QA Group shall provide the Services outlined in this agreement and in accordance with the schedule listed above (Table II).

Quality Reviews

Quality reviews will be made upon completion of the following tasks and submission of the associated deliverables:

⇒ **Quality Review #1**
Input data quality assessment report.

⇒ **Quality Review #2a and 2b**
Proposed localized BGC and mapping entities.

⇒ **Quality Review #3**
Map Entities (Site Mapcode) approval

⇒ **Quality Review #4**
Proposed knowledge base and preliminary KB reliability report.

⇒ **Quality Review # 5**
Project Completion: metadata, attribute database(s), spatial file(s) and final report.

MINISTRY CONTACTS

All localized BGC, mapping entities, and proposed knowledge base inquiries shall be directed to the:

MoF Regional Ecologist:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>

All inquiries regarding RISC standards and/or QA Guidelines shall be directed to the MSRM Representative. All PEM map entity coding requests shall be directed to the ecology correlator.

Ecology Correlator:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>

QA GROUP CONTACTS

QA Ecologist:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>

GIS/Spatial QA:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>

Database/Non-spatial QA:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>

<other QA specialists>:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>

CLIENT CONTACTS

Client Project Monitor:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>

CONSULTANTS CONTACTS

Consultant Project Coordinator:

<organization>

<address>

<city, province>

<postal code>

<phone>

<fax>

<e-mail>