



PROJECT TITLE: **WARI 1801 – CEMENT ALTERNATIVES**

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THIS REPORT:

**RECOMMENDED LABORATORY QUALIFICATION CRITERIA
FOR CHEMICAL CEMENT ALTERNATIVE TESTING PROTOCOLS**

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EXECUTIVE SUMMARY

Following the identification and summary of Chemical Cement Alternative testing protocols as captured in previously submitted Report-01 and the recommended procedures per protocol in Report-02 as well as the development of acceptance criteria in Report-03, this Report-04 focuses on the development of the criteria for approving laboratories for Chemical Cement Alternative Testing in Alberta.

In executing Work Package 5, Wilkie Enterprises reviewed current industry practice, ISO 9001:2015 and ISO 17025:2005 to select acceptance criteria. The justification is contained in this Report-04.

Upon acceptance of the laboratory testing criteria by PTAC and the AER, the format for a Laboratory Approval Certificate and Approval Letter will be developed.

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INTRODUCTION

Wilkie Enterprises was contracted by PTAC to deliver the following:

- Identify, approach Stakeholders and develop standardized testing protocols for the approval of Chemical Cement Alternatives in the Province of Alberta
- Deliver a roadmap, complete with capable vendors and industry partners, to provide an achievable, repeatable, consistent testing process for Chemical Cement Alternatives.

The detailed scope of work comprises the following work packages:

Work Package	The Work
1	Verify current Chemical Cement Alternative protocols used by the major industry Stakeholders in Alberta
2	Research and identify Chemical Cement Alternative testing protocols used in the oil and gas industry of other provinces and major international markets
3	Review all identified protocols and recommend (and justify) standardised testing for each protocol based on: a) Industry best practice b) Test duration for each protocol c) Cost Estimate for each protocol
4	Upon review of all of the above information, recommend (and justify) a standard value for each property, where applicable, for all identified protocols
5	Propose criteria for approving laboratories for Chemical Cement Alternative protocols testing (if non-existent)
6	Identify and evaluate laboratories or facilities for conducting Chemical Cement Alternative protocol testing
7	Propose a list of "Approved Laboratories" for the above testing protocols
8	Propose a format for test reporting to the AER
9	Develop and submit Final Report

Table 1: Work Packages

Having submitted Report #1 through #3 that covered the work in Work Packages 1 to 4, this report covers the work done in Work Package 5.

In executing Work Package 5, Wilkie Enterprises reviewed all the recommended procedures and acceptance criteria captured in Report #3 and identified suitable criteria for qualifying laboratories in Alberta capable of conducting qualification activities for the following protocols:

- I. Safety and Toxicology during storage, handling and transportation
- II. Leaching toxicity
- III. Groundwater protection
- IV. Field Pilot
- V. Bonding to casing, cement and formation
- VI. Effects of products on the wellbore (i.e. corrosion, limits wellbore access, etc.)
- VII. Longevity of the product in wellbore conditions with evidence supporting the expected longevity
- VIII. Product integrity under anticipated adverse conditions (example interaction with H₂S or diesel products)
- IX. Field deployment verification

METHODOLOGY FOR WORK PACKAGE 5

Work Package 5: **Proposed Criteria for Accepting Laboratories for Chemical Cement Alternative Protocol Testing**

Work Package Objective

To provide standard criteria for approving laboratories for Chemical Cement Alternative protocol testing in Alberta.

Recommended Acceptance Criteria

Following a review of current industry practice, ISO 9001:2015 and ISO 17025:2005, the following criteria are recommended as the basis for qualifying a laboratory to meet the above stated objective.

- 1) The laboratory is not owned, promoted or is an affiliate with a specific type of Chemical Cement Alternative or Oil Well Cement manufacturer or seller.
- 2) A valid Provincially or Federally Certified Safety Management System
- 3) Permit to Practice engineering or geoscience from the Association of Professional Engineers and Geoscientists of Alberta (APEGA) or the Association of Science and Engineering Technology Professionals of Alberta (ASET)
- 4) ISO 9001:2015 Quality Management Systems -- Requirements
- 5) The process for conducting each test procedure from Attachment 1A to 1J within the laboratory's capability
- 6) List of equipment and facilities provided by the laboratories for conducting the testing procedures listed in Attachment 1A to 1J
- 7) Equipment Calibration Program in accordance with Provincial Requirements of Alberta
- 8) Ability to develop non-standardised testing procedures if required
- 9) List of personnel capable of executing the procedures and operating the equipment
- 10) Certification validating personnel as being able to operate the equipment pertaining to each procedure

Justification for Recommended Acceptance Criteria

The Acceptance Criteria were selected from current industry practice, ISO 9001:2015 and ISO 17025:2005 in accordance with the recommendation from the document titled "Recommended Practice Technology Qualification DNVGL-RP-A203" by Det Norske Veritas GL, a global quality assurance and risk management company.

Inspection Team

- 1) The Inspection Team for visiting a laboratory in Alberta to qualify it for Chemical Cement Alternative protocol testing shall comprise of a Lead Inspector with a minimum of one other Inspector.
- 2) The Lead Inspector shall have a minimum of fifteen (15) years cementing experience from the wellsite, office-based well engineering roles, laboratories and/or cement manufacturing plants. While the accompanying Inspector can have a lower years of experience.

Approval Certificate

- 1) To be issued to a laboratory stating only protocols they have capability to satisfactorily handle.
- 2) Details of the protocols approved for the laboratory shall be outlined in a letter accompanying the Approval Certificate.
- 3) An Approval Certificate shall be valid for 36 months only from date of issue.

INSPECTION REPORT FORMAT

Approval Form for Chemical Cement Alternative Protocol Testing Laboratories in Alberta

1	Inspection Date	
2	Inspectors	Lead Inspector:
		Inspector:
		Inspector:

The Laboratory

1	Laboratory Name	
2	Laboratory Address	
3	Contact Phone Number	
4	Contact Email	
5	Contact Person	

The Laboratory Inspection

	Inspection	Items	Remarks
1	Laboratory Certificate of Incorporation	Registration #:	
		Date:	
2	Valid Laboratory APEGA or ASET Permit to Practice	Permit #:	
		Expiry Date:	
3	Laboratory relationship with any Chemical Cement Alternative manufacturer		
4	Certificate of Recognition (COR) – Alberta Occupational Health and Safety	Certificate #:	
		Certificate Issuer:	
		Date Issued:	
		Expiration Date:	
5	ISO 9001:2015 Certified	Certificate #:	
		Certificate Issuer:	
		Date Issued:	
		Expiration Date:	
6	List of Procedures per Chemical Cement Alternative this Laboratory can handle	See Attachments 1A - 1J	
7	List of Equipment Per Procedure	See Attachments 1A - 1J	
8	List of Equipment Calibration Certificates	See Attachments 1A - 1J	
9	List of Personnel and Relevant Certification	Attachment 2	

The Inspection Result (delete one)

All criteria for approving this Laboratory for conducting Chemical Cement Alternative Protocol Testing in Alberta has been met. **Or** The following gaps have been identified and will have to be addressed for a follow-up inspection. See attached summary sheet of the gaps supported by Attachments 1A to 1J and Attachment 2.

Report Signed by Lead Inspector:

Name: _____

Signature: _____

Date: _____

Attachment 1A: List of Procedures, Equipment, Current Calibration Certificate for Modified Cements/ceramics (non-setting)

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedures		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-A-001	Section 8.2.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V	Diffusion coefficient	CCA-A-002	Not required				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-A-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-A-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-A-005	API RP 10B-5 ring test				
V, VI	Hardened	CCA-A-006	API RP 10B-5 ring test				
Shrinkage							
V, VI	During hardening	CCA-A-007	API RP 10B-5 ring test				
V, VI	Hardened	CCA-A-008	API RP 10B-5 ring test				
V, VI	Differential thermal expansion	CCA-A-009	ASTM E228				
V, VI, VII	creep	CCA-A-010	ASTM C512-10				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-A-0011	Not required				
VII	Cohesion	CCA-A-0012	Not required				
VII	Poisson's ratio	CCA-A-0013	Not required				
VII	Internal friction angle	CCA-A-0014	Not required				
VII	Hydrostatic compressive yield	CCA-A-0015	Not required				
VII	UCS	CCA-A-0016	API RP 10B-2				
VII	Tensile strength	CCA-A-0017	ASTM C496				
VII	Elastic modulus	CCA-A-0018	ASTM C469				
VII	Hardness	CCA-A-0019	ASTM E384				
OTHER							
V, VII	Shear bond strength	CCA-A-0020	See Section 8.6 of "Guidelines on Qualification of Materials for the Abandonment of				

			Wells" [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-A-0021	Not required				
VII	Decomposition temperature	CCA-A-0022	Not required				
II	Density	CCA-A-0023	ASTM C 138				
V, VI, VII	Stress relaxation	CCA-A-0024	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-A-0025	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-A-0026	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-A-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1B: List of Procedures, Equipment, Current Calibration Certificate for Grouts

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-B-001	Section 8.2.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V	Diffusion coefficient	CCA-B-002	Not required				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-B-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-B-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-B-005	Not required				
V, VI	Hardened	CCA-B-006	Not required				
Shrinkage							
V, VI	During hardening	CCA-B-007	Not required				
V, VI	Hardened	CCA-B-008	Non – identified				
V, VI	Differential thermal expansion	CCA-B-009	ASTM E228				
V, VI, VII	creep	CCA-B-010	Not required				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-B-0011	Not required				
VII	Cohesion	CCA-B-0012	Not required				
VII	Poisson's ratio	CCA-B-0013	Not required				
VII	Internal friction angle	CCA-B-0014	Not required				
VII	Hydrostatic compressive yield	CCA-B-0015	Not required				
VII	UCS	CCA-B-0016	Not required				
VII	Tensile strength	CCA-B-0017	Not required				
VII	Elastic modulus	CCA-B-0018	Not required				
VII	Hardness	CCA-B-0019	Not required				
OTHER							
V, VII	Shear bond strength	CCA-B-0020	See Section 8.6 of "Guidelines on Qualification				

			of Materials for the Abandonment of Wells” [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-B-0021	Not required				
VII	Decomposition temperature	CCA-B-0022	Not required				
II	Density	CCA-B-0023	Pressurized mud balance				
V, VI, VII	Stress relaxation	CCA-B-0024	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-B-0025	'See Section 8.10 of “Guidelines on Qualification of Materials for the Abandonment of Wells” [1]				
IV, IX	Function Test	CCA-B-0026	As identified in Appendix 8 performed by Shell Global Solutions in “Guidelines of the Qualification of Materials Used in the Abandonment of Wells” [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-B-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1C: List of Procedures, Equipment, Current Calibration Certificate for Thermosetting Polymers and Composites

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-C-001	Not required				
V	Diffusion coefficient	CCA-C-002	See section 8.2.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-C-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-C-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-C-005	See section 8.4.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-C-006	See section 8.4.1 of [1]				
Shrinkage							
V, VI	During hardening	CCA-C-007	See section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-C-008	See section 8.4.2 of [1]				
V, VI	Differential thermal expansion	CCA-C-009	ASTM E228				
V, VI, VII	creep	CCA-C-010	ISO 899-1				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-C-0011	Not required				
VII	Cohesion	CCA-C-0012	Not required				
VII	Poisson's ratio	CCA-C-0013	Not required				
VII	Internal friction angle	CCA-C-0014	Not required				
VII	Hydrostatic compressive yield	CCA-C-0015	Not required				

VII	UCS	CCA-C-0016	API RP 10B-2 or API 10 A [2] or ASTM D695 [3](GA, USA),				
VII	Tensile strength	CCA-C-0017	ISO 527-1 or ASTM D638 [3]				
VII	Elastic modulus	CCA-C-0018	ISO 527-1 or API 10 A [2] or ASTM D638 [3]				
VII	Hardness	CCA-C-0019	See section 8.4.2 of [1]				
OTHER							
V, VII	Shear bond strength	CCA-C-0020	See Section 8.6 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-C-0021	Not required				
VII	Decomposition temperature	CCA-C-0022	TGA/DTA/DSC measurement				
II	Density	CCA-C-0023	ISO 1183-1				
V, VI, VII	Stress relaxation	CCA-C-0024	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-C-0025	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-C-0026	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-C-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1D: List of Procedures, Equipment, Current Calibration Certificate for Thermoplastic Polymers and Composites

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Current Equipment Calibration Certificate
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-D-001	Not required				
V	Diffusion coefficient	CCA-D-002	See section 8.2.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-D-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-D-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-D-005	See section 8.4.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-D-006	See section 8.4.1 of [1]				
Shrinkage							
V, VI	During hardening	CCA-D-007	See section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-D-008	See section 8.4.2 of [1]				
V, VI	Differential thermal expansion	CCA-D-009	ASTM E228				
V, VI, VII	creep	CCA-D-010	ISO 899-1				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-D-0011	Not required				
VII	Cohesion	CCA-D-0012	Not required				
VII	Poisson's ratio	CCA-D-0013	Not required				
VII	Internal friction angle	CCA-D-0014	Not required				
VII	Hydrostatic compressive yield	CCA-D-0015	Not required				
VII	UCS	CCA-D-0016	ISO 604				
VII	Tensile strength	CCA-D-0017	ISO 527-1				
VII	Elastic modulus	CCA-D-0018	ISO 527-1				

VII	Hardness	CCA-D-0019	ISO 868				
OTHER							
V, VII	Shear bond strength	CCA-D-0020	See Section 8.6 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-D-0021	Not required				
VII	Decomposition temperature	CCA-D-0022	TGA/DTA/DSC measurement				
II	Density	CCA-D-0023	ISO 1183-1				
V, VI, VII	Stress relaxation	CCA-D-0024	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-D-0025	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-D-0026	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-D-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1E: List of Procedures, Equipment, Current Calibration Certificate for Elastomeric Polymers and Composites

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-E-001	Not required				
V	Diffusion coefficient	CCA-E-002	See section 8.2.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-E-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-E-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-E-005	See section 8.4.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-E-006	See section 8.4.1 of [1]				
Shrinkage							
V, VI	During hardening	CCA-E-007	See section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-E-008	See section 8.4.2 of [1]				
V, VI	Differential thermal expansion	CCA-E-009	ASTM E228				
V, VI, VII	creep	CCA-E-010	ISO 899-1 / ASTM D395				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-E-0011	Not required				
VII	Cohesion	CCA-E-0012	Not required				
VII	Poisson's ratio	CCA-E-0013	ISRM suggested method				
VII	Internal friction angle	CCA-E-0014	Not required				
VII	Hydrostatic compressive yield	CCA-E-0015	Not required				
VII	UCS	CCA-E-0016	BS EN ISO 604				
VII	Tensile strength	CCA-E-0017	BS EN ISO 527-1				
VII	Elastic modulus	CCA-E-0018	BS EN ISO 527-1				

VII	Hardness	CCA-E-0019	ISO 868				
OTHER							
V, VII	Shear bond strength	CCA-E-0020	See Section 8.6 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-E-0021	Not required				
VII	Decomposition temperature	CCA-E-0022	TGA/DTA/DSC measurement				
II	Density	CCA-E-0023	ISO 1183-1				
V, VI, VII	Stress relaxation	CCA-E-0024	ASTM D395 and NORSOK M710				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-E-0025	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-E-0026	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-E-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1F: List of Procedures, Equipment, Current Calibration Certificate for Formation

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-F-001	See Section 8.2.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V	Diffusion coefficient	CCA-F-002	Not required				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-F-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-F-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-F-005	Not required				
V, VI	Hardened	CCA-F-006	ISRM suggested method				
Shrinkage							
V, VI	During hardening	CCA-F-007	Not required				
V, VI	Hardened	CCA-F-008	ISRM suggested method				
V, VI	Differential thermal expansion	CCA-F-009	ASTM E228				
V, VI, VII	creep	CCA-F-010	ASTM C512-10				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-F-0011	ISRM suggested method				
VII	Cohesion	CCA-F-0012	ISRM suggested method				
VII	Poisson's ratio	CCA-F-0013	ISRM suggested method				
VII	Internal friction angle	CCA-F-0014	ISRM suggested method				
VII	Hydrostatic compressive yield	CCA-F-0015	ISRM suggested method				
VII	UCS	CCA-F-0016	ISRM suggested method				
VII	Tensile strength	CCA-F-0017	ASTM C496				
VII	Elastic modulus	CCA-F-0018	ASTM C469				
VII	Hardness	CCA-F-0019	Not required				
OTHER							
V, VII	Shear bond strength	CCA-F-0020	Not required				
V, VII	Tensile bond strength	CCA-F-0021	Not required				
VII	Decomposition temperature	CCA-F-0022	Not required				

II	Density	CCA-F-0023	Not required				
V, VI, VII	Stress relaxation	CCA-F-0024	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-F-0025	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-F-0026	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-F-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1G: List of Procedures, Equipment, Current Calibration Certificate for Gels

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-G-001	See Section 8.2.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V	Diffusion coefficient	CCA-G-002	See Section 8.2.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-G-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-G-004	Absorption index				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-G-005	Not required				
V, VI	Hardened	CCA-G-006	Not required				
Shrinkage							
V, VI	During hardening	CCA-G-007	See Section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells"				
V, VI	Hardened	CCA-G-008	See Section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells"				
V, VI	Differential thermal expansion	CCA-G-009	ASTM E228				
V, VI, VII	creep	CCA-G-010	Not required				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-G-0011	Not required				
VII	Cohesion	CCA-G-0012	Not required				

VII	Poisson's ratio	CCA-G-0013	Not required				
VII	Internal friction angle	CCA-G-0014	Not required				
VII	Hydrostatic compressive yield	CCA-G-0015	Not required				
VII	UCS	CCA-G-0016	Not required				
VII	Tensile strength	CCA-G-0017	Not required				
VII	Elastic modulus	CCA-G-0018	Not required				
VII	Hardness	CCA-G-0019	Not required				
OTHER							
VI	Corrosion	CCA-G-0020	API Recommended Practice 13B-1.				
V, VII	Shear bond strength	CCA-G-0021	See Section 8.6 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-G-0022	Not required				
VII	Decomposition temperature	CCA-G-0023	TGA / DTA / DSC				
II	Density	CCA-G-0024	Not required				
V, VI, VII	Stress relaxation	CCA-G-0025	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-G-0026	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-G-0027	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-G-0028	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1H: List of Procedures, Equipment, Current Calibration Certificate for Glass

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-H-001	Not required				
V	Diffusion coefficient	CCA-H-002	Not required				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-H-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-H-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-H-005	See Section 8.4.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-H-006	See Section 8.4.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
Shrinkage							
V, VI	During hardening	CCA-H-007	See Section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-H-008	See Section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Differential thermal expansion	CCA-H-009	ASTM E228, may need to investigate thermal shock				
V, VI, VII	creep	CCA-H-010	Not required				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-H-0011	Not required				
VII	Cohesion	CCA-H-0012	Not required				
VII	Poisson's ratio	CCA-H-0013	Not required				
VII	Internal friction angle	CCA-H-0014	Not required				
VII	Hydrostatic compressive yield	CCA-H-0015	Not required				

VII	UCS	CCA-H-0016	API RP 10B-2				
VII	Tensile strength	CCA-H-0017	Not required				
VII	Elastic modulus	CCA-H-0018	ASTM C469				
VII	Hardness	CCA-H-0019	ASTM E384				
OTHER							
V, VII	Shear bond strength	CCA-H-0020	See Section 8.6 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-H-0021	Not required				
VII	Decomposition temperature	CCA-H-0022	Not required				
II	Density	CCA-H-0023	ASTM C138				
V, VI, VII	Stress relaxation	CCA-H-0024	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-H-0025	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-H-0026	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-H-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 11: List of Procedures, Equipment, Current Calibration Certificate for Metals

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-I-001	Not required				
V	Diffusion coefficient	CCA-I-002	Not required				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-I-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-I-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-I-005	See Section 8.4.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Hardened	CCA-I-006	See Section 8.4.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
Shrinkage							
V, VI	During hardening	CCA-I-007	See Section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1], may need to investigate thermal shock				
V, VI	Hardened	CCA-I-008	See Section 8.4.2 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V, VI	Differential thermal expansion	CCA-I-009	ASTM E228				
V, VI, VII	creep	CCA-I-010	ISO 204				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-I-0011	ISRM suggested method				
VII	Cohesion	CCA-I-0012	Not required				
VII	Poisson's ratio	CCA-I-0013	ISRM suggested method (triaxial) or ASTM E1876				

VII	Internal friction angle	CCA-I-0014	Not required				
VII	Hydrostatic compressive yield	CCA-I-0015	ISRM suggested method				
VII	UCS	CCA-I-0016	ASTM E9				
VII	Tensile strength	CCA-I-0017	ISO 6892-1				
VII	Elastic modulus	CCA-I-0018	ISO 3312 or ASTM E9				
VII	Hardness	CCA-I-0019	ASTM E18, ASTM E10 or ASTM E384				
OTHER							
VI	Corrosion	CCA-I-0020	ISO 1516/NACE MR0175				
V, VII	Shear bond strength	CCA-I-0021	See Section 8.6 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1], recommended that substrate rugosity measurements done as per ASTM D7172				
V, VII	Tensile bond strength	CCA-I-0022	Not required				
VII	Decomposition temperature	CCA-I-0023	TGA/DTA/DSC measurement				
II	Density	CCA-I-0024	ISO 3369				
V, VI, VII	Stress relaxation	CCA-I-0025	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-I-0026	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-I-0027	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-I-0028	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 1J: List of Procedures, Equipment, Current Calibration Certificate for Modified in-situ materials

Subject (Applicable Protocol #)	Property	Procedure Code #	Test Procedure		Does the Alternative Procedure meet Recommended Test Requirements	Applicable Equipment	Equipment Calibration Certificate # & Expiry Date
			Recommended Test Procedures	Alternative Procedures Used by the Laboratory			
PERMEATION TESTING							
V	Nitrogen Permeability	CCA-J-001	See Section 8.2.1 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
V	Diffusion coefficient	CCA-J-002	Not required				
INTERACTION WITH FLUID							
II, VIII	Dry Mass	CCA-J-003	Measurement of mass after drying to constant mass at 105°C				
V, VI	Absorption	CCA-J-004	Not required				
DIMENSIONAL STABILITY							
Expansion/Swelling							
V, VI	During hardening	CCA-J-005	Not required				
V, VI	Hardened	CCA-J-006	ISRM suggested method				
Shrinkage							
V, VI	During hardening	CCA-J-007	Not required				
V, VI	Hardened	CCA-J-008	ISRM suggested method				
V, VI	Differential thermal expansion	CCA-J-009	ASTM E228				
V, VI, VII	creep	CCA-J-010	ASTM C512-10				
MECHANICAL TESTING							
VII	Triaxial testing	CCA-J-0011	ISRM suggested method				
VII	Cohesion	CCA-J-0012	ISRM suggested method				
VII	Poisson's ratio	CCA-J-0013	ISRM suggested method				
VII	Internal friction angle	CCA-J-0014	ISRM suggested method				
VII	Hydrostatic compressive yield	CCA-J-0015	ISRM suggested method				
VII	UCS	CCA-J-0016	ISRM suggested method				
VII	Tensile strength	CCA-J-0017	ASTM C496				
VII	Elastic modulus	CCA-J-0018	ASTM C469				
VII	Hardness	CCA-J-0019	Not required				
OTHER							
V, VII	Shear bond strength	CCA-J-0020	Not required				
V, VII	Tensile bond strength	CCA-J-0021	Not required				
VII	Decomposition temperature	CCA-J-0022	Not required				

II	Density	CCA-J-0023	Not required				
V, VI, VII	Stress relaxation	CCA-J-0024	Not required				
VIII	Ageing Testing (i.e. Product integrity under anticipated adverse conditions such as H2S or diesel products)	CCA-J-0025	'See Section 8.10 of "Guidelines on Qualification of Materials for the Abandonment of Wells" [1]				
IV, IX	Function Test	CCA-J-0026	As identified in Appendix 8 performed by Shell Global Solutions in "Guidelines of the Qualification of Materials Used in the Abandonment of Wells" [1]. See also lines 291-299 of same document.				
II, III	Leaching Toxicity	CCA-J-0027	AER accepted modified US EPA 1311 procedure for leachate testing of Chemical Cement Alternatives				

Attachment 2: List of Personnel and Relevant Qualification

	Equipment as Per Attachment 1A-1J	Operator's Name	Relevant Certification
1		1)	1)
		2)	2)
		3)	3)
2		1)	1)
		2)	2)
		3)	3)
3		1)	1)
		2)	2)
		3)	3)
4		1)	1)
		2)	2)
		3)	3).
5		1)	1)
		2)	2)
		3)	3)
6		1)	1)
		2)	2)
		3)	3)
7		1)	1)
		2)	2)
		3)	3)
8		1)	1)
		2)	2)
		3)	3)
9		1)	1)
		2)	2)
		3)	3)
10		1)	1)
		2)	2)
		3)	3)

NEXT MILESTONE DELIVERABLES

As per the contract, the next Milestone is to complete Work Package 6, 7 and 8 by May 31st, 2019. The objective of the next Work Packages are:

1. To identify and evaluate laboratories or facilities for conducting Chemical Cement Alternative protocol testing (for non-AER approved labs)
2. To propose a list of “AER Accepted Laboratories” for the above testing protocols.
3. To propose a format for test reporting to the AER

SCHEDULE "A" MILESTONE AND INVOICING SCHEDULE

Payment Milestones	Work Package	Proposed Completion Date	Actual Completion Date				Anticipated Completion Date	
1. Meetings with Stakeholders and development of categories and protocols required per category.	1	Nov 30, 2018	Jan 31, 2019					
2. Develop list of current Chemical Cement Alternative protocols per category in Alberta	1	Dec 31, 2018	Jan 31, 2019					
3. Develop list of current Chemical Cement Alternative protocols per category outside Alberta	2	Jan 31, 2019	Jan 31, 2019					
4. Propose best practice protocols	3	Feb 28, 2019		Feb 28, 2019				
5. Propose standard value per property (where applicable)	4	Mar 31, 2019			Mar 31, 2019			
6. Develop criteria for approving of laboratories for Chemical Cement Alternative testing	5	Apr 30, 2019				Apr 30, 2019		
7.								
8. Develop list of "Approved Laboratories" for testing protocols	6 & 7	May 31, 2019					May 31, 2019	
9. Provide format for test reporting to the AER	8	May 31, 2019					May 31, 2019	
10. Final Report	9	Jun 30, 2019						Jun 30, 2019

Table 2: Milestones and Work Packages Schedule

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