



# OPERATIONS PROGRAM FOR

Well Name/UWI  
LIC #

## PROGRAM BUSINESS DRIVER

### DEADLINE FOR OPERATIONS (if applicable)

Approvals	Title	Signature/Date
Prepared by:	_____	_____
Approval 1:	_____	_____
Approval 2:	_____	_____
Approval 3:	_____	_____
Approval 4:	_____	_____

**When conducting work**

- ✓ Plan
- ✓ Prepare
- ✓ Execute

**Any change from the plan**

- ✓ Involve the right people
- ✓ Reassess
- ✓ Mitigate
- ✓ Proceed



ANY CIRCUMSTANCE DURING THE COURSE OF OPERATIONS THAT WOULD INVOLVE EXECUTING PROGRAM STEPS IN WHICH THERE ARE NO DOCUMENTED AND APPROVED CNRL PROGRAM STEPS AVAILABLE ON LOCATION WOULD CONSTITUTE A SCOPE CHANGE. IN THIS SITUATION THE WELLSITE SUPERVISOR WILL CONTACT HIS IMMEDIATE SUPERVISOR AS SOON AS PRACTICAL WHOM WILL ACTIVATE SCOPE CHANGE PROTOCOL.



**Well Name:** ARROWHEAD O-38  
**UWI:** 300/O-38-60.40-122.45/00  
**License #:** WID1983  
**Field:** FT LIARD (5501)  
**Profile:** Directional  
**Zone:** Slave Point  
**Class:** Level I

**OBJECTIVE:** Abandon non-compliant wellbore to OROGO regulations.

1. Test for SCVF/GM.
2. Remove BPV from tubing hanger.
3. MIRU Slickline. Recover hook wall plug / slip stop.
4. Pressure test tubing / FSG plug in ON/OFF profile. Run replacement plug if required.
5. MIRU Service Rig and associated services.
6. Release ON/OFF from PERM packer. Pull production equipment.
7. MIRU Wireline. RIH and set Permanent Bridge Plug @ 2197 mKB.
8. Pressure Test Casing to 7 MPa for 10 minutes.
9. Perform radial cement bond log from new PBSD depth to surface.
10. Cap BP with minimum 30 metres (620 litres) cement circulated into place.
11. Circulate well to fresh water.
12. Based on cement evaluation; perform remedial cementing of identified porous zones as required.
13. Test for SCVF/GM.
14. Cut and Cap well.

AREA CONTACTS			
OROGO	24-hour incident reporting		(867) 445-8551
Abandonment Superintendent	Dale Duffy Dale.Duffy@cnrl.com	Mobile	(403) 512-7803
		Work	(587) 955-0442
Abandonment Engineer	Logan Simmonds Logan.Simmonds@cnrl.com	Mobile	(403)-554-4288
		Work	(403) 386-8984
Abandonment Manager	James Ireland James.Ireland@cnrl.com	Mobile	(780)-872-4169
		Work	(403) 386-5955
Area Foreman	Bill Muss Bill.Muss@cnrl.com	Mobile	(780) 835-1872
		Work	(780) 835-7577
Safety Coordinator	Brent Cote Brent.Cote@cnrl.com	Mobile	(250) 261 8999
		Work	(250) 263 6474
Area Landman	Donna Poitras Donna.Poitras@cnrl.com	Mobile	(250) 261-1590
		Work	(250) 263-6464

## **SAFETY & ENVIRONMENT**

All operations must comply with Canadian Natural Resources Limited's Management Systems. These include, but are not limited to; Safety Management System, Emergency Management, Asset Integrity, Security, Technical Safety and Environmental Protection programs. These systems are in place to assess hazards, mitigate risk and ensure that the effects from an emergency are minimized through the activation of Emergency Response Plans. These systems have been submitted to OROGO as part of the Operations Authorization application.

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## **REGULATORY**

- All work is completed under the existing Operations Authorization for the Fort Liard Region OA-2018-005-CNRL and well specific ACW-2019-013-CNRL-O-38-WID1983.
- All applicable regulations, including, but not limited to the well specific OROGO ACW approval, OROGO Well Suspension and Abandonment Guidelines, Oil and Gas Occupational Safety and Health Regulations (NWT) and Occupational Health and Safety (OHS) Regulations (NWT) are to be strictly adhered to.
- All verbal notifications and approvals from government regulatory agencies will be recorded on CNRL's daily report tour sheet. The name of the individual contacted and the subject matter of approval or notification should be recorded on same.
- CNRL shall provide all staff and contractors for this program with the OROGO 24-hour incident reporting phone number ((867) 445-8551) prior to commencing any work or activity.
- CNRL shall submit to OROGO an updated operator contact list for this program prior to any work or activity by email at [orogo@gov.nt.ca](mailto:orogo@gov.nt.ca).
- CNRL shall submit to OROGO certificates and inspection documents for any service rig, well control and associated equipment (including boilers) at least 10 days prior to the rig commencing work by e mail at [orogo@gov.nt.ca](mailto:orogo@gov.nt.ca).
- CNRL shall submit to OROGO all reports required under the Oil and Gas Drilling and Production Regulations in a timely manner to OROGO by email at [orogo@gov.nt.ca](mailto:orogo@gov.nt.ca).
- CNRL shall submit to OROGO, completed Change of Well Status form 30 days after the service rig release date or when the abandonment operation has been finished by email at [orogo@gov.nt.ca](mailto:orogo@gov.nt.ca).

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## PROCEDURES

1. Ensure the Regulations, Safety & Compliance Expectations (for Completions & Abandonments) document (April 2019) is reviewed, discussed and adhered to by all lease personnel prior to the start of any operations. Follow all requirements and guidelines outlined in the document (see Appendix 1).
2. Ensure that you are on the right well. Confirm location using well co-ordinates. If you are not sure, check with the area foreman. Document all calls.
3. Ensure that you have a Hazard Assessment issued to the Development Operations Canadian Natural representative to determine the site hazards and control measures. Confirm the method of isolation and lockout/tag out. Reference CNRL SMS procedure 6.44. Work must not begin until this is completed.
4. Ensure that you have a copy of the CORPORATE ERP. Contact the area safety coordinator and area foreman prior to commencing operations to discuss the ERP in the event of an unplanned release.
5. Perform a walk around lease inspection/hazard identification prior to any equipment entering the lease.
6. Hold a pre-job safety meeting with all lease personnel prior to any operations and again prior to any critical operations. Ensure all personnel have received CNRL orientation. Confirm that all services have a job specific JSA with hazards and controls for each task to be carried out. Confirm all personnel know where to find the transportation of injured worker documentation. Review all Hazard Assessments and if applicable, discuss the ERP. Ensure proper safety measures are adhered to as per CNRL and all applicable regulatory body guidelines.
7. Conduct atmospheric testing following CNRL SMS Procedure 5.06. The well has been classified as a Level I well based on gas compositional analysis available (H<sub>2</sub>S = 123 ppm). Ensure that the Exposure Control Plan (ECP) for H<sub>2</sub>S products is in place if required (see Appendix 1 for the form to be filled out).
8. Review the expected H<sub>2</sub>S concentration of open zones, as documented on the program schematic. Obtain the H<sub>2</sub>S concentration of the wellbore. Refer to CNRL SMS Procedure 5.04 or 5.05 if testing is not being conducted by a service provider with appropriate procedures.
9. Record SITP & SICP as per SMS 21.16. Compare to program schematic. If pressures are significantly different, communicate results to Calgary.
10. Confirm if a SCV assembly is installed. Review historical SCVF test results as documented on the program schematic. Complete a 10 minute bubble test (minimum) for SCVF. If flow is detected (and not previously identified), contact Calgary for further direction on testing. Document a flow rate if possible (bubbles per minute).  
**Note:** A surface casing vent flow test must be completed and entered into WellView on every well.
11. Inspect and confirm the wellhead size and pressure rating. Confirm the pressure rating of the production casing flange.

12. If identified in the Hazard Assessment; perform NORM contamination readings on all wellhead, piping and equipment prior to removal. Ensure to enter Geiger-Müller counter reading results into daily WellView reports. Refer to CNRL's handling of NORM Contaminated Tubing, Wellhead and Piping Procedure.

13. **Move in Wellhead Crew. Install and pressure test lubricator as required. Remove BPV.**

**Contingency: This step can be performed with the service rig on location, prior to or after installation of Service Rig BOP's.**

14. *Steps 22 – 26, Rig-less slickline operations, can be completed prior to service rig operations.*

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### **SERVICE RIG OPERATIONS**

15. Review Well Details found in Program Schematic. Discuss and confirm the services required with CNRL Abandonment Superintendent. Note tubing connections and thread specifications, ensure proper tubing equipment is on site to remove the string. A workstring should be available if required.

16. Move in and spot all necessary auxiliary services for Service Rig operations as per CNRL and all regulatory requirements. Ensure proper regulatory equipment spacing is in place, or if necessary; a spacing exemption has been granted.

17. Ensure adequate volumes of fresh water are on site for well kill operations and filling the casing after the bridge plug is set. Refer to program schematic for hole volumes, tubular capacities and reservoir parameters.

**Note:** Refer to H2S ECP regarding the need for H2S scavenger. IF scavenger is required refer to chemical provider for mixing ratios and ensure adequate scavenger is onsite.

18. Move in and rig up service rig and its associated equipment as per CNRL and all regulatory requirements. Conduct a service rig inspection if one has not been completed within the last 30 days. Hold a safety & procedures meeting with all personnel on-site. Record inspection & safety meeting on tour book & daily report. Bring any deficiencies to Calgary's immediate attention.

19. Pressure test pumping surface lines to 1.4 MPa; and to the lesser of the formation pressure or the wellhead pressure rating for ten minutes each.

20. Pressure test casing with fresh water to 7 MPa for 10 minutes. All pressure tests must include documentation in daily report of initial and final pressures, as well as the duration (time) of the stabilized test. Bleed off casing pressure.

21. Install a 35 MPa Class III BOP system consisting of blind rams, pipe rams and an annular preventer as follows:

- i) Stump test Class III BOP system. Pressure test each ram preventer, full opening safety valve, pump manifold and all lines to 1,400 kPa for 10 minutes (low test). Pressure test again to the lesser of formation pressure or wellhead pressure rating (high test).
- ii) Pressure test the annular preventer to the formation pressure or 7,000 kPa (whichever is less).

- iii) Perform flow checks, ND top section of wellhead. Confirm lifting threads, BPV type and inspect tubing hanger for signs of scale, if present test for NORMS. Install lifting pup and stabbing valve. Strip on BOPs and pressure test all connections to 1,400 kPa for 10 minutes (low test). Pressure test again to the lesser of formation pressure or wellhead pressure rating (high test).
  - iv) Ensure that all pressure tests are recorded in WellView.
22. **Move in and rig up a Slickline unit for operations as per CNRL and applicable regulatory body requirements. Conduct an equipment Inspection & hold a Safety & Procedures Meeting w/ all Personnel On-Site. Record Inspection and Safety Meeting in Tour Book & Daily Report.**
23. **Install BOP's and lubricator onto service rig BOP's as per IRP 13. P/T as required by regulatory body. Ensure the lubricator is purged with N2 after ever run. Breathing air must be worn when breaking integrity / removing the lubricator.**
24. Review schematic for wellbore restrictions and tubing dimensions. Equalize lubricator with N2 to prevent hydrates for all runs. Roundtrip gauge ring(s) to ensure the tubing is free of restrictions and to locate hook wall plug. Confirm depth(s). Note any additional tagging or tight sections in wellbore. If necessary roundtrip a broaching tool to clear any minor tubing obstructions. If the tools come back to surface with scale collect a sample to be sent for analysis and contact Abandonment Superintendent for further directions.
25. Review well pressures. RIH with retrieving tool. Ensure pressure is equalized across the plug. Retrieve hook wall plug and slip stop set @ 128 mCF. Monitor well response. Rig out Slickline after well is confirmed dead.
26. Bleed off any gas head to the test vessel and flare stack. Rig in pump lines to pressure test the tubing with fresh water to 7 MPa for 10 minutes. All pressure tests must include documentation in daily report of initial and final pressures, as well as the duration (time) of the stabilized test. Bleed off pressure to the test vessel and flare stack.
- Contingency:** If tubing pressure test fails use Slickline to recover existing tubing plug and to install a new tubing plug to isolate the bottom hole pressure at the packer and allow the release of the ON/OFF tool above the packer.
27. Unseat hanger and release ON/OFF overshot from permanent packer. Monitor well response. If the well does not remain dead contact CNRL Abandonment Superintendent. Analyze the well response and select the appropriate kill procedure as per WSBOP Initial Kill – Considerations & Procedures. Bleed off any pressure to the test vessel and flare stack. Use fresh water to kill the well circulating to the test vessel as necessary.
- Contingency:** If unable to release ON/OFF from packer then confirm free point and cut tubing directly above ON/OFF. Consult with OROGO operations before cutting.
28. POOH downhole equipment. Visually inspect the tubing string as it is pulled for scale, corrosion, etc. If the condition is adequate then use as workstring. If scale on the outside of the tubing is observed then test for NORMS. Confirm with CNRL Abandonment Superintendent if a scraper run is required based on the equipment and well conditions observed. Wellsite observations supersede the below note.

**Note:** A review of the well history and current wellbore configuration (packer / inhibited water) indicate additional conditioning of the casing (scraper run) is not required.

**Note:** Trickle fresh water down casing for metal displacement as necessary for well control.

29. MIRU Wireline services as per CNRL and applicable regulatory body requirements. Conduct an equipment Inspection & hold a Safety & Procedures Meeting w/ all Personnel On-Site. Record Inspection and Safety Meeting in Tour Book & Daily Report.

30. Function test BOP's. Install BOP's and lubricator onto wellhead. P/T as required by regulatory body. Ensure the lubricator is purged with N2 after ever run. Breathing air must be worn when breaking integrity / removing the lubricator.

31. Round trip gauge ring to setting depth. Note any restrictions or tight sections and consult with Superintendent if a scraper run is required.

32. Confirm casing size. Tally and RIH 177.8 mm 10K permanent bridge plug, setting tool and GR/CCL on wireline. RIH to setting depth. Correlate to 2003-02-25 packer setting record log.

33. Set the bridge plug COE at 2197 mKB. Avoid setting the plug in a casing collar. If the plug setting depth is within two metres of a casing collar contact the Abandonment Superintendent before setting the plug.

**Contingency:** If tubing was cut above ON/OFF as contingency then set bridge plug within 1 metre of cut tubing top.

34. Pressure test bridge plug and casing with fresh water to a stabilized pressure of 7 MPa for 10 minutes. All pressure tests must include documentation in daily report of initial and final pressures, as well as the duration (time) of the stabilized test.

**Contingency:** If pressure test fails RIH with a double grip packer to pressure test the bridge plug and locate any casing failures.

Casing failures are to be abandoned as per OROGO Well Suspension and Abandonment Guidelines and Interpretation Notes section 6A – Downhole Abandonment Requirements.

35. Run in hole Radial Cement Evaluation Logging toolstring. Correlate on depth to the openhole GR log. Log the following intervals:

#### **PBTD – Surface**

36. RIH with tubing workstring. Land tubing directly above bridge plug. Batch mix a minimum 620 litres of thermal cement utilizing a small batch mixer. Pump 0.5 m3 fresh water spacer ahead of the cement slurry. Pump the cement slurry into the tubing. Circulate the cement into place above the bridge plug with 9.8 m3 fresh water to cap the bridge plug with a minimum 30 vertical metres of cement. Once cement is volumetrically circulated into place then slowly pull tubing joints to the theoretical cement top.

**Note:** Calculations based on 88.9 mm workstring. Confirm all calculations with CNRL Abandonment Superintendent before proceeding.

37. Circulate wellbore over to fresh water above cement.
  38. Submit cement evaluation logs to Calgary and OROGO for review. If all porous intervals as listed in the Abandonment Requirements document are covered or isolated by cement then continue to STEP 39. If there are porous intervals which are not isolated above or below the BGW then follow the remedial cementing procedures as outlined in Appendix 2. Repeat as necessary to isolate all porous intervals before proceeding to STEP 39.
  39. Lay down tubing workstring. Top up well with fresh water and ensure fluid level is between 2 – 5 metres from surface for freeze protection.
  40. Remove BOP's. Make up and secure wellhead.
  41. Rig out service rig and release all services. Ensure the lease has been cleaned to its prior state.
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### **CUT & CAP**

42. **Confirm with Abandonment Superintendent that all abandonment requirements as per the regulations have been completed. If there are no signs of SCVF, GM or fluid influx then Cut and Cap well as per OROGO Well Suspension and Abandonment Guidelines and Interpretation Notes section 6E – Surface Abandonment Requirements.**



# **APPENDIX 1**

1. General:

- a. Canadian Natural encourages and stresses the importance of safety in its operations. It is the responsibility of CNRL's Wellsite supervisors and service providers to adhere to, Canadian Natural's safety management system (SMS), provincial Acts & Regulations, industry recommended practices (IRP's), and CNRL's approved/authenticated well program.
- b. Safety and protection of the personnel, public, environment & assets are of paramount importance during all phases of the well program. They shall be the overriding consideration in matters relating to operations.
- c. It is the responsibility of the wellsite supervisor to ensure an approved (signed) or authenticated (stamped) well program is on site before the starting of a job. No operations can be started without the approved/authenticated well program.
- d. All personnel on location have the right to implement CNRL's Code 99 Policy which states "We are obligated to refuse unsafe, uneconomical & unready work". It is our expectation of the wellsite supervisor to inform all onsite workers that it is their responsibility and/or obligation to refuse unsafe, uneconomical and/or unready work

2. CNRL Safety Management System (SMS):

- a. Safety Excellence: safety at Canadian Natural IS FRONT LINE DRIVEN and every person is responsible for his or her own safety, as well as the people around them.
- b. As a wellsite supervisor we must hold people accountable to follow processes, procedures, polices, guidelines, and standards. ZERO TOLERANCE FOR NON-ADHERENCE.
- c. NO WORK CAN START UNTIL CNRL's 4 PILLARS ARE COMPLETE
  - Worker Orientations
  - Canadian Natural's Hazard Assessment
  - Service Provider Hazard Assessment / Job Safety Analysis (JSA)
  - Transportation of injured worker & evacuation plan
- d. New or revised hazard assessments will be completed throughout the job with changing operations to ensure all personnel on location are aware of the new potential hazards and controls required to execute the job safely.
- e. It is the Wellsite Supervisors responsibility to review the CNRL Hazard Assessment and re-complete as needed to account for changing operations. The Hazard Assessment must be acknowledged by all service providers and any applicable procedures/JSA's reviewed. If the contractors believe that any action/procedure within the completion program or change request contravenes their own policies or procedures then they must bring this to the attention of the CNRL Wellsite Supervisor immediately.
- f. The Wellsite Supervisor is responsible to ensure that the equipment provided is appropriate to the work being done and adequately maintained.
- g. The Wellsite Supervisor will ensure regular safety meetings and equipment inspections are conducted and documented in Wellview. These meetings are to be held at the beginning of each program, shift changes, prior to critical elements with the program (i.e pressure testing, etc) and/or as conditions warrant. The safety meeting must include all involved personnel on site to ensure familiarity with the job, their duties, job hazards, pressure limitations, ERP, and safety procedures.
- h. All service providers must supply SDS's for all controlled products. The SDS and a ECP (exposure control plan) must be reviewed by all applicable workers prior to the use of the product.

3. Well Program & Change Requests:

- a. A well program contains approved (signed) or authenticated (stamped) procedures to complete an objective in a safe and efficient manner, while maintaining regulatory requirements. There may be circumstances the approved or authenticated procedures have to be deviated from during the execution phase of the well. Any change or deviation from the approved or authenticated procedures shall be discussed, documented, and approved or authenticated using the change request form to ensure that

- changes do not compromise worker & public safety, the environment, regulatory requirements or capital efficiency.
- b. Depending on the change or deviation from the well program a pause in the execution might be required as per CNRL's Code 99 policy which states "We are obligated to refuse unsafe, uneconomical and/or unready work".
  - c. All changes or deviations from the approved or authenticated well program **MUST** be documented using the Change Request Form.
  - d. The request for change can be initiated by the Wellsite Supervisor, Completions Supervisor, Superintendent, Engineer, or Programmer.
  - e. It is the Superintendent/Completion Supervisor's responsibility to ensure the required approvals are complete and the appropriate personnel are included in the final distribution.
  - f. It is the Wellsite Supervisors responsibility to review the CNRL Hazard Assessment and re-complete to account for changes to program.
4. Response to APEGA Authentication Requirements (Q42018) – Drilling, completions, Well Servicing & abandonments:
- a. Our group's prepare documents (well programs) to guide Wellsite Supervisors on how to execute proposed operations while conforming to regulatory requirements (Directives), while executing utilizing best practices (IRP's) and identifying steps to execute using optimized practices (Equipment selection, tool selection) based on operational experience and utilization of applicable safety procedures (SMS Procedures).
  - b. The well programs prepared are therefore procedures based on a compilation of Regulatory Requirements and Service Provider designs, and are within the design/operating envelope of the equipment for the intended use. Therefore these documents are not authenticated (Stamped); but they are always reviewed and approved (signed) by prescribed levels of technical input & support.
  - c. Documents **WILL** be authenticated when direction given specifically requests crews to exceed design/operating envelope of equipment.
    - This will require the identification and authentication of the critical elements (exceedances) within the program.
    - Final authentication will be done with appropriate peer review, and not borne by any single individual.
  - d. All well programs that deviate due to technical challenges or major scope changes will be identified in the Learning Events section within the CNRL Wellview reporting system, and/or the Change Request system. This will be subject to an end-of-well audit to ensure that the above validation processes were utilized.
  - e. All workers are to be aware of maximum operating pressures and equipment limits as part of the site Hazard Assessment process. Through the operational use of equipment, components may have reduced integrity (tubulars, wellheads, etc.) where failure can occur prior to reaching original design limits. There must be an awareness and risk of equipment degradation due to operating life/conditions. These risks are to be communicated and reviewed during appropriate safety meetings. When pressure testing or applying loads to equipment, personnel shall be limited in the identified "danger" zones to only those required as per service provider requirements.
5. Supporting Emergency Services:
- All wellsite operations must provide onsite Emergency support services as required by provincial OHS regulation. Below are a summary of requirements. For additional details a table can be found in the Canadian Natural Employee Guide to Safety and Compliance (CNRL-OVR-PRG-LM-000018) for each province.
- a. ETV (Emergency Transfer vehicle)
    - All locations farther than (BC 20 minutes, Alta 40 minutes, Sask/MB 30 Minutes) by land vehicle under normal driving conditions from a 24-hour Health Care Facility or Emergency Medical Service shall have an Emergency Transport Vehicle (ETV).
  - b. First Aid services:

- A first aid attendant and a shower unit are required onsite during acid pumping operations.
  - In B.C. a first aid attendant is required if more than 10 workers are on location at one time.
  - In Alberta a first aid attendant is required if more than 50 workers on location.
- c. Fire protection requirements for flammable fluids when there is: (Frac only, Methanol, etc.)
- One (1) fluid tank (63 m3) on location - One continuous foam unit with on board water supply is required.
  - Two to four (2-4) fluid tanks (63 m3) on location - One continuous foam unit with a 15.8 m3 water truck is required.
  - Five or more fluid tanks (63 m3) on location two continuous foam units with two 15.8 m3 water truck is required.
  - Additional fire suppression resources may be required to provide for equipment protection. Review regulation and service provider requirements,
- d. H2S protection
- Reference: CNQ-OVR-PRG-LM-000009 CODE OF PRACTICE HYDROGEN SULFIDE (H2S)
  - A fit test to the breathing apparatus for all identified rescue personnel on location must be done by the Safety Company and documented.
  - It is expected that a breathing apparatus is used during any integrity break on surface, i.e fluid testing, offloading fluids, etc.
  - When working on wells with continuous H2S levels over 100 PPM air trailer and safety supervisor are required. In addition the work area must be monitored for low level H2S by personal monitor, fixed station or portable monitor.
6. Exposure Control Plans (ECP)
- a. CNQ-OVR-PRG-LM-000015 CODE OF PRACTICE SILICA DUST
  - b. CNQ-OVR-PRG-LM-000009 CODE OF PRACTICE HYDROGEN SULFIDE (H2S)
  - c. CNQ-OVR-PRG-LM-000002 CODE OF PRACTICE BENZENE
7. Flaring Gas (Directive 60):
- a. Ensure that all AER D60 flaring requirements are followed. If allotted flowing times and/or volumes are expected to be exceeded, notify the regulator and all residents within the alert area 24 hours in advance. Send the completed copy of both the regulator and the public notification forms to the Calgary office.
  - b. When possible all gas produced during the clean-up operations should be flowed inline to minimize the flaring volumes.
  - c. During the fire season, please contact Wildlife Management at 780-723-8507 before commencement of all flaring of gas.
  - d. Sour Gas Flaring:
    - When circulating to kill, bleeding off or flowing wells with H2S concentrations over 10 PPM gas must be flared.
    - A flare stack that has a minimum height of 12 meters is required for H2S concentrations over 100ppm.
    - An air effluent dispersion model must be conducted for SO2 concentration levels to determine flare stack height, flare rate and volume limitations for concentration over 10,000ppm (1%)
    - The AER requires a flaring permit for H2S concentrations over 50,000ppm (5%) unless flaring under the low rate, low volume exemption. (This is the same requirement for flaring approval in BC)
8. Working with potential Explosive Mixture & Ignition: (IRP 18 or Directive 33):
- a. Canadian Natural will safely manage the potential for explosive mixtures and ignition sources as part of our overall well control and blowout prevention plans during well service and completion operations.

- b. It is the responsibility of the Canadian Natural Wellsite Supervisor to initiate the following steps prior to proceeding with well servicing or completion operations.
- Ensure Canadian Natural's - Hazard Assessment has been completed.
  - Check the location for potential hazardous vapor releases prior to rigging up. (Reference the Canadian Natural's – Hazard Assessment / Procedure for Hazardous Vapors.)
  - Ensure the well program or task is reviewed and available.
  - Ensure the Fire & Explosion Prevention Plan form has been filled out and reviewed with the area Superintendent.
  - The service provider's hazard assessment, JSA or procedures must include the possible creation of a flammable or explosive environment by:
    - introduction of air to the well bore
    - increased pressure or temperature within the well bore
    - introduction of oxidizing chemicals into the well bore
    - release of hydrocarbon onto the worksite
    - identify the possible ignition sources
- “A control must be in place for each of the above hazards.”**
9. Ground Disturbance:
- a. Reference: CNQ-OVR-PRG-LM-000006 CODE OF PRACTICE GROUND DISTURBANCE
  - b. Prior to the commencement of any excavation operations, or installation of rig anchors, CNRL'S GROUND DISTURBANCE GUIDE & PERMIT must be fulfilled.
  - c. Rig anchor locations MUST be approved by CNRL's wellsite supervisor prior to installation.
10. Pulling Tubing Conveyed Perforating or Wireline Conveyed Perforating Guns:
- a. Perforating systems are to be considered live, until confirmed by a certified blaster to be safe.
  - b. When pulling TCP above BOP it is important that there are only a **maximum of two workers** on around the work floor (Operator & Rig Supervisor). All unessential workers will position themselves a minimum of 50.0m from work floor.
  - c. A licensed blaster **must** be present for the deployment or retrieval of a perforating system from a well bore.
  - d. Detonation bars should be recovered immediately after being dropped when there are existing perforations in the well. The bar should also be removed if the TCP will be left in the well for an extended period of time.
11. N.O.R.M. Management:
- a. Reference: CODE OF PRACTICE NATURALLY OCURRING RADIOACTIVE MATERIAL (N.O.R.M)
  - b. Naturally Occurring Radioactive Material (N.O.R.M) has been recognized as a potential hazard in the petroleum industry. CNRL's Code of Practice is the guiding reference for the safe handling of N.O.R.M by all employees and contractors.
  - c. Prior to starting work on any well, the wellsite supervisor must assess the potential hazard of N.O.R.M by checking with the local Production Foreman and the Area Safety & Compliance Coordinator for prior field or well history.
  - d. All wells suspecting of potential N.O.R.M hazards should be surveyed by the Area Safety & Compliance Coordinator or other qualified personnel.
    - Wells at high risk of N.O.R.M. are low permeability formations such as Montney, as well as formations with significant water production and/or scale.
  - e. All personnel handling potential N.O.R.M contaminated equipment must be protected by using the proper Personal Protective Equipment (PPE) as specified in CNRL's Code of Practice.
  - f. All potentially N.O.R.M contaminated equipment should be treated as CONTAMINATED and handled accordingly until proven negative through proper testing.

12. Hydrate Awareness & Prevention

- a. Hydrates are complex, snow-like compounds that can form into hard ice plugs from water and light hydrocarbons, such as natural gas, under certain conditions.
- b. The formation of a hydrate can occur in any operations; downhole, wellhead, flowlines, and/or test separator.
- c. Hydrates DO NOT form instantaneously. If the formation of a Hydrate is understood they are preventable.
- d. Refer to CAPP Guide to “Prevention & Safe Handling of Hydrate”.
- e. CNRL Guidelines to preventing Hydrates:

SICP Pressures (MPa)	Action
<14	<p><b>Hydrate awareness.</b> Extended bleeds downs can lead to the formation of Hydrated down hole. Ensure flow back temperatures and rates are monitored. Discuss pressure and rate trends for potential hydrates and the use of Methanol water before running tubing in the wellbore with the superintendent.</p>
≥ 14	<p><b>Hydrate Prevention.</b> Under no circumstance will water be pumped without methanol. All pressure testing or hole fill must be done with methanol water. Before any tools or tubing are run in the wellbore a minimum of 1,000 vertical meters of methanol water is to be bullheaded down the wellbore. When snubbing in the hole with tubing, 1m<sup>3</sup> of methanol water will be pumped in the wellbore for every 300m of tubing run. Hydrate curves are to be supplied for the well specific conditions. (i.e. Gas Compositions with Pressure &amp; Temperature curve). This will aid in any flow back parameters to prevent a hydrate from forming.</p>

13. Hydraulic fracturing & Induced Seismic Response (Directive 83 & IRP 24):

- a. Reference: Completions Frac Process Operations Foundation, CNRL Inter-Wellbore Communication Guideline, and Completions Induced Seismicity Response Plan Guideline
- b. In case an Induced Seismic activity is experienced, the CNRL Wellsite Supervisor must follow the activation plan outlined in the site specific induced seismicity response plan; if there is not a site specific the activation plan, follow the activation plan outlined in the Completions Induced Seismicity Response Plan Guideline.

14. Abandonment Notifications

- a. Alberta – Directive 20 - DDS submission is required for all abandonment operations (including zonal abandonment) a minimum of 24-hours prior to commencing activity. When situations warrant unexpected plugging (<24-hours), appropriate AER field office must be contacted for notification.
- b. Saskatchewan – All downhole plugging (including recompletion work) requires approval from MER through IRIS application and approval number.
- c. British Columbia – A Notice of Operation including proposed program is required 7-days in advance of downhole plugging operations.



TASK DESCRIPTION	H2S CONTROL MEASURE(S)



# **APPENDIX 2**

## REMEDIAL CEMENTING PROCEDURES

1. Run in hole with a perforation gun (Big-Hole 20 SPM, 20g, 60° phasing or similar shallow penetration charge). Correlate on depth to the cement evaluation log. If perforation interval is located on a collar, confirm with superintendent if an adjustment is required.

**Note:** Perforation interval to be confirmed by Calgary.

2. With the wellbore full of fresh water perforate the production casing. Monitor surface casing vent for communication when perforating. Surface guns and inspect to ensure that all shots have fired.
3. Fill casing with fresh water and perform a feed rate test. Note and record results of same. Do not exceed fracture gradient 19.8 kPa/m at MPP. Contact Calgary with results and for cementing program design. If no feed rate is possible the perforations will be abandoned with a permanent bridge plug capped with 8 vertical metres of cement.

**Note:** For groundwater protection if a feed rate is unsuccessful isolate the non-saline groundwater using a balanced cement plug and squeeze.

4. Run in hole and set cement retainer within 15 metres of perforations. Avoid setting the retainer in a casing collar. Fill casing with fresh water and pressure test casing and retainer to 7 MPa for 10 minutes.
5. Function test retainer. Pull stinger into neutral and pressure test tubing string.
6. Confirm feed rate test with fresh water. Attempt to break circulation to surface if possible. Contact Calgary with results. Refine cementing program as required.
7. Move in and rig up cementers and associated services as per CNRL and applicable regulatory body requirements. Conduct an equipment Inspection & hold a Safety & Procedures Meeting w/ all Personnel On-Site. Record Inspection and Safety Meeting in Tour Book & Daily Report.
8. Pressure test surface lines and equipment to 1,400kPa (low) and to the max wellhead working pressure (be sure not to exceed the MAWP of the lowest rated inline component).
9. Follow the CNRL approved cementing program as prepared by cementing company.
10. Based on feed rate pull stinger from retainer and circulate cement to bottom while holding back pressure on casing. Sting back into the retainer and perform remedial cement treatment.  
**Note:** For groundwater protection if circulation is successful cement must be circulated to surface with a minimum 0.5 m<sup>3</sup> cement returns.
11. Pull stinger from retainer. Circulate as required to balance the remaining cement above the cement retainer. Pull tubing to backwash with fresh water and cap retainer with a minimum 15 vertical metres of cement. Pull out of the hole with tubing and stinger.
12. Repeat procedures as required for all remedial intervals.