



Induced Seismicity Operational Manual

VERSION 1.0: February 2025

About the Regulator

The BC Energy Regulator (the Regulator or BCER) is the single-window regulatory agency with responsibilities for regulating oil and gas activities in British Columbia, including exploration, development, pipeline transportation and reclamation.



The Regulator's core roles include reviewing and assessing applications for industry activity, consulting with First Nations, ensuring industry complies with provincial legislation and cooperating with partner agencies. The public interest is protected by ensuring public safety, protecting the environment, conserving petroleum resources and ensuring equitable participation in production.

Vision, Mission and Values

Vision

A resilient energy future where B.C.'s energy resource activities are safe, environmentally leading and socially responsible.

Mission

We regulate the life cycle of energy resource activities in B.C., from site planning to restoration, ensuring activities are undertaken in a manner that:



Protects public safety and the environment



Supports reconciliation with Indigenous peoples and the transition to low-carbon energy



Conserves energy resources



Fosters a sound economic and social well-being

Values

Respect is our commitment to listen, accept and value diverse perspectives.

Integrity is our commitment to the principles of fairness, trust and accountability.

Transparency is our commitment to be open and provide clear information on decisions, operations and actions.

Innovation is our commitment to learn, adapt, act and grow.

Responsiveness is our commitment to listening and timely and meaningful action.

Manual Revisions

The Regulator is committed to the continuous improvement of its documentation. Revisions to the documentation are highlighted in this section and are posted to the [Energy Professionals](#) section of the Regulator's website. Stakeholders are invited to provide input or feedback on Regulator documentation to Systems@bc-er.ca.

Version Number	Posted Date	Effective Date	Chapter Section	Summary of Revision(s)
1.0	February 13, 2025	February 13, 2025	-	<p>This is a new document. Users are encouraged to review in full.</p> <p>For further information, refer to Technical Update 2025-02 on the BCER's News & Publications webpage.</p>

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Preface

About

The Induced Seismicity Operational Manual is a reference document for permit holders planning and undertaking injection operations in British Columbia. It outlines regulatory requirements and associated considerations for injection pre-planning, operations, and post-operations processes. While the manual is generally comprehensive, it may not cover every possible scenario. For situations not covered, contact the BCER for further guidance.

Manual Scope

This manual is specific to the BCER's processes, and the authorities and requirements established within the Energy Resource Activities Act (ERAA) and subsidiary regulations. Permit holders may require additional approvals or information from other regulators or have obligations under other statutes. For convenience, this manual seeks to identify other relevant agencies and regulatory processes, however this listing is not exhaustive.

Additional Guidance

Additional BCER manuals and guidelines are available in the [Documentation](#) section of BCER's website. The glossary on the [BCER's website](#) provides a comprehensive list of common terms above and beyond what is listed in these resources.

Compliance and Enforcement

This document does not replace legislation or affect legislative requirements. Permit holders are ultimately responsible for understanding and meeting all requirements of the ERAA related to their permits. Not adhering with the ERAA may result in compliance and enforcement actions by the BCER. For more information on these processes, please refer to the [Compliance and Enforcement Manual](#).

All activities pertinent to the practice of professional engineering or professional geoscience are expected to comply with the Professional Governance Act, [SBC 2018], c. 47 and the Bylaws of Engineers and Geoscientists British Columbia (EGBC), including any requirements for document authentication.

Manual Overview

This manual focuses on the regulatory framework and operational guidelines pertaining to injection activities affected by induced seismicity (IS) in BC, as stipulated by the ERAA and subordinate regulations. It is divided into three sections:

- **Section 1:** Covers the regulations for fluid injection activities across BC, including pre-planning guidance, the legal framework, and reporting methods for injection activities impacted by IS.
- **Section 2:** Highlights additional requirements within the Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA) and North Montney Seismic Monitoring and Mitigation Area (NMSMMA) Special Project Orders, with a focus on hydraulic fracturing.
- **Section 3:** Addresses pre-operational requirements, operational considerations, and post-operational requirements for disposal and other injection activities.

Section 1: Regulations Covering Injection Activities in British Columbia

Subsurface fluid injection activities include hydraulic fracturing, disposal, enhanced oil recovery schemes, geothermal energy activities, and carbon storage and sequestration activities. This section provides an overview of the regulatory framework governing injection activities affected by IS along with additional considerations. It outlines pre-planning guidance, legal obligations, and reporting procedures to ensure compliance and mitigate risk.

Regulations:

Energy activities undertaking injection operations in BC are regulated under the ERAA, Drilling and Production Regulation, and, specifically [section 21.1](#), if seismicity is encountered:

Induced seismicity

- 21.1**
- 1) During fracturing, injection or disposal operations on a well, the well permit holder must immediately report to the Regulator any seismic event within a 3 km radius of the drilling pad that is recorded by the well permit holder or reported to the well permit holder by any source available, if
 - a. the seismic event has a magnitude of 4.0 or greater, or
 - b. a ground motion is felt on the surface by any individual within the 3 km radius.
 - 2) If a well is identified by the well permit holder or the Regulator as being responsible for a seismic event that has a magnitude of 4.0 or greater, the well permit holder must suspend fracturing, injection and disposal operations on the well immediately.
 - 3) Fracturing, injection and disposal operations suspended under subsection (2) may continue once the well permit holder has implemented operational changes satisfactory to the Regulator to reduce or eliminate the initiation of additional induced seismic events.

[en. B.C. Reg. 159/2015, s. 5; am. B.C. Regs. 165/2015; 146/2017, App. 1, s. 10.]

Seismic events can be reported from any source. However, the magnitude determination by the BCER will serve as the magnitude of record and basis for regulatory decisions. Please refer to the [Standard for Calculation of Local Magnitude in the Western Canada Sedimentary Basin](#) published by the Regulator, which outlines the procedure for calculating local magnitude.

Pre-Planning:

Prior to beginning any injection operations, permit holders should review the seismogenic history of the region and assess the subsurface structural setting to gauge the potential for seismic events. To access relevant data, the BCER publishes a [catalogue](#) that is updated daily for all events above magnitude 1.5. In addition, the [Northeast BC Seismicity App](#) provides a visual review of seismicity. Private array data, if available, should also be incorporated in the review.

For areas outside of Northeast BC, seismic history is published by Natural Resources Canada via the [Canadian National Seismograph Network](#).

Furthermore, permit holders should be aware of critical infrastructure and local residences relevant to their planned activities. In the case of a significant seismic event, engagement with local residents and stakeholders may be required.

Reporting:

Seismic events recorded within 3 km of any injection activity require specific actions depending on the event's magnitude. Details on how the radius of a well is determined can be found in Appendix A and please review Appendix B for additional guidance on information to be contained within an email notification to the BCER.

Guidance: *If the magnitude of the event is equal to or greater than local magnitude 4.0 and the event is linked to the injection operation, all injection activities must be suspended immediately, and the BCER notified. If there is no damage reported or expected from the event, notification of the event can be done by calling 1-877-500-2237 and a [minor incident report](#) must be submitted. If damage is reported or suspected from the event on or off the activity site, the permit holder must contact Emergency Management BC immediately through the 24-hour reporting line at 1-800-663-3456 and submit a [minor incident report](#).*

Guidance: *If the magnitude of the event is less than local magnitude 4.0 but is reported as felt or suspected of being felt, there are no immediate changes to injection activities required and the BCER must be notified. Notification of the event and details can be sent to: SeismicMonitoring@bc-er.ca*

If the event occurred due to multi-stage, hydraulic fracturing in a horizontal well bore targeting the Montney Formation within the KSMMA or targeting the Montney or Doig Formations within the NMSMMA, please review the specific reporting requirements outlined in Section 2.

Section 2: Hydraulic Fracturing Activities within the Kiskatinaw Seismic Monitoring and Mitigation Area Special Project Order and North Montney Seismic Monitoring and Mitigation Area Special Project Order.

Distinct patterns of seismicity have been recorded within the Montney Trend. These areas have additional operating conditions beyond the Drilling and Production Regulation. Specific rules and guidance for the Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA) Special Project Order and the North Montney Seismic Monitoring and Mitigation Area (NMSMMA) Special Project Order are provided in this section.

Kiskatinaw Seismic Monitoring and Mitigation Area Special Project Order:

The KSMMA Special Project Order is broken down into three sections:

- Pre-operations;
- During operations;
- Post-operations;

The following goes through the KSMMA special project order and provides guidance where additional clarity may be useful.

Operations Where KSMMA Applies

The [KSMMA Special Project Order](#) only applies to operations involving horizontal, multi-stage hydraulic fracturing targeting the Montney Formation in a well located wholly within the prescribed area of the Special Project Order. See [Map I](#).

KSMMA Regulatory Framework:

2. Designation
 - 2.1. As of February 13, 2025 this Order cancels and replaces Order 18-90-001 issued on May 28, 2018 as amended on April 16, 2021.
 - 2.2. The Regulator makes this Order designating an innovative method of carrying out certain energy resource activities and related activities as a special project under section 75(1)(c) of the Energy Resource Activities Act in the area identified in Appendix I of this Order, subject to conditions stated in section 3 of this Order.
3. Conditions
 - 3.1. Under section 75(2) of the Energy Resource Activities Act, the Regulator specifies the following.

KSMMA Pre-Operations:

3.2. Pre-Operation Requirements

3.2.1. Prior to conducting hydraulic fracturing operations on or after February 13, 2025, a well permit holder must:

- a. Prepare and submit to the Regulator an induced seismicity pre-assessment with each notice of operation;

Guidance: When submitting a notice of operation via eSubmission for a well within the KSMMA where the Special Project Order applies, an induced seismicity pre-assessment document must be uploaded as a supplementary document in either word (.doc/.docx) or portable document format (.pdf).

Please follow the [pre-assessment template](#) available on bc-er.ca

- b. Notify individuals in accordance with the requirements set out in Appendix II of this Order; and

Guidance: Notification will be given in writing no less than two days prior to initiating hydraulic fracturing operations. Alternative and exemptions to notification may be considered on written request to the Regulator. A permit holder must give the following information to an individual who resides on land that is located within 3 km of the well trajectory (resident):

- a) a description of what activities will be taking place, where the activities will be located (well pad location), well trajectories (subsurface), and when the activities will happen;
- b) an explanation that the activities may induce seismic events;
- c) a description of what experiencing a seismic event is like and the impacts that might occur with seismic events;
- d) well permit holder contact details, and an explanation that the BCER may require the well permit holder to contact recipients as a result of a seismic event; (Note: If a resident or stakeholder informs the well permit holder during their communication that they do not wish to be contacted in the event of a seismic event, the well permit holder is not required to follow up. A resident or stakeholder may elect at any time during the activities to change their preference.);
- e) a description of how these activities are regulated and contact information for the Regulator. This can include the Regulator's 24-hour contact line: 1-877-500-2237 and information on accessing the Regulator's NEBC Seismicity Web Map: www.bc-er.ca/seismicmonitoring
- f) a copy of the KSMMA Order or alternatively, direction to an online copy; and
- g) a summary of the submitted induced seismicity pre-assessment.

- c. Notify the Regulator not less than 24 hours and not more than 72 hours before hydraulic fracturing operations begin on a common drilling pad.

Guidance: The permit holder must inform the BCER 1 to 3 days before fracturing (pumping) begins via email (SeismicMonitoring@bc-er.ca). This is not for notification of equipment moves, setup, flowback or demobilization. One notification for all wells on a common drilling pad is sufficient. Include the surface location, well name(s) and well authorization (WA) number(s) in the body of the notification email.

KSMMA Active Hydraulic Fracturing Operation Requirements:

During hydraulic fracturing operations, a well permit holder must:

3.3. Active Hydraulic Fracturing Operations Requirements

3.3.1. During hydraulic fracturing operations, a well permit holder must, in accordance with applicable guidance published by the Regulator and as amended or replaced from time to time:

- a. ensure that ground motion monitoring is conducted within 5km of the well bore trajectories from the common drilling pad:

Guidance: *There should be a minimum of 1 (one) ground motion monitor per common drilling pad location. Some additional considerations for ongoing monitoring include:*

- *The BCER may, at any time, request ground motion monitoring data via a [Ground Motion Monitoring Report](#).*
- *If additional ground motion monitors are deployed within 5 km of the common drilling pad, any ground motion data obtained from these monitors should be included in the [Ground Motion Monitoring Report](#).*
- *Monitoring during all fracturing (pumping) operations during hydraulic fracturing activities is required.*
- *Please review the [Guideline for Extraction of Ground Motion Parameters](#) and the [Ground Motion Monitoring and Submission Guideline](#).*
- *Monitoring during flowback is encouraged, but not required. If monitoring is on-going during flowback, any events of 0.008g and above or reported felt events should be included in the [Ground Motion Monitoring Report](#).*

- b. ensure that continuous monitoring is conducted using a seismic array providing real-time seismicity readings; and

Guidance: *The permit holder must have access to real-time, continuous seismic monitoring and analysis during all fracturing operations that provide a magnitude of completeness of magnitude 1.5 or better for a radius of 5 km around the well trajectories.*

- c. maintain complete records of seismic events and ground motion monitoring data, for production on request by the Regulator.

Guidance: *The permit holder may be requested to submit seismic event location data (e.g., latitude, longitude, date, time, magnitude) for all seismic events equal to or above magnitude 1.5 or as requested by the BCER in the [Ground Motion Monitoring Report](#).*

KSMMA Seismic Thresholds During Active Operations:

The Regulator's Earthquake Catalog is the magnitude of record for all events. Action by the permit holder is to be initiated upon the first detected actionable magnitude. If the Regulator's magnitude varies from the magnitude detected on the permit holder's array, further action may be required at the level appropriate to the Regulator's recorded magnitude.

Guidance: *The BCER follows a [Local Magnitude Standard](#) as outlined in the [INDB 2021-05](#)*

Permit holders' actions following seismic activity within 5 km of a well trajectory with hydraulic fracturing operations, is outlined below:

3.4. Seismic Thresholds During Hydraulic Fracturing Operations

3.4.1. If a seismic event with a magnitude of 1.50 or greater is identified within a 5 km radius of the well bore trajectory, the well permit holder must notify the Regulator via email as soon as practicable and in any event, within 24 hours.

Guidance: *The permit holder must communicate all events, including magnitude, location, date, and time for any seismic event equal to or greater than magnitude 1.5 to the BCER at SeismicMonitoring@bc-er.ca. Notification emails should always include the well name(s) and well authorization number(s).*

3.4.2. If a seismic event with a magnitude of 2.00 to 2.99 is identified within a 5 km radius of the well bore trajectory and hydraulic fracturing operations at the common drilling pad are identified as responsible for the seismic event, the well permit holder must initiate its mitigation plan as outlined in its induced seismicity pre-assessment and take action accordingly.

Guidance: *The well permit holder's submitted mitigation response plan must initiate at magnitude 2.00 or greater.*

3.4.3. If a seismic event with a magnitude of 3.00 or greater is identified within a 5 km radius of the well bore trajectory, the well permit holder must immediately suspend hydraulic fracturing operations on the common drilling pad and notify the Regulator immediately via phone:

Guidance: *Notify the BCER by calling 1-877-500-2237 and complete a minor incident report online via CM-IS. However, if damage is reported or suspected from the event on or off the activity site, the permit holder must contact Emergency Management BC immediately through the 24-hour reporting line at 1-800-663-3456 and complete a minor incident report online via CM-IS. This guidance also applies to 3.4.5*

3.4.4. Hydraulic fracturing operations suspended under 3.4.3 may continue once the well permit holder has received written permission from the Regulator to resume hydraulic fracturing operations.

Guidance: *All hydraulic fracturing operations must be suspended immediately and may not restart until they receive written permission from the Regulator.*

If it is determined that the event is not linked to the permit holder's activities. This may be due to concurrent activities or other injection activities in the vicinity. Normal operations may be eligible to resume with written permission from the Regulator.

If the seismic event can be attributed to a specific well and/or a specific bench within the formation. In this case, all wells within the specific bench and dominant direction are suspended, but the remaining wells may be eligible to resume normal operations with written permission from the Regulator.

This guidance also applies to 3.4.6.

3.4.5. If a well permit holder resumes hydraulic fracturing operations pursuant to 3.4.4 and a seismic event with a magnitude of 2.70 or greater is subsequently identified within a 5 km radius of the well bore trajectory, the well permit holder must immediately suspend hydraulic fracturing operations on the common drilling pad and notify the Regulator immediately via phone.

- 3.4.6. Hydraulic fracturing operations suspended under 3.4.5 may continue once the well permit holder has received written permission from the Regulator to resume hydraulic fracturing operations.
- 3.4.7. The well permit holder must ensure that any operations to reduce reservoir pressure during the applicable suspension period(s) in 3.4.3 or 3.4.5 are not undertaken except with written permission from the Regulator.

KSMMA Post-Operation Requirements:

3.4. Post-Operation Requirements

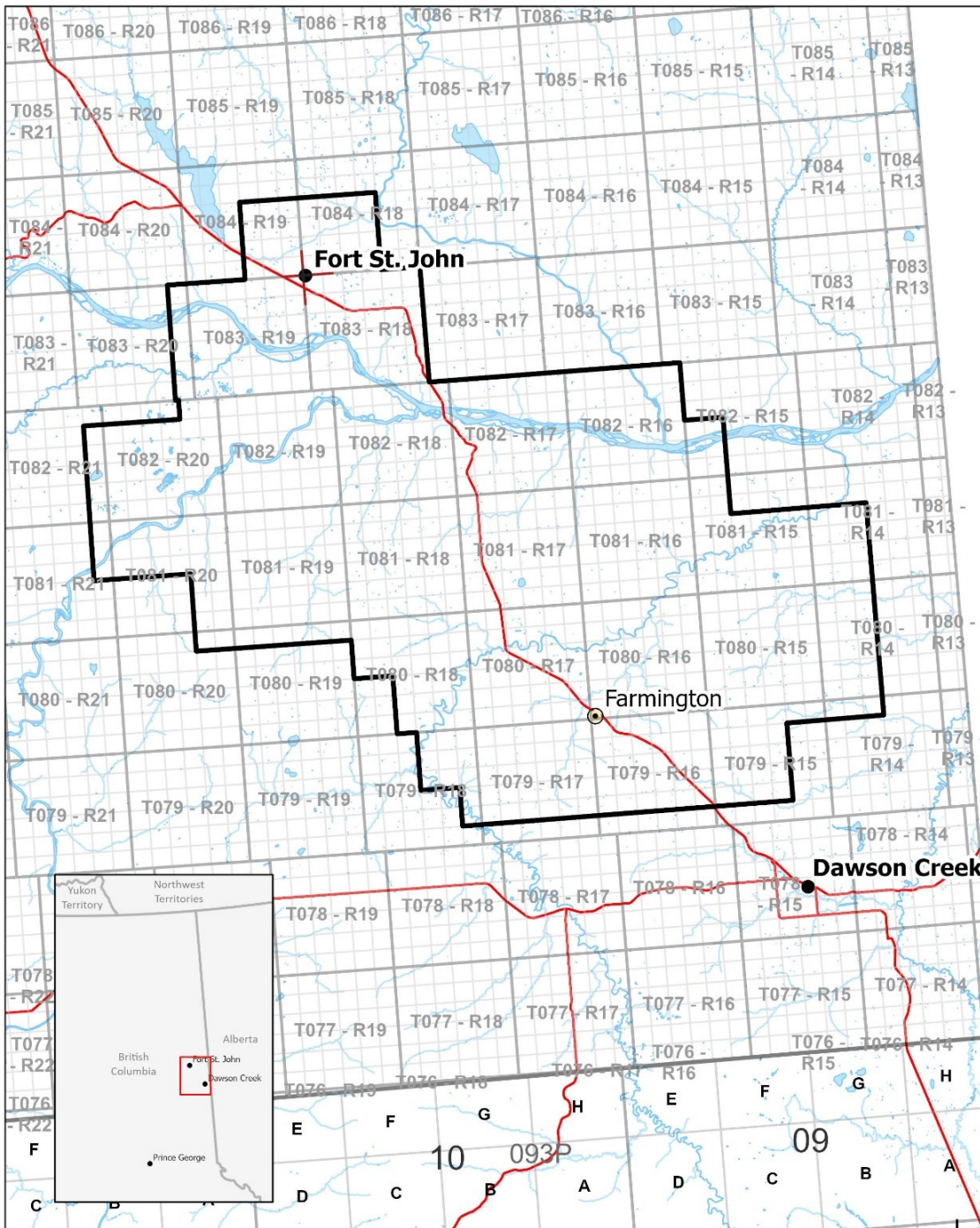
- 3.5.1. Within 30 days of concluding hydraulic fracturing operations, a well permit holder must submit to the Regulator a hydraulic fracturing operations monitoring report.

Guidance: This requirement refers to the submission of a [Ground Motion Monitoring Report](#). A [Ground Motion Monitoring Report](#) must be submitted to the Regulator in a (.pdf) format outlining accelerometer deployment locations and a data summary.

- If applicable, the following data files summarizing all ground motions equal to 0.008g and greater or reported events that were felt at surface level regardless of intensity should be submitted alongside the Ground Motion Monitoring Report
 - One (.csv) report, using the Regulator's standard format.
 - One .seed format file.
 - Miniseed (.mseed) files are not acceptable as they do not contain the necessary information about the sensor
- For each event of 0.008g and above or felt event, the SEED file containing instrument response and waveform from 30 seconds before the observed event and 60 seconds after must be submitted.
- The [Ground Motion Monitoring Reports](#) must be submitted within 30 days of the completion of hydraulic fracturing activities via email to welldatamail@bc-er.ca.
 - File Naming: WANUM_GMMR_YYYYMMDD_OPTIONAL DESCRIPTION.PDF/CSV/SEED

[Ground Motion Monitoring Reports](#) are considered to be information obtained from or about a well. As such, they will be treated as well reports and well data, as per 17 (1) of the Energy Resource Activities Act General Regulation.

Map I: Kiskatinaw Seismic Monitoring and Mitigation Area Map



Map Legend

Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA) Outline:

North Montney Seismic Monitoring and Mitigation Area Special Project Order:

The North Montney Seismic Monitoring and Mitigation Area (NMSMMA) Special Project Order is broken down into four sections:

- Pre-operations;
- During operations;
- Post-operations; and,

Operations Where NMSMMA Applies

The [NMSMMA Special Project Order](#) only applies to operations involving horizontal, multi-stage hydraulic fracturing targeting the Montney or Doig formations in a well located wholly within the prescribed area of the Special Project Order. See [Map II](#).

The following goes through the entire order and provides guidance where additional clarity may be useful.

NMSMMA Regulatory Framework:

2. Designation
 - 2.1. The Regulator makes this Order designating an innovative method of carrying out certain energy resource activities and related activities as a special project under section 75(1)(c) of the Energy Resource Activities Act in the area identified in Appendix I of this Order, subject to conditions stated in section 3 of this Order.
3. Conditions
 - 3.1. Under section 75(2) of the Energy Resource Activities Act, the Regulator specifies the following.

NMSMMA Pre-Operations:

- 3.2. Pre-Operation Requirements
 - 3.2.1. Prior to conducting hydraulic fracturing operations on or after February 13, 2025 a well permit holder must:
 - a. prepare and submit to the Regulator an induced seismicity pre-assessment with each notice of operation; and

Guidance: When submitting a notice of operation via eSubmission for a well within the NMSMMA where the Special Project Order applies, an induced seismicity pre-assessment document must be uploaded as a supplementary document in either word (.doc/.docx) or portable document format (.pdf).

Please follow the [pre-assessment template](#) available on [bc-er.ca](#)

- b. notify the Regulator via email not less than 24 hours and not more than 72 hours before hydraulic fracturing operations begin on a common drilling pad.

Guidance: The permit holder must inform the BCER 1 to 3 days before fracturing (pumping) begins via email (SeismicMonitoring@bc-er.ca). This is not for notification of equipment moves, setup, flowback or demobilization. One notification for all wells on a common drilling pad is sufficient. Include the surface location, well name(s) and well authorization (WA) number(s) in the notification.

NMSMMA Active Hydraulic Fracturing Operation Requirements:

During hydraulic fracturing operations, a well permit holder must:

3.3. Active Hydraulic Fracturing Operations Requirements

3.3.1. During hydraulic fracturing operations, a well permit holder must, in accordance with applicable guidance published by the Regulator and as amended or replaced from time to time:

- a. ensure that ground motion monitoring is conducted within 5km of the well bore trajectories from the common drilling pad:

Guidance: There should be a minimum of 1 (one) ground motion monitor per common drilling pad location. Some additional considerations for ongoing monitoring include:

- The BCER may, at any time, request ground motion monitoring data via a [Ground Motion Monitoring Report](#).
- If additional ground motion monitors are deployed within 5 km of the common drilling pad, any ground motion data obtained from these monitors should be included in the [Ground Motion Monitoring Report](#).
- Monitoring during all fracturing (pumping) operations during hydraulic fracturing activities is required.
- Please review the [Guideline for Extraction of Ground Motion Parameters](#) and the [Ground Motion Monitoring and Submission Guideline](#).
- Monitoring during flowback is encouraged, but not required. If monitoring is on-going during flowback, any events of 0.008g and above or reported felt events should be included in the [Ground Motion Monitoring Report](#).

- b. ensure that continuous monitoring is conducted using a seismic array providing real-time seismicity readings; and

Guidance: The permit holder must have access to real-time, continuous seismic monitoring and analysis during all fracturing operations that provide a magnitude of completeness of magnitude 1.5 or better for a radius of 5 km around the well trajectories.

- c. maintain complete records of seismic events and ground motion monitoring data, for production on request by the Regulator.

Guidance: The permit holder may be requested to submit seismic event location data (e.g., latitude, longitude, date, time, magnitude) for all seismic events equal to or above magnitude 1.5 or as requested by the BCER in the [Ground Motion Monitoring Report](#).

NMSMMA Seismic Thresholds During Active Operations:

The Regulator's Earthquake Catalog is the magnitude of record for all events. Action by the permit holder is to be initiated upon the first detected actionable magnitude. If the Regulator's magnitude varies from the magnitude detected on the permit holder's array, further action may be required at the level appropriate to the Regulator's recorded magnitude.

Guidance: The BCER follows a [Local Magnitude Standard](#) as outlined in the [INDB 2021-05](#)

Permit holders' actions following seismic activity within 5 km of a well trajectory with hydraulic fracturing operations, is outlined below:

3.4. Seismic Thresholds During Hydraulic Fracturing Operations

3.4.1. If a seismic event with a magnitude of 2.50 or greater is identified within a 5 km radius of the well bore trajectory, the well permit holder must notify the Regulator via email as soon as practicable and in any event, within 24 hours.

Guidance: The permit holder must communicate all events, including magnitude, location, date, and time for any seismic event equal to or greater than magnitude 1.5 to the BCER at SeismicMonitoring@bc-er.ca. Notification emails should always include the well name(s) and well authorization number(s).

3.4.2. If a seismic event with a magnitude of 3.00 to 3.99 is identified within a 5 km radius of the well bore trajectory and hydraulic fracturing operations at the common drilling pad are identified as responsible for the seismic event, the well permit holder must initiate its mitigation plan as outlined in its induced seismicity pre-assessment and take action accordingly.

Guidance: The well permit holder's submitted mitigation response plan must initiate at magnitude 2.00 or greater.

3.4.3. If a seismic event with a magnitude of 4.00 or greater is identified within a 5 km radius of the well bore trajectory, the well permit holder must immediately suspend hydraulic fracturing operations on the common drilling pad and notify the Regulator immediately via phone:

Guidance: Notify the BCER by calling 1-877-500-2237 and complete a minor incident report online via CM-IS. However, if damage is reported or suspected from the event on or off the activity site, the permit holder must contact Emergency Management BC immediately through the 24-hour reporting line at 1-800-663-3456 and complete a minor incident report online via CM-IS. This guidance also applies to 3.4.5

3.4.4. Hydraulic fracturing operations suspended under 3.4.3 may continue once the well permit holder has received written permission from the Regulator to resume hydraulic fracturing operations.

Guidance: All hydraulic fracturing operations must be suspended immediately and may not restart until they receive written permission from the Regulator.

If it is determined that the event is not linked to the permit holder's activities. This may be due to concurrent activities or other injection activities in the vicinity. Normal operations may be eligible to resume with written permission from the Regulator.

If the seismic event can be attributed to a specific well and/or a specific bench within the formation. In this case, all wells within the specific bench and dominant direction are suspended, but the remaining wells may be eligible to resume normal operations with written permission from the Regulator.

This guidance also applies to 3.4.6.

3.4.5. If a well permit holder resumes hydraulic fracturing operations pursuant to 3.4.4 and a seismic event with a magnitude of 3.70 or greater is subsequently identified within a 5 km radius of the well bore trajectory, the well permit holder must immediately suspend hydraulic fracturing operations on the common drilling pad and notify the Regulator immediately via phone.

3.4.6. Hydraulic fracturing operations suspended under 3.4.5 may continue once the well permit holder has received written permission from the Regulator to resume hydraulic fracturing operations.

3.4.7. The well permit holder must ensure that any operations to reduce reservoir pressure during the applicable suspension period(s) in 3.4.3 or 3.4.5 are not undertaken except with written permission from the Regulator.

NMSMMA Post-Operation Requirements:

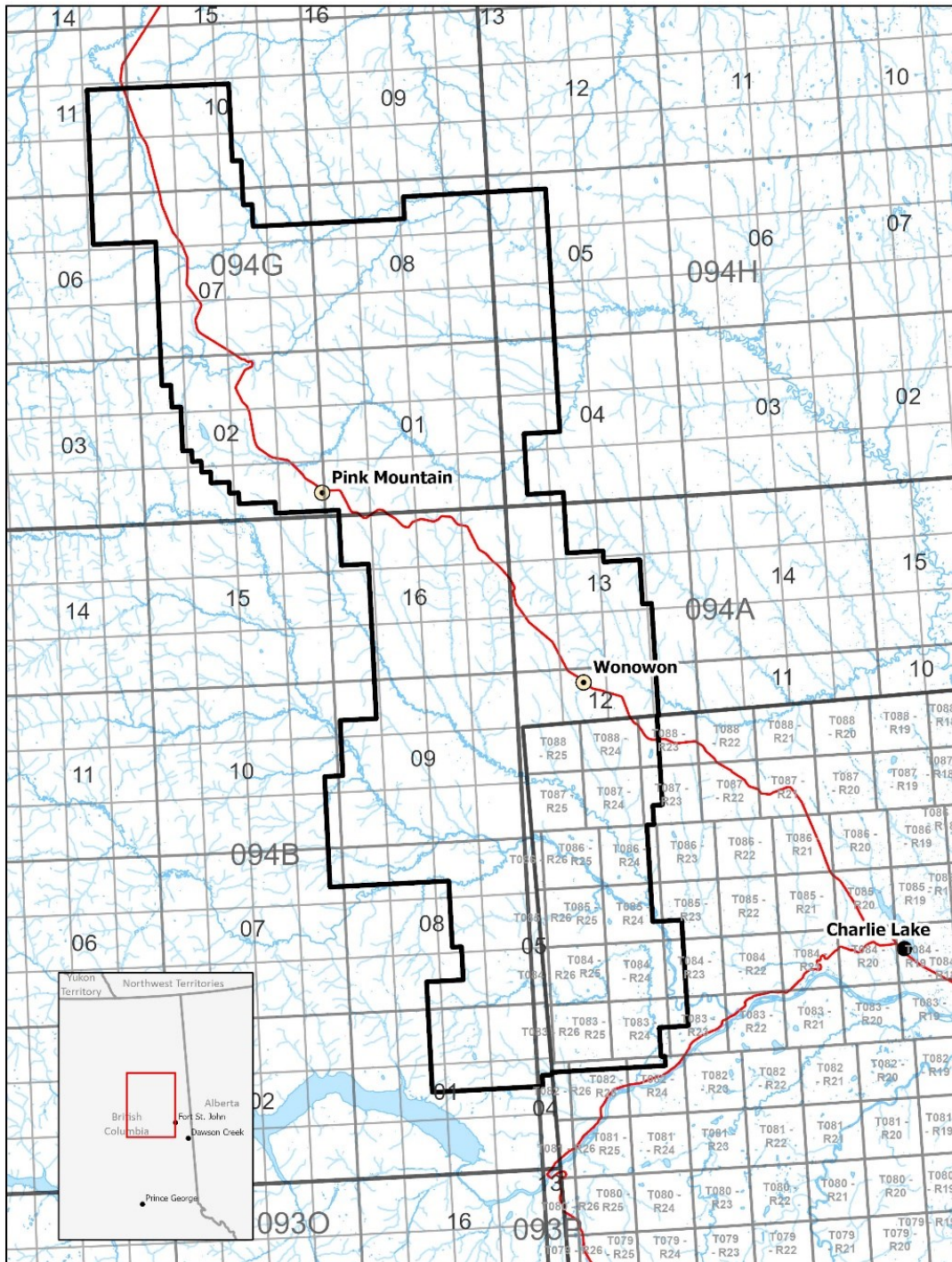
3.5. Post-Operation Requirements

- 3.5.1. Within 30 days of concluding hydraulic fracturing operations, a well permit holder must submit to the Regulator a hydraulic fracturing operations monitoring report.

Guidance: This requirement refers to the submission of a [Ground Motion Monitoring Report](#). A [Ground Motion Monitoring Report](#) must be submitted to the Regulator in a (.pdf) format outlining accelerometer deployment locations and a data summary.

- If applicable, the following data files summarizing all ground motions equal to 0.008g and greater or reported events that were felt at surface level regardless of intensity should be submitted alongside the Ground Motion Monitoring Report
 - One (.csv) report, using the Regulator's standard format.
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 - For each event of 0.008g and above or felt event, the SEED file containing instrument response and waveform from 30 seconds before the observed event and 60 seconds after must be submitted.
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- [Ground Motion Monitoring Reports](#) are considered to be information obtained from or about a well. As such, they will be treated as well reports and well data, as per 17 (1) of the Energy Resource Activities Act General Regulation.

Map II: North Montney Seismic Monitoring and Mitigation Area Map



Map Legend

North Montney Seismic Monitoring and Mitigation Area (NMSMMA) Outline:

Section 3: Disposal and Other Injection

Disposal, pressure maintenance and storage (CCS, natural gas, hydrogen) activities are approved through special project orders on a well-by-well basis. Conditions to monitor for seismicity may be included in the order if historic seismicity has occurred, detectable faults appear favorable for slipping and/or seismicity begins after injection operations are initiated. Monthly seismic reporting and notifications of felt events will be required if seismic monitoring requirements are in place.

The following considerations for pre-operations, during operations, and post-operations serve as guidance for special project orders. For specific points of guidance for waste water disposal wells, please consult the [Application Guidance for Deep Well Disposal](#).

Pre-Operation Considerations

Planning a disposal or injection well involves numerous considerations, including the stratigraphic zones to be utilized, any stimulation requirements and the pressure increases expected with the project. Key pre-operation planning considerations include:

- **Seismic History:** Review the seismic history of the region around the proposed project. To access relevant data, the BCER publishes a [catalogue](#) that is updated daily for all events above magnitude 1.5. In addition, the [Northeast BC Seismicity App](#) provides a visual review (map) of seismicity. Private array data, if available, should also be incorporated in the review.
- **Hazard Assessment:** Perform a hazard assessment to understand the seismic potential of known or mapped faults and to determine the activity level that will be present during active operations. Reflective seismic is recommended for this review.
- **Well Setup and Downhole Configuration:** Plan carefully for each stratigraphic zone, considering their specific seismic risks, and determine the directionality of wells to be stimulated or pressurized during the proposed operations.

Operational Considerations

- **Seismometer Array:** Upon review of the application, a seismometer array may be required at the start of injection operations. Or, when seismic events are noted on the public array, a permit holder will be required to set up an array with sufficient density to detect depth of events to within +/- 500m.
- **Frequency of Events:** During operations, if seismic events are triggered, the frequency and magnitude of events should be carefully observed to determine if there are additional hazards or an increase in magnitude that may arise from operations.
- **Mitigations:** Implement mitigations when thresholds magnitudes are met or exceeded. Mitigations may need to be implemented prior to meeting pre-defined thresholds if felt reports or event frequency becomes significant.
- **Contact with the Regulator:** Notify the BCER via email SeismicMonitoring@bc-er.ca for events exceeding threshold magnitudes identified in the Special Project Order or local magnitude 2.5, whichever is lower.
- **Suspension:** If a magnitude 4.0 or greater event is recorded within 3km of the injection well, or within the suspension area and magnitude threshold defined within the well's special project order, immediately suspend operations. Notify the BCER by calling 1-877-500-2237 and submit a minor incident report online via CM-IS. However, if damage is reported or suspected from the event on or off the activity site, the permit

holder must contact Emergency Management BC immediately through the 24-hour reporting line at 1-800-663-3456 and complete a minor incident report online via CM-IS.

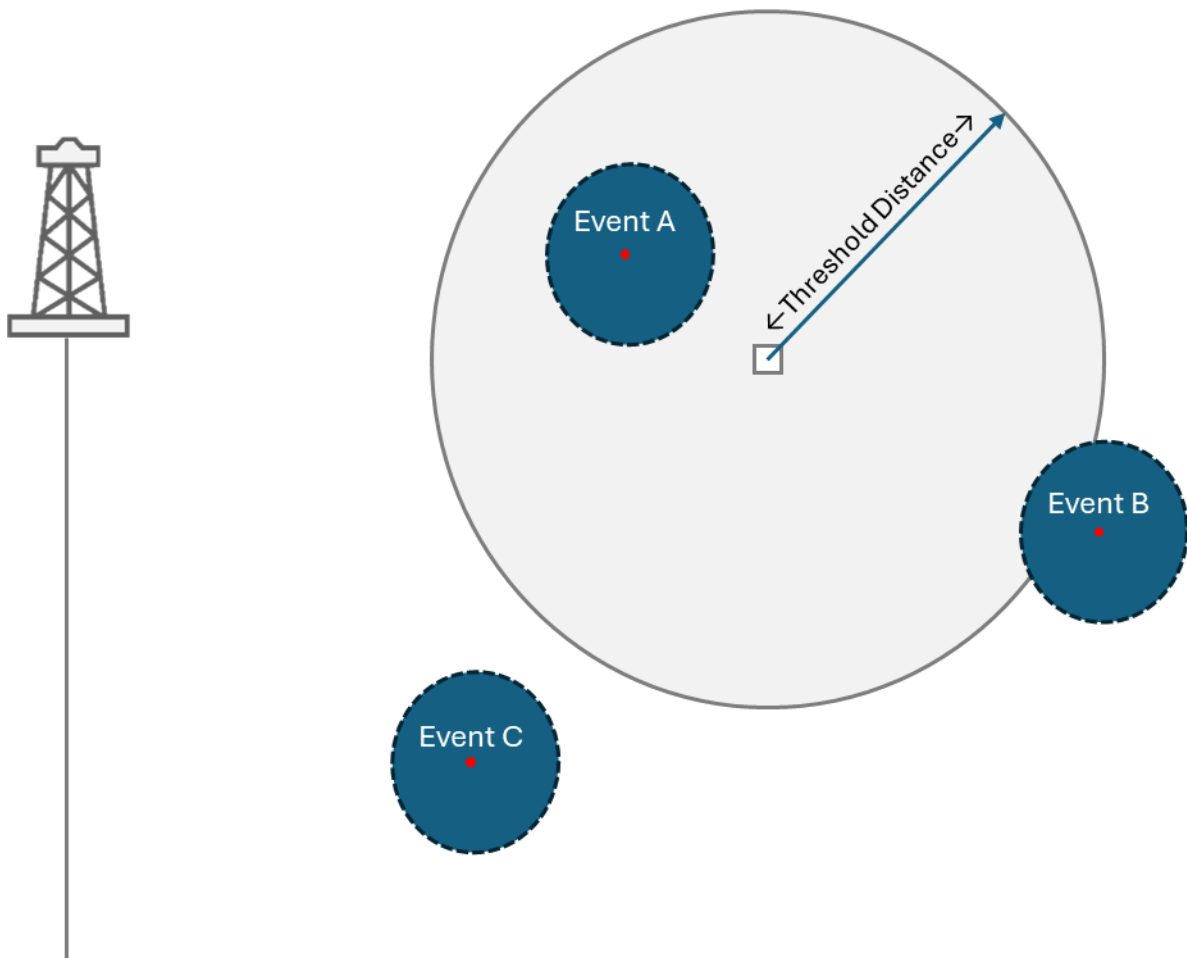
- **Incident Reporting:** Significant events, magnitude 2.5 or higher or felt events, may result in a request for additional injection data. As well, all events are reported in the monthly report, as indicated in the Special Project Approval for disposal operations.

Post-Event Considerations

- **Well Data Submissions:** [Ground Motion Monitoring Reports](#) will be treated as well reports and well data, as per 17 (1) of the Energy Resource Activities Act General Regulation.
- **Post-Event Review:** Responsibilities may include collaboration with other disposal operators in the area to determine the cause of the event(s) and minimize future potential seismicity. A report to the Regulator may be required.

Appendix A: Determination of Well Radius and Seismic Event Location for Reporting

Vertical Wells

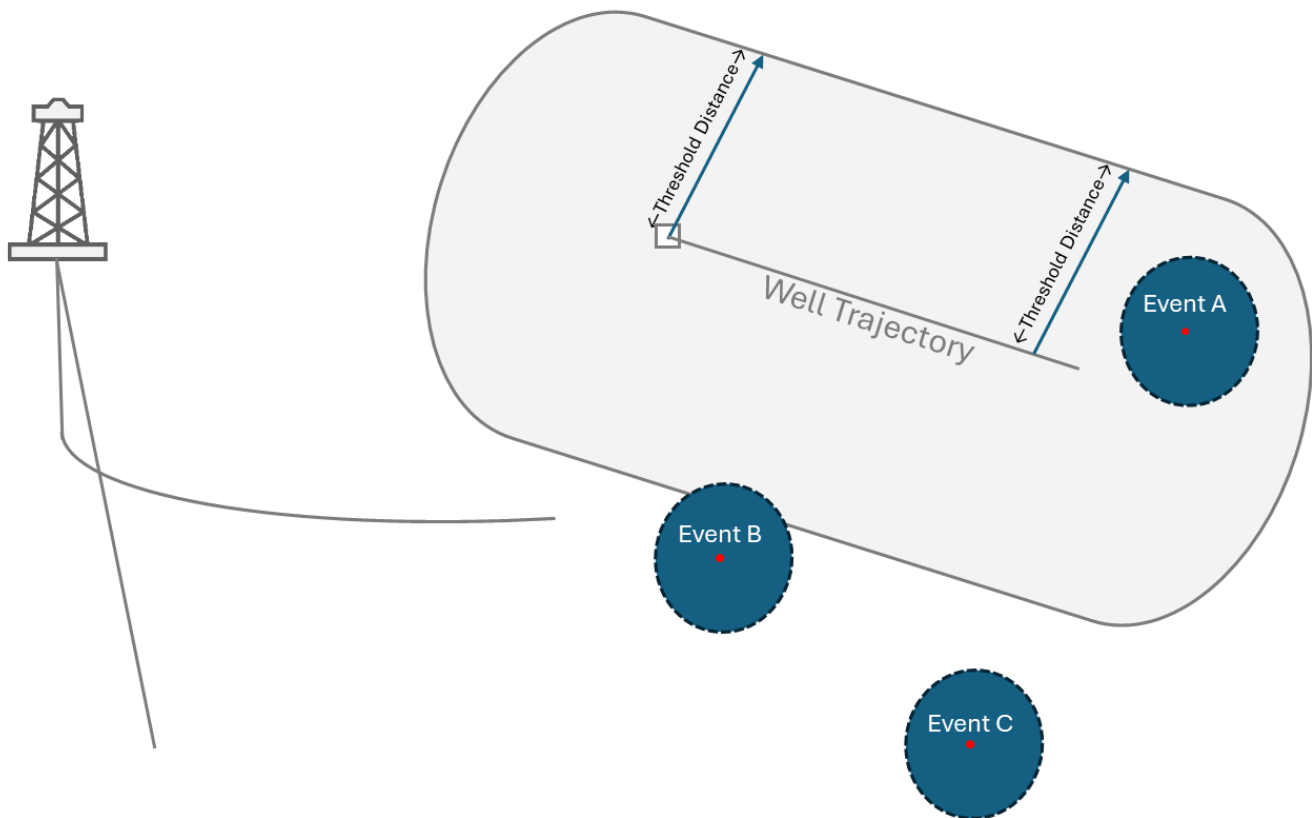


Seismic Event A: the seismic event is located within the reporting radius

Seismic Event B: Although the seismic event is located outside the reporting radius, the error ellipse for the seismic event is within the reporting radius. Therefore, the seismic event should be treated as though the event occurred within the reporting radius.

Seismic Event C: The seismic event, including its error ellipse, occur completely outside the reporting radius. No action required.

Horizontal and Deviated Wells



Seismic Event A: the seismic event is located within the reporting radius

Seismic Event B: Although the seismic event is located outside the reporting radius, the error ellipse for the seismic event is within the reporting radius. Therefore, the seismic event should be treated as though the event occurred within the reporting radius.

Seismic Event C: The seismic event, including its error ellipse, occur completely outside the reporting radius. No action required.

Appendix B: Notification and Reporting of Induced Seismicity Events

Decision Trees:

The following decision trees are available on bc-er.ca that provide simplified processes to follow when seismic events occur.

For Seismic Event Reporting and Required Actions Decision Tree for Injection Operations.

For Seismic Event Reporting and Required Actions Decision Tree for Hydraulic Fracturing Operations.

For Seismic Event Reporting and Required Actions Decision Tree for Hydraulic Fracturing Operations within the KSMMA and NMSMMA.

Guidance for Email Notification:

When communicating with the BCER via the SeismicMonitoring@bc-er.ca email address, please include the following information.

Subject: The subject line should include the area and the type of notification

Examples: Tower Lake Daily Operational Update
Town Seismic Event Notification
Septimus Disposal Operation Update

Body of the Email: Please include the well pad name and the WA#(s), as applicable, and the information to be shared.

Examples: Well pad: Tower Lake 03-09-81-17
WA#: 36432-39
Update: Currently, ...

Well pad: Town d-061-G/094-B-16
WA#: 42253-56
Seismic Event: A magnitude ...

Event Details: For seismic events, along with the above, local magnitude, latitude, and longitude of the seismic event along with the local time and date of the event(s). Additional details regarding the operations that was occurring leading up to the event and current operations. For current operations, include total number of stages and total number of stages completed, if applicable. If the event has been experienced locally, please let us know the approximate number of people that felt the event and their location along with the perceived intensity of the event.