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GLOSSARY

Blowout Preventer (BOP): A safety device that connects to the wellhead to prevent an uncontrolled release of fluids

Buoyancy Module: Buoyant material added to the riser to reduce the weight of the riser in water

LMRP (Lower Marine Riser Package): A connector system that allows the riser to be disconnected from the BOP on the wellhead

Remotely Operated Vehicle (ROV): An unmanned submersible unit for performing underwater functions and observations

Riser: The conduit that connects the drillship to the Blowout Preventer (BOP) on the wellhead

Synthetic-Based Mud (SBM): Synthetic fluid-based drilling mud

Valued Components (VCs): Environmental attributes associated with the Project that are of particular value or interest because they have been identified to be of concern to Aboriginal peoples, regulatory agencies, Shell, resource managers, scientists, key stakeholders, and/or the general public
EXECUTIVE SUMMARY

Shell Canada Limited (Shell) is considering response options following an event in which the marine riser (riser) and Lower Marine Riser Package (LMRP) accidentally fell to the seafloor near the Cheshire L-97 wellsite during activities associated with Shell’s Shelburne Basin Venture Exploration Drilling Project. One response option for consideration is to leave the riser and/or LMRP in place, with no plans for future recovery. The other option is recovery of the riser and/or LMRP from the seafloor.

Shell commissioned Stantec Consulting Ltd. (Stantec) to conduct a comparative review of the two response options for the marine riser and the LMRP. The purpose of this Options Review is to inform proponent and regulatory decision-making by providing insight into the advantages and disadvantages of the options with regards to health and safety; environment; Aboriginal and commercial fisheries considerations; and technical feasibility.

In summary, the Options Review concludes that recovery of the riser and/or LMRP would:

- present a low risk to the health and safety of ocean users, but present a considerable health and safety risk to offshore personnel related to the complexity and highly specialized nature of offshore recovery operations, the size and scale of the equipment involved, the interaction between equipment and offshore personnel, as well as the harsh environmental conditions offshore;
- not likely result in significant adverse environmental effects to the marine environment and commercial and Aboriginal fisheries, provided appropriate mitigations are in place; and
- be technically feasible but have considerable logistical challenges due to the complexity of each operational phase (excavation, cutting and recovery), the considerable depth of water where the riser and LMRP are located (2143 m), and the use of specialized equipment and techniques.

It is anticipated that leaving the riser and/or LMRP in place would:

- present negligible health and safety risk to offshore personnel or other ocean users;
- not likely result in significant adverse environmental affects to the marine environment and commercial and Aboriginal fisheries, provided appropriate mitigations are in place; and
- be technically feasible.
1.0 INTRODUCTION

Shell Canada Limited (Shell) commissioned Stantec Consulting Ltd. (Stantec) to conduct a comparative review of response options (Options Review) following an event in which the marine riser (riser) and the Lower Marine Riser Package (LMRP) fell to the seafloor near the Cheshire L-97 wells site. The options under consideration are: leave the riser and/or LMRP in place on the seafloor; or the recovery of the riser and/or LMRP. The purpose of the Options Review is to inform proponent and regulatory decision-making by providing insight into the advantages and disadvantages of each response option with regards to health and safety; environmental considerations; Aboriginal and commercial fisheries considerations; and technical feasibility.

In conjunction with this Options Review, Shell also engaged Stantec to complete an independent Environmental Review of riser/LMRP response options (Stantec 2016). The Environmental Review is referenced throughout the Options Review in support of the consideration of potential environmental effects and associated mitigation measures.

The health and safety of offshore personnel in the execution of either leaving the riser and/or LMRP in place or the recovery of the riser and/or LMRP, while safeguarding the health and safety of other ocean users, is a top priority in incident management and response. Another response priority is to avoid or reduce adverse environmental effects, through selecting a response option that is technically feasible and that can be undertaken efficiently. The information provided within both the Options Review and the Environmental Review documents is intended to inform and support a recommendation from Shell to the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) regarding a preferred response option. A final decision to either leave the riser and/or LMRP in place or to recover the riser and/or LMRP will be made by the CNSOPB.

2.0 INCIDENT DESCRIPTION

Shell recently completed drilling the Cheshire L-97 Well, a deepwater exploration well located approximately 250 km offshore of Nova Scotia within Exploration Licence (EL) 2426 (Figure 1). Drilling operations commenced on October 23, 2015 and were completed on September 21, 2016.

On March 5, 2016 while waiting on weather, the Stena IceMAX (IceMAX) disconnected from the Cheshire L-97 well at the blowout preventer (BOP) via the LMRP. After successful disconnect, the IceMAX was in the process of moving away from the well to a pre-designated location, when the riser tensioner load ring on the IceMAX released from the riser slip joint, allowing the riser and the LMRP to drop to the seafloor. No personnel were injured during this event and no synthetic-based mud (SBM) or other hydrocarbons or hydrocarbon-based products were released to the marine environment.
Fig 1 Project Location

Stantec Consulting Ltd. © 2016
Surveys of the seafloor completed after the incident, using a remotely-operated vehicle (ROV), confirmed the location and configuration of the LMRP and the 2 km long riser on the seafloor in water depth of 2143 m. The riser string was shown to crisscross and/or loop over itself at least 20 times on the seafloor. The maximum elevation of the riser above the seafloor during the ROV survey was approximately 7 m. The majority of the riser is located northeast, east, southeast and south of the Cheshire well location within an approximate 280 m x 240 m area (Shell 2016). Seventeen of the 804 buoyancy modules originally affixed to the riser were dislodged by the fall: nine were released to surface (and subsequently lost at sea) during the incident, and eight remained partially attached to or pinned under the riser. Observations made during the ROV survey indicated that the remaining 787 buoyancy modules at the seafloor remained securely attached. The ROV survey also determined that the LMRP is completely buried in the seafloor silt, with no part of the unit visible. In May 2016, the riser was resurveyed using the ROV. The maximum elevation of the riser above the seafloor was observed to be 6 m. Six of the eight modules originally identified as dislodged and partially attached to the riser were recovered and the remaining modules were confirmed to be secure. A final ROV survey was conducted on September 20-21, 2016 and confirmed that there has been no noticeable change to the riser location on the seafloor, and the remaining modules were still secure.

Each riser joint is 24.4 m (80 ft) long and weighs approximately 20 MT without buoyancy modules (Figure 2), and approximately 28 MT with buoyancy modules attached (Figure 3). The buoyancy modules (Figure 4) are composed of a syntactic foam core, covered by a fiberglass exterior skin. The buoyancy modules are considered chemically inert and do not contain any hazardous material.

The LMRP has a dry weight of 114.4 MT, and is approximately 7 m high and 5 m wide (Figure 5). It is estimated that there could be approximately 40-50 MT of silt packed around the LMRP.
Figure 2  Riser Joints without Buoyancy Modules Attached

Figure 3  Riser Joints with Buoyancy Modules Attached
SHELBURNE BASIN VENTURE EXPLORATION DRILLING PROJECT: MARINE RISER/LOWER MARINE RISER PACKAGE OPTIONS REVIEW

Figure 4 Buoyancy Module


Figure 5 LMRP

Stantec
3.0 RESPONSE OPTIONS UNDER CONSIDERATION

This Options Review considers the following response options:

- leaving the riser and/or LMRP in place
- recovery of the riser and/or LMRP

The term ‘the Project’ is used throughout this Option Review to refer to the potential implementation of any one of these response options, or the potential implementation of more than one of these response options in combination. Each response option under consideration represents a potential ‘Project activity’ in this Options Review and is described below.

The following response option descriptions and procedures are based primarily on Project information provided to Stantec by Shell.

3.1 LEAVING THE RISER AND/OR LMRP IN PLACE

Leaving the riser and/or LMRP in place would consist of the riser and/or LMRP remaining on and/or embedded in the seafloor indefinitely, with no plans for future recovery. With this option, there is a low risk of the buoyancy modules on the riser breaking apart and/or becoming loose and detaching over time, in which case they could ascend to the surface and become lost at sea. Any released modules would pose a very low risk to surface navigation and other ocean users.

Leaving the riser/LMRP components on the seafloor could potentially result in the localized release of contaminants or other substances, related to the corrosion and/or degradation of the riser/LMRP, into the marine environment over time; however, this risk is low. Any potential release of these potential contaminants from the riser and/or the LMRP would be in very small quantities over a long time and would be quickly diluted in the ocean such that any potential effects on sediment and/or water quality would be highly localized.

3.2 RECOVERY OF THE RISER AND/OR LMRP

Recovery of the riser and/or LMRP would include underwater cutting of the riser into smaller segments, excavation via trenching/jetting into the seafloor, and slinging and lifting the riser and/or LMRP to the surface and onto a recovery vessel. The recovered components of the riser and/or LMRP would then be disposed and/or recycled at appropriate land-based facilities. A safety zone may be established around Project vessels actively engaged in recovery activities therefore temporarily restricting other ocean users in the Project Area. Recovery activity would be scheduled for execution over the summer months during optimal meteorological and oceanographic (metocean) conditions and to minimize the risk to offshore workers. Recovery activities for the riser and/or LMRP would not be undertaken until after the completion of Shell’s current two well exploration drilling campaign.
3.2.1 Riser

The recovery of the riser would be conducted in stages: 1) surveying, 2) excavation, and 3) cutting and recovery of the riser joints.

Prior to commencing any recovery operation, a detailed ROV survey of the riser, identifying each joint individually, would be required. A cutting and recovery plan would also be developed to safely and effectively manage the riser recovery operations.

The riser recovery operations would be completed with a specialized vessel, equipped with at least two ROVs and a suitable (e.g., heavy lift, active heave compensated) crane, as well as suitable deck space to store and transport recovered riser joints. Specialized excavation and cutting tools will also be required.

To remove the riser from the seafloor, excavation would be required at designated locations along the riser joints for the installation of lifting slings. An ROV mounted with a specialized excavation tool would be deployed to excavate approximately 0.5 m under the riser joints. A soft sling would be threaded under the riser (in the excavated locations) and choked around the buoyancy material to hold the riser in place for cutting. The cutting operations would be carried out using the Diamond Wire Cutting Machine (DWCM). The ROV excavation tool would then be used, as required, to excavate under the areas of the riser where cutting is required. Once cut and secured, the cut riser joint would be lifted to the surface via the specialized crane and secured on the deck of the vessel. Either this vessel or an additional Platform Supply Vessel (PSV) would be utilized to transport the recovered cut riser joints and any debris ashore. This process would be completed for each of the 85 riser joints to be recovered from the seafloor.

During underwater cutting operations, numerous fragments of buoyancy modules (comprised of syntactic foam core and a fiberglass skin) could be released to the surface, resulting in floating debris. Although all reasonable efforts would be made to recover this material, it is anticipated that only some of the debris would be recoverable and the remainder would be lost at sea. A smaller vessel with the capability to recover any debris from the water may be required on standby.

It is estimated that recovery of the approximately 2 km of riser (comprising 85 marine riser joints) from the seafloor could take approximately 6 months or more to complete. Operations would be limited to suitable metocean conditions and the availability of specialized vessels.

3.2.2 Lower Marine Riser Package (LMRP)

There are several variables that will determine the procedures to be implemented for the recovery of the LMRP. Prior to commencing any excavation work, a detailed ROV survey of the area around the LMRP impact location would be required. This survey would locate the point where the riser enters the seafloor leading back from the buried LMRP. Initial excavation operations would commence at that location, removing the silt from the riser/LMRP connection point working back towards the buried LMRP to establish the actual location and attitude/angle
SHELBURNE BASIN VENTURE EXPLORATION DRILLING PROJECT: MARINE RISER/LOWER MARINE RISER
PACKAGE OPTIONS REVIEW

of the LMRP. Post-incident ROV surveys were unable to confirm whether the LMRP is upright/vertical or lying on its side given it is buried in the seafloor.

The LMRP recovery operations would be completed utilizing a drillship/drilling rig equipped with at least two ROVs and suitable heavy lift cranes, and would utilize excavation tools, as well as additional specialized equipment. Additional support vessels would also be required to support recovery operations.

Once the location and the angle of the LMRP is determined, extensive excavation of the seafloor would be required to access the LMRP for recovery. Excavation would be carried out using an excavation tool run on drill pipe from a drillship/drilling rig. The excavation tool produces 25,000 m³ of water per hour and is powered by seawater pressure (up to 3,000 psi) through the drill string from the drillship/drilling rig mud pumps. It can be expected that significant amounts sediment would be released into the water column during excavation activities.

Excavation would continue until a large crater has been opened all the way around the LMRP until the unit is sufficiently free to allow it to be lifted clear of the seafloor and recovered to the rig. The angle of the LMRP in the seafloor would determine how the LMRP would be disconnected from the riser to enable lifting/recovery, and this could require cutting.

Recovery of the LMRP would likely be undertaken using a drillship/drilling rig and is expected to take approximately 20 to 30 days, assuming the LMRP is in a generally upright/vertical position in the seafloor. Additional time may be required if it is discovered that the LMRP is lying on its side and could also potentially preclude recovery of the LMRP.

4.0 OPTIONS ANALYSIS

The decision to either leave or recover the riser and/or LMRP requires a broad range of factors to be considered. The following factors have been addressed in this section: health and safety; environment; Aboriginal and commercial fisheries; and technical feasibility.

4.1 HEALTH AND SAFETY CONSIDERATIONS

While the health and safety risks to the public associated with each response option are considered low, the health and safety risks to offshore personnel involved in the recovery option are considerable.

The potential loss of debris to the open ocean is associated with both leaving the riser and/or LMRP in place (potential release of buoyancy modules over time) and the recovery of the riser and/or LMRP (release of buoyancy module debris such as syntactic foam and/or the fibreglass skin). However, given the distance of the Cheshire wellsite offshore (250 km offshore), the water depth, the relatively low use of the area for fisheries or other ocean users, dispersion into the open ocean and potential degradation over time, any debris associated with either option is...
considered to have a low risk to public health and safety. This potential risk would be mitigated through communications with First Nations and fishers before, during, and after Project activities. Details regarding the timing and location of Project activities would be published in Notices to Shipping and Notices to Mariners, which would allow First Nations and fishers to plan activities accordingly. A more detailed discussion of the potential risk to Aboriginal and Commercial fisheries is discussed in Section 4.3.

The health and safety risks to offshore personnel differ substantially between the two response options. There are limited health and safety risks to offshore personnel associated with leaving the riser and/or LMRP in place, however there are considerable health and safety risks to offshore personnel associated with the recovery of the riser and/or LMRP.

The health and safety risks to offshore personnel could be affected by a combination of factors, including: the logistical complexity of subsea trenching, excavation and cutting operations, as well as associated heavy lifting operations; the condition and extent of the damage of the riser and the LMRP; the size and scale of equipment involved; the scope of interaction between equipment and recovery personnel onboard the vessels involved in recovery operations; and the highly technical and specialized nature of the expertise and competence of the workforce required to carry out each step of the recovery process.

The offshore environment also includes the potential for extreme fluctuations in wind, visibility, sea state, air temperature and currents that subject offshore recovery personnel to a broad spectrum of ambient health and safety hazards arising from additional unpredictable or emergent risks, including exposure. Inclement weather and increased risk of exposure could result in an offshore emergency and require evacuation of offshore personnel.

Potential health and safety risks to offshore personnel associated with the recovery of the riser and/or LMRP are listed below.

1. Occupational health and safety risks including:
   - direct unplanned contact of personnel with moving equipment and/or machinery on Project-related vessels, including swinging loads during offshore lifting operations
   - falling overboard from reaching outboard on a moving vessel or recovery vessel or being struck by rogue wave while personnel are working on deck
   - objects falling off the damaged riser during transfer to or from the recovery vessel (e.g., loose buoyancy modules, joint fins, choke or kill line, other sharp objects, other debris and materials)
   - potential loss of control of heavy swinging loads due to vessel motion resulting in vessel damage or injury to personnel
   - deck personnel becoming trapped against/between riser joints on deck as a result of vessel motion causing damaged riser to shift or due to congested deck
   - deck personnel sustaining hand and finger injuries due to handling irregular and sharp or damaged components/equipment
difficulty in securing irregular shaped/damaged joints and components on deck and resulting tripping hazards on the working deck, resulting in injury to personnel or damage to vessels

work-related upper limb disorders and musculoskeletal injuries due to repetitive work tasks over prolonged period (months)

environmental exposure to seasonally variable harsh weather conditions offshore

2. Risks associated with transportation and crew change of personnel offshore including:

the prolonging of operations over an extended duration which would expose offshore personnel to additional risk during vessel to vessel transfer (i.e., where primary recovery vessel/barge has no helicopter landing capability)

potential for limited offshore emergency response and evacuation procedures during periods of low/reduced visibility or inclement weather conditions

3. Vessel collision and damage risks including:

the management of marine operations, which may involve vessels on or close to the Project Area including simultaneous operations

recovery vessel hull damage resulting from heavy loads breaching surface or being swung inboard, including potential puncturing of hydraulic hoses or fuel tanks and/or loss of watertight integrity (i.e., choke and kill lines and other sharp protrusions)

risk of buoyancy modules and debris coming to surface during cutting, potentially hitting vessel hulls or damaging thrusters

re-suspension of sediment from recovery operations could cause reduced visibility thereby increasing risk of ROV collision with riser

4.2 ENVIRONMENTAL CONSIDERATIONS

This section summarizes potential environmental effects arising from the response options presented in the Environmental Review of Riser/LMRP Incident Response Options (Stantec 2016). Aboriginal and commercial fisheries are discussed in Section 4.3 below and in Stantec 2016. Potential environmental effects arising from activities associated with the response options can be generally characterized by criteria presented in Table 1 and Table 2 below.

The Valued Components (VCs) assessed in the Environmental Review include: Fish and Fish Habitat; Marine Mammals and Sea Turtles; Marine Birds; Special Areas; Commercial Fisheries; and Current Aboriginal Use of Lands and Resources for Traditional Purposes.

Leaving the Riser and/or LMRP In Place

As determined in the Environmental Review, residual adverse environmental effects (i.e., after application of proposed mitigation) of activities associated with leaving the riser and/or LMRP in place are predicted to be not significant. While this option will permanently leave debris on the
seafloor with some (unknown) potential for localized release of leachable material, or the
release of buoyant material, the riser could also increase habitat diversity by creating a reef
effect. Table 1 highlights the residual environmental effects of the option of leaving the riser
and/or LMRP in place. Refer to Table 3 in Section 5.3.1 of the Environmental Review for definitions
of criteria for characterization of residual environmental effects.

Table 1 Residual Environmental Effects – Option: Leaving the Riser and/or LMRP in
Place

<table>
<thead>
<tr>
<th>Residual Environmental Effect Characterization Criteria</th>
<th>Residual Environmental Effects Characteristics</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Effects</td>
<td>Positive, Neutral and Adverse</td>
<td>Although most effects are generally expected to be adverse (i.e., detrimental relative to baseline), the introduction of hard substrate may improve habitat quality for some benthic and demersal species.</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Negligible to Low</td>
<td>Any measurable change in species populations or habitat quality or quantity is expected to be within the range of natural variability and to not pose a risk to short-term viability of populations.</td>
</tr>
<tr>
<td>Geographic Extent</td>
<td>Project Area to Regional Assessment Area (RAA)</td>
<td>Effects would be limited to the Project footprint, except in the low probability event that buoyancy modules on the riser break apart and/or become loose and detach over time thereby resulting in floating debris that may extend to the RAA.</td>
</tr>
<tr>
<td>Duration</td>
<td>Long-Term</td>
<td>Effects would extend beyond the duration of Project activities (i.e., effects would be permanent).</td>
</tr>
<tr>
<td>Frequency</td>
<td>Sporadic to Continuous</td>
<td>Effects associated with buoyancy modules potentially breaking apart and/or becoming loose and detaching over time would occur sporadically, whereas effects associated with the presence of the riser and/or LMRP on/in the seafloor would occur continuously over the long term.</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Irreversible</td>
<td>Effects associated with the presence of the riser and/or LMRP on/in the seafloor would only be reversible upon removal of the riser and/or LMRP, which is not being considered within the scope of this potential Project activity.</td>
</tr>
</tbody>
</table>

Recovery of the Riser and/or LMRP

Recovery of the riser and/or LMRP may include underwater cutting of the riser into smaller
segments, excavation via trenching/jetting into the seafloor, and slinging and lifting the riser
and/or LMRP to the surface and onto a recovery vessel. These activities will result in a
disturbance of benthic habitat and resuspension of sediments, as well as increased vessel
lighting and underwater sound, potentially resulting in adverse effects on marine fish, mammals,
sea turtles and birds. These effects could persist for six months or more for the duration of recovery operations. However, the recovery option will result in the removal of all or much of the foreign structures from the seafloor allowing return of the benthic environment to a more natural state over time.

Residual adverse environmental effects associated with the recovery of the riser and/or LMRP are predicted to be not significant (Stantec 2016). Table 2 summarizes the residual environmental effects associated with recovery.

### Table 2 Residual Environmental Effects Characteristics – Option: Recovery of the Riser and/or LMRP

<table>
<thead>
<tr>
<th>Residual Environmental Effect Characterization Criteria</th>
<th>Residual Environmental Effects Characteristics</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Effects</td>
<td>Adverse</td>
<td>Effect is detrimental relative to baseline.</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Low to Moderate</td>
<td>Depending on the VC under consideration and which component(s) is/are recovered (i.e., riser and/or LMRP), the magnitude varies from a measurable change that is within the range of natural variability and does not pose a risk to short-term viability of populations to a measurable change that may exceed natural variability but does not pose a risk to long-term viability of populations.</td>
</tr>
<tr>
<td>Geographic Extent</td>
<td>LAA to RAA</td>
<td>Re-suspended sediments, underwater noise, and effects associated with the presence and operation of Project vessels would extend beyond the Project footprint to the Local Assessment Area (LAA), and substantial amounts of debris could rise to the surface and be lost to the RAA.</td>
</tr>
<tr>
<td>Duration</td>
<td>Medium-Term to Long-Term</td>
<td>Effects associated with excavation, cutting, slingling and lifting, and the presence and operation of Project vessels would extend through the duration of Project activities (i.e., approximately ≥6 months), whereas effects associated with the potential loss of surficial debris to the marine environment would extend for an indeterminate amount of time beyond the duration of Project activities.</td>
</tr>
<tr>
<td>Frequency</td>
<td>Continuous</td>
<td>Effects would occur continuously for the durations specified above.</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Reversible to Irreversible</td>
<td>VCs would recover to baseline conditions before or after completion of Project activities, except in the case of environmental effects related to the loss of surficial debris to the marine environment (which would persist for an indeterminate amount of time).</td>
</tr>
</tbody>
</table>
4.3 ABORIGINAL AND COMMERCIAL FISHERIES CONSIDERATIONS

ENGAGEMENT WITH FIRST NATIONS, ABORIGINAL ORGANIZATIONS AND KEY FISHERIES STAKEHOLDERS

Shell has been proactively engaging with key fisheries stakeholders, Aboriginal organizations and First Nations since the riser incident occurred on March 5, 2016. Shell met with the CNSOPB’s Fisheries Advisory Committee (FAC), the Kwilmu’kw Maw-klusuaqn Negotiation Office (KMKNO) – representing the Assembly of Nova Scotia Mi’kmaq Chiefs (ANSMC), Mi’kmaw Fisheries Managers and environmental organizations, the St. Mary’s and Woodstock Maliseet First Nations in New Brunswick, and the Mi’gmawe’l Tplu’taqnn Incorporated (MTI) – representing Mi’kmaw First Nations in New Brunswick. Information was also shared with the Sipekne’katik and Millbrook First Nations. A full list of meetings is outlined in Table 3 below.

<table>
<thead>
<tr>
<th>Date</th>
<th>Group/Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 20, 2016</td>
<td>CNSOPB – Fisheries Advisory Committee (FAC)</td>
</tr>
<tr>
<td>April 21, 2016</td>
<td>Kwilmu’kw Maw-klusuaqn Negotiation Office (KMKNO) / Assembly of Nova Scotia Mi’kmaq Chiefs (ANSMC)</td>
</tr>
<tr>
<td>May 18, 2016</td>
<td>Mi’gmawe’l Tplu’taqnn Incorporated (MTI)</td>
</tr>
<tr>
<td>May 18, 2016</td>
<td>St. Marys and Woodstock First Nations</td>
</tr>
<tr>
<td>June 22, 2016</td>
<td>FAC</td>
</tr>
<tr>
<td>June 23, 2016</td>
<td>KMKNO/ANSMC</td>
</tr>
<tr>
<td>September 21, 2016</td>
<td>FAC</td>
</tr>
<tr>
<td>September 22, 2016</td>
<td>KMKNO/ANSMC</td>
</tr>
<tr>
<td>October 31, 2016</td>
<td>St. Mary’s First Nation</td>
</tr>
<tr>
<td>November 3, 2016</td>
<td>Mi’kmaq Fisheries Managers</td>
</tr>
</tbody>
</table>

Meetings with key fisheries stakeholders, Aboriginal organizations and First Nations were held at different stages of incident investigation and reporting. The first round of meetings was held in April to describe what was known about the incident to date; sub-surface conditions at the wellsite; the mechanics of a riser system and how it works; and preliminary options for the riser system on the seabed (leave in place or remove). The second round of meetings was held in June, once the investigation into the incident had concluded. Shell shared the results of the investigation, including key findings and corrective actions; and preliminary results from an independent environmental review of the riser options by Stantec. In September, Shell shared a draft copy of the Stantec Environmental Review with First Nations and key fisheries stakeholders in advance of another round of meetings from September to November 2016. These meetings focused on the corrective actions in place to prevent a future incident, the results of the independent Environmental Review, and preliminary information from the options assessment document.
In general, key fisheries stakeholders, Aboriginal organizations and First Nations have a good understanding of rationale for potentially leaving the riser in place; the technical requirements for removal of the riser; and the potential risks/impacts and benefits of both options.

Tables 4 and 5 below capture the most frequently expressed concerns regarding both options, as well as the response provided by Shell.

**Table 4  Recovery of the Riser and/or LMRP**

<table>
<thead>
<tr>
<th>Comment</th>
<th>Response from Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential harmful effects to fish and habitat due to a proposed extended period of trenching and jetting around the riser and LMRP.</td>
<td>Removal of the riser will require extensive trenching and jetting in the Project Area for the duration of the operation (approximately six months), during which time there will be disturbance to habitat.</td>
</tr>
<tr>
<td>Restricted fishing activity during the removal operation (safety zone around the operation for approximately 6 months).</td>
<td>During a recovery operation, an exclusion safety zone would be implemented around the operation; this would be similar to that which is in place with the IceMAX during drilling operations. However, due to the low level of fishing activity in the area, it is anticipated that impacts to fishing would be minimal.</td>
</tr>
<tr>
<td>High potential for health and safety risks to offshore personnel.</td>
<td>A recovery operation would entail an unreasonably high degree of exposure to offshore hazards for recovery and salvage personnel, which cannot be mitigated satisfactorily to bring the risk to a level as low as reasonably practicable (This has been summarized in Section 4.1 of this Options Review document).</td>
</tr>
<tr>
<td>Potential for substantial amounts of debris to come to the surface during removal operations.</td>
<td>It is expected that fragments of buoyancy modules released during underwater cutting operations of the riser could rise to the surface, resulting in floating debris. Although all reasonable efforts would be made to recover this material, it is anticipated that only some of the debris would be recoverable while the remainder would be lost at sea. The potential for damage to commercial fishing gear caused by debris released to the surface during recovery activities is limited. However, Project-related damage to fishing gear, if any, would be compensated in accordance with the Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2002).</td>
</tr>
</tbody>
</table>
### Table 5  Leaving the Riser and/or LMRP in Place

<table>
<thead>
<tr>
<th>Comment</th>
<th>Response from Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for interference/interaction of the riser on the seabed with fishing equipment/gear.</td>
<td>The limited amount of fishing that occurs in the area is longline fishing for pelagic species utilizing topline gear. Longline fishing gear extends approximately 400 m into the water column. The riser is sitting at a depth of approximately 2000 m where it would not interfere with longline fishing gear. There is no bottom trawl fishery in the area. To mitigate any potential interaction, at a minimum, the site of the riser/LMRP would be published in Notices to Mariners for consideration by fishers and other marine users.</td>
</tr>
<tr>
<td>The Mi’kmaq of Nova Scotia are concerned about potential adverse impacts to Aboriginal and Treaty rights to fish in the area now, and seven generations into the future. While there may not be specific Mi’kmaq fisheries in the project area at this time, this does not preclude Mi’kmaq rights to fish now or in the future.</td>
<td>Shell acknowledges that the Mi’kmaq have Aboriginal and Treaty rights to fish in the waters of Nova Scotia. All efforts have been made to understand and accommodate the concerns of the Mi’kmaq of Nova Scotia. Shell maintains that since there is very little fishing in the area, and that fishing activity in the foreseeable future will likely remain that way, there would be a very low potential for adverse impacts to Mi’kmaq fishing rights.</td>
</tr>
<tr>
<td>Submersed equipment may break loose and surface, causing potential interactions with vessels.</td>
<td>There is a low likelihood of the buoyancy modules or other equipment breaking apart and/or becoming loose and detaching over time. The riser equipment and buoyancy module system is designed for deep ocean conditions and is highly resilient to salt water and pressures at these sea depths. The modules are attached to the riser with ¾ inch stainless steel studs and mechanical degradation of the modules is expected to be minimal. Any potential loss of buoyancy modules from the riser would be expected to occur incrementally and intermittently over several years, with individual modules/fragments released gradually due to the slow corrosion of thread studs and/or degradation of the modules.</td>
</tr>
<tr>
<td>Materials in submerged equipment may deteriorate over time and cause negative impacts to habitat.</td>
<td>See response immediately above.</td>
</tr>
<tr>
<td>Possibility that the riser may shift over time and damage the abandoned wellhead at the Cheshire Wellsite.</td>
<td>There have been three ROV surveys at the riser site since the incident on March 5th. Each survey indicates that the riser is settling onto the seabed, and in some cases, parts of the riser (as well as the LMRP) are already buried in the seabed. The closest piece of equipment is a section of the riser resting 12 m from the abandoned wellhead. The well has been abandoned and plugged with cement, according to regulatory requirements and industry standards. Any potential interaction</td>
</tr>
</tbody>
</table>
RECOMMENDATIONS

In addition to the concerns expressed and outlined above, a number of recommendations were also made to Shell which have been outlined below in Table 6.

Table 6 Recommendations Made to Shell During Engagement

<table>
<thead>
<tr>
<th>LEAVE IN PLACE:</th>
<th>RECOVERY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A number of people have recommended that Shell leave the riser/LMRP in place.</td>
<td>Some people have recommended that Shell recover the riser/LMRP.</td>
</tr>
<tr>
<td>• This is in keeping with other “items” lost or abandoned at sea (i.e. containers, fishing vessels, cables, pipelines).</td>
<td>• Shell should demonstrate its commitment to being an environmentally-friendly operator.</td>
</tr>
<tr>
<td>• The potential disturbances to habitat from operations related to riser/LMRP removal are not worth the risk.</td>
<td>• Leave all buried equipment in place and remove what is visible.</td>
</tr>
<tr>
<td>• The health and safety risks to personnel are too great to warrant removing the riser/LMRP.</td>
<td>• Remove the riser/LMRP to prevent any current or future interactions with fisheries in the area.</td>
</tr>
<tr>
<td>• If the riser/LMRP is left in place, establish a monitoring program to monitor potential deterioration of materials, any release of materials, and potential shifting of the riser and/or LMRP over time.</td>
<td></td>
</tr>
</tbody>
</table>

4.4 TECHNICAL FEASIBILITY

Technical feasibility indicates the potential success of an activity based on technologies and approaches demonstrated previously for similar applications at similar scales. The option to leave the riser and/or LMRP in place is technically feasible given both the riser and LMRP would be left in place on the seafloor.

The procedures for recovery of the riser and/or LMRP are described in Sections 3.2.1 and 3.2.2, respectively. The recovery option for the riser and/or LMRP is technically challenging from both a logistical and operational perspective due to the complexity and specialized nature of the operational activities, the depth of water (2143 m), the use of specialized equipment (vessels, drillship/drilling rig, ROVs, excavations tools, cutting tools, etc.) and techniques required, the offshore working conditions (i.e., unpredictable weather and oceanographic conditions), the
length of time to carry out operations, and the health and safety risk posed to offshore personnel. There may be further technical complexities around the removal of the LMRP depending on the position of the LMRP within the seafloor. These variables could affect the ability to cut the riser connection to the LMRP and the method of slinging based on available lifting points.

The risk of compromising the integrity of the Cheshire exploration well during LMRP recovery is low due to the subsurface barriers installed in the well bore during the permanent abandonment of the well.

The estimated time to plan and execute the recovery of the riser and/or LMRP would be approximately 1 year to account for the sourcing of specialized recovery vessels, the application of the vessel intake process and the limited window of optimal metocean conditions. The metocean conditions offshore Nova Scotia and associated restricted window of operations, would present additional significant operational and safety challenges while presenting an increased risk to the offshore workers involved.

5.0 HISTORICAL PROJECT EXAMPLE: COHASSET-PANUKE

The Cohasset-Panuke project is a relevant example of a decommissioned and abandoned offshore oil installation in Atlantic Canadian waters. It is positioned 41 km southwest of Sable Island in relatively shallow water depth of 45 m. Cohasset-Panuke comprised a mobile offshore drilling unit (MODU) that contained the processing equipment and accommodation facilities necessary to produce from two separate wells at the Cohasset and Panuke reservoirs. Production ceased on December 17, 1999. In December 2003, the operator (Encana Corporation) submitted an application to the CNSOPB to amend the Cohasset development plan to allow a decommissioning program based on the partial removal of the subsea equipment and material, with some equipment, including flowlines and related subsea infrastructure, abandoned in place (CNSOPB 2004).

During the regulatory review of Encana Corporation’s proposed decommissioning plan, the CNSOPB reviewed findings from other jurisdictions which commonly demonstrated that pipeline removal options, as compared to abandoning them in place, carried a greater risk to personnel due to increased hands-on activities (CNSOPB 2004). Ultimately, the Board was satisfied that it would not be prudent to put personnel at increased risk to remove the flowlines and related material. The Board was also satisfied that partial abandonment was not likely to cause significant adverse environmental effects. Board approval was therefore provided to abandon the flowlines and related subsea infrastructure in place.
6.0 CONCLUSION AND SUMMARY

The Options Review was conducted to evaluate the advantages and disadvantages of leaving the riser and/or LMRP in place and the recovery of the riser and/or LMRP with regards to health and safety, environmental considerations, Aboriginal and commercial fisheries, and technical feasibility, which are summarized below.

In summary, the Options Review concludes that recovery of the riser and/or LMRP would:

- present a low risk to the health and safety of ocean users, but present a considerable health and safety risk to offshore personnel related to the complexity and highly specialized nature of offshore recovery operations, the size and scale of the equipment involved, the interaction between equipment and offshore personnel, as well as the harsh environmental conditions offshore;
- not likely result in significant adverse environmental affects to the marine environment and commercial and Aboriginal fisheries, provided appropriate mitigations are in place; and
- be technically feasible but have considerable logistical challenges including the complexity of each operational phase (excavation, cutting and recovery), the considerable depth of water where the riser and LMRP are located (2143 m), and the use of specialized equipment and techniques.

It is anticipated that leaving the riser and/or LMRP in place would:

- present negligible health and safety risk to offshore personnel or other ocean user;
- not likely result in significant adverse environmental affects to the marine environment and commercial and Aboriginal fisheries, provided appropriate mitigations are in place; and
- be technically feasible.
**Table 7  Summary of Considerations for the Leaving or Recovering of the Riser and/or LMRP**

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Leaving the Riser and/or LMRP In Place</th>
<th>Recovery of the Riser and/or LMRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and Safety</td>
<td>• Health and safety considerations for leaving the riser and/or LMRP in place are considered negligible.</td>
<td>• Potential occupational health and safety risks to offshore personnel related to the complexity and highly specialized nature of offshore recovery operations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Vessel collision and damage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increased exposure to health and safety risks due to Project delays and transportation and crew change of offshore personnel.</td>
</tr>
<tr>
<td>Environmental</td>
<td>• The introduction of hard substrate with interstitial spaces may result in a positive change in habitat quality and use by enhancing the diversity of benthic habitat and creating an artificial ‘reef effect’.</td>
<td>• The magnitude varies from a measurable change that is within the range of natural variability and does not pose a risk to short-term viability of populations to a measurable change that may exceed natural variability but does not pose a risk to long-term viability of populations. Re-suspended sediments, underwater noise, and effects associated with the presence and operation of Project vessels would extend beyond the Project footprint to the LAA, and substantial amounts of debris could rise to the surface and be lost to the RAA.</td>
</tr>
<tr>
<td></td>
<td>• Any measurable changes in species populations or habitat quality or quantity do not pose a risk to short-term viability of populations.</td>
<td>• Excavation, cutting, slinging and lifting, and the presence and operation of Project vessels would extend through the duration of recovery activities.</td>
</tr>
<tr>
<td></td>
<td>• Effects would be limited to the Project footprint, except in the sporadic event that buoyancy modules on the riser break apart and/or become loose and detach over time.</td>
<td>• Potential loss of debris to the marine environment would extend for an indeterminate amount of time beyond the duration of recovery operations.</td>
</tr>
<tr>
<td>Aboriginal and Commercial Fisheries</td>
<td>• The potential for buoyancy modules/fragments to break loose over an extended period and interact with fisheries would be relatively low, particularly following dispersal of any fragments in the open ocean.</td>
<td>• VCs would recover to baseline conditions before or after completion of Project activities, except in the case of environmental effects related to the loss of debris to the marine environment.</td>
</tr>
<tr>
<td></td>
<td>• Although the presence of the riser and/or LMRP would be permanent, potential interactions with Aboriginal or commercial fisheries are expected to be limited since there are no unique fishing grounds within the Project Area, therefore potential effects on fisheries access are expected to be limited.</td>
<td>• There is a limited potential for damage to occur to commercial fishing gear caused by debris released to the surface.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A safety (exclusion) zone may be established during recovery operations which could temporarily restrict access for fishing activities in the affected area. However, there are no unique fishing grounds or concentrated fishing effort that occurs exclusively within the Project Area.</td>
</tr>
</tbody>
</table>

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**Stantec**
Table 7  Summary of Considerations for the Leaving or Recovering of the Riser and/or LMRP

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Leaving the Riser and/or LMRP In Place</th>
<th>Recovery of the Riser and/or LMRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grounds or concentrated fishing effort that occurs exclusively within the Project Area.</td>
<td>surficial debris may extend out beyond the Project Area. The debris field is expected to disperse relatively quickly in the open ocean, at which point its potential effects on commercial fishing activities are reversible.</td>
<td></td>
</tr>
</tbody>
</table>
| Technical Feasibility         | • Leaving the riser and/or LMRP in place is technically feasible given the equipment would be left in place. | • With the application of the Project-specific recovery plans, recovery efforts of the riser and/or LMRP from the seafloor are predicted to be technically feasible.  
  • Recovery efforts are more technically challenging because of the complexity of each operational phase, depth of water, specialized equipment and techniques, the challenging offshore working conditions (i.e., unpredictable weather), the length of time it takes to carry out operations, and the health and safety considerations. |
| Summary of Considerations     | • Limited health and safety risks to other ocean users and offshore personnel  
  • Low environmental effect over a longer period  
  • Low effect on Aboriginal and commercial fisheries  
  • Technically feasible (equipment left in place) | • Considerable health and safety risk to offshore personnel  
  • Greater environmental effect over a shorter period  
  • Low effect on Aboriginal and commercial fisheries  
  • Technically feasible but logistically and operationally challenging  
  • Substantial time |
7.0 REFERENCES


