Environmental Screening Report for the Shell Canada Ltd. Quest Carbon Capture and Storage Project

Prepared by: Natural Resources Canada and Canadian Transportation Agency

March 2012

CEAR Reference No.: 10-01-55916

1. INTRODUCTION

Pursuant to paragraph (5)(1)(b) of *Canadian Environmental Assessment Act* (CEA Act) Natural Resources Canada (NRCan) is a Responsible Authority (RA) for Shell Canada Limited's (Shell) proposed Quest Carbon Capture and Storage project (the Project) as it may provide funding to the Project through the Clean Energy Fund (CEF). Pursuant to paragraph 5(1)(d) of the CEA Act the Canadian Transportation Agency (CTA) may also be an RA as it may issue an authorization that is captured in the *Law List Regulation*s. As such, NRCan and CTA are required to ensure that environmental assessment (EA) is conducted in compliance with the CEA Act. The Project is subject to a screening-level EA.

Given that carbon capture and storage technology of this magnitude is considered a new technology, it was determined that public consultation pursuant to section 18(3) of the CEA Act would be conducted for this Project.

Pursuant to subsection 12(3) of the CEA Act, Fisheries and Oceans Canada (DFO), Environment Canada (EC), Health Canada (HC) and Transport Canada (TC) participated as federal authorities (FAs) during the EA. FAs provided specialist or expert information or knowledge to inform decision-making and provided advice to RAs in areas related to their mandate. This included providing advice about the mitigation measures and monitoring for the Project, which Shell has committed to implementing.

This screening report provides a summary of the federal EA process conducted for the Project and is based on the information presented in Shell's EA documents and expert information and knowledge provided by the FAs participating in the EA process. The information collected during the provincial EA process and comments by the public and Aboriginal Groups were also considered by NRCan and the CTA in the development of this screening report. Key documents for the EA include:

- Screening Scoping Document for the proposed Shell Quest Carbon Capture and Storage Project (August 2010) (see CEA Agency et. al 2010);
- Final Terms of Reference Environmental Assessment Report for the proposed Shell Quest Carbon Capture and Storage Project (AENV 2010);
- Quest Carbon Capture and Storage Project: Environmental Assessment (November 2010) (see Shell 2010a, 2010b, and 2010c);
- Pipeline Environmental Protection Plan (EPP) (see Shell 2010a Appendix I) and Conservation and Reclamation Plans for the CO_2 Pipeline and Well Pads (see Shell 2010a Appendices E and F, respectively);
- Update to the Environmental Assessment Project Description (Shell 2011d);
- A letter to the ERCB, dated August 25, 2011, describing the relocation of a candidate injection well and an erratum in Section 10 of the originally filed Environmental Assessment (November 2010) for the Project (see Shell 2011a); and
- Responses to supplemental information requests from:
    - Alberta Environment and responsible and federal authorities on July 20, 2011 (see Shell 2011b), and
    - Alberta Environmental and responsible and federal authorities on October 25, 2011 (see Shell 2011c).

1.1 Federal EA Contact Information

The Federal Environmental Assessment Coordinator for this project is the Canadian Environmental Assessment Agency (the Agency). For information related to the EA for this Project please contact:

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2. PROJECT DESCRIPTION

Project Information			
Project Title	Shell Quest Carbon Capture and Storage Project		
Description of Work/Activity	CO_2 capture, transportation and storage		
Project Location	Alberta, Canada Capture infrastructure and pipeline start point: -113° 5 min 17 sec longitude, 53° 10 min 15 sec latitude Area of Interest centre point: -113° 2 min 24 sec longitude, 54° 10 min 15 sec latitude		
Proponent and Contact Information	Shell Canada Limited Kathy Penney Regulatory and Environmental Manager – Quest CCS Project Shell Canada Energy Shell Centre, 400 4th Avenue SW Calgary, AB T2P 2H5 Tel: (403) 691-3111 Fax: (403) 691-3321 Email: Kathy.Penney@shell.com		
Provincial Application Date	November 30, 2010	CEAA Registration Date	June 23, 2010
CEAA Triggers	Section 5(1)(b) and potentially 5(1)(d) (if Shell is required to obtain permits or authorizations listed in the Law List Regulations) of the CEAA		
Assessment Coordinator	Michelle Camilleri, Environmental Assessment Officer		
CEAA Determination Date	TBD		

Shell, on behalf of the Athabasca Oil Sands Project, which is a joint venture between Shell Canada Energy, Chevron Canada Limited, and Marathon Oil Canada Corporation, is proposing to construct, operate and reclaim the Project. The Project will capture, transport and permanently store carbon dioxide (CO_2), thereby reducing greenhouse gas emissions from the existing Scotford Upgrader. The Scotford Upgrader is located about 40 km northeast of Edmonton, Alberta, within Alberta's Industrial Heartland (AIH) (see Figure 1-1).

The Project is within the municipal boundaries of Strathcona County, Lamont County, Sturgeon County and Thorhild County. The Project occurs entirely on privately held lands, except for several named watercourse crossings (bed and banks) administered by the Crown. Land use across most of the Project area is agricultural. The CO_2 capture infrastructure and the southern

portion of the pipeline route are on industrial lands, within AIH. Land uses in AIH are industrial, agricultural, subsurface and other resource extraction (i.e., quarries, logging).

More information about the Project is available in the *Quest Carbon Capture and Storage Project: Environmental Assessment (November 2010) (Shell 2010a, 2010b, and 2010c) and Update to the Environmental Assessment Project Description (Shell 2011d).*

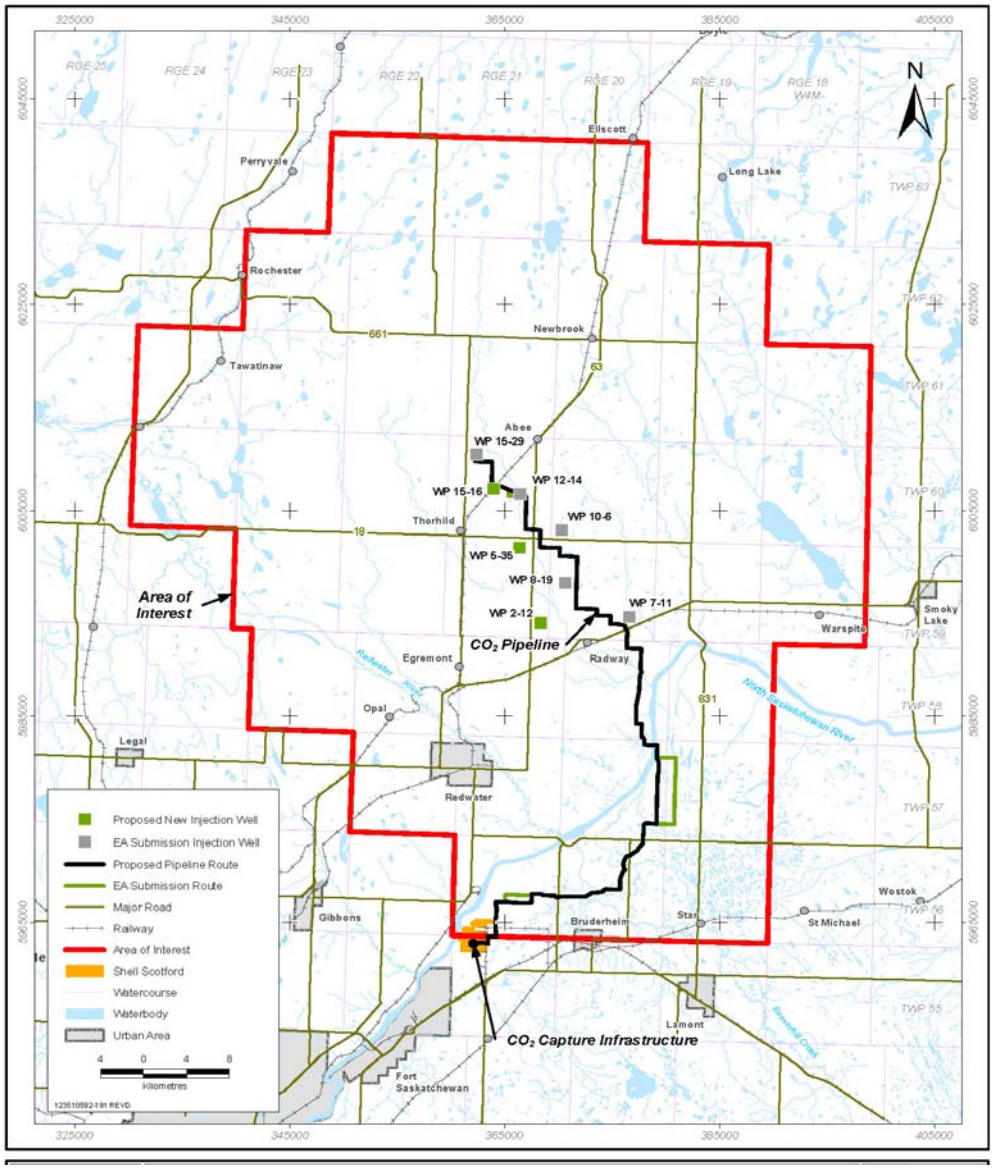

Figure 1-1 Map showing project components and Area of Interest (AOI)

The Project components include:

- CO_2 capture infrastructure, which involves a process modification to the existing Scotford Upgrader. The method of capture is based on a licensed Shell activated amine technology called ADIP-X;
- A CO_2 pipeline measuring approximately 80 km that will transport the CO_2 from the Scotford Upgrader to injection wells for CO_2 storage; and
- Permanent storage of the CO_2 through three to eight injection wells, which will inject the CO_2 into the Basal Cambrian Sands (BCS), a deep saline geological formation, for permanent storage at a depth of about 2 km below ground level.

The CO_2 capture infrastructure will be located on pre-disturbed land within the Scotford Upgrader. The CO_2 pipeline will extend from the Scotford Upgrader, north across the North Saskatchewan River and terminate north of the hamlet off Thorhild. The injection wells will be situated in the CO_2 storage Area of Interest (AOI), occupying about 40 townships in area. Shell has currently identified eight candidate injection well locations.

2.1. Project Schedule

Assuming that all required regulatory and internal management approvals are received by Q1 2012, the schedule for the construction start-up and operation of the Project is expected to be as outlined below in Table 1-2.

Activity	Timeline
Drilling and completions of injection wells	Q2 2012 and continuing through 2015
Construction of CO_2 pipeline within Shell Scotford fenceline	Q3 2012
Construction of CO_2 capture infrastructure	Q3 2012 to Q4 2014
Setup and initiation of a Horizontal Directional Drill at North Saskatchewan River	To begin in Q3 2013
Construction of CO_2 pipeline (exclusive of watercourse crossings and Shell Scotford connection)	Q4 2013 to Q2 2014
Construction of CO_2 laterals	Q4 2013 and continuing through 2015
Commissioning and start-up of operations	Q1 2015
Full sustained operations	By Q4 2015 with operations continuing for the life of the Scotford Upgrader (greater than 25 years)

3. SUMMARY OF THE ENVIRONMENTAL ASSESSMENT

For the purposes of the federal EA, the scope of the Project determined by Responsible Authorities, pursuant to authority under section 15(1) of CEAA, included the following elements and activities:

- the construction of the capture infrastructure, CO_2 pipeline and storage facilities;
- the operation of the capture infrastructure, CO_2 pipeline and storage facilities, under normal operation as well as accidents or malfunctions that might occur during its operation; and

- the decommissioning and abandonment of the capture infrastructure, CO_2 pipeline and storage facilities at the end of its useful life, to the extent that is currently known.

The scope of the federal environmental assessment is outlined in the *Screening Scoping Document for the Proposed Shell Quest Carbon Capture and Storage Project* (August 4, 2010), and *Final Terms of Reference Environmental Assessment Report for the proposed Shell Quest Carbon Capture and Storage Project* (November 2, 2010). The scope of the EA included mandatory factors under section 16(1)(a) to (d) of the CEA Act and additional factors identified under sections 16(1)(e), 16(2) and as determined by the RAs under section16(3) of the *CEA Act*.

3.1. Environmental Assessment Methods

The EA methods are described in detail in the Quest Carbon Capture and Storage Project: Environmental Assessment (November 2010).

The EA focused on Valued Environmental Components [1](VECs) that are likely to be affected by the Project and that were identified through examination of Project activities and plans, or identified by RAs and FAs involved in the EA. The following VECs were considered in the EA:

- Atmospheric environment
  - air quality
  - sound quality
- Groundwater resources
- Aquatic environment
- Terrestrial environment
  - soils and terrain
  - vegetation and wetlands
  - wildlife and wildlife habitat
- Archaeological and heritage resources
- Current use of land and resources, including for traditional purposes by Aboriginal persons
- Land use
- Public health and safety
- Socio-economics

The EA also considered any potential cumulative environmental effects and environmental effects that could occur as a result of accidents, malfunctions and unplanned events.

[1] VECs are defined as broad components of the biophysical or human environments that, if altered by the Project, may be of concern or 'value' to federal authorities, regulators, resource managers, scientists, the public, and Aboriginal communities.

The EA identified adverse environmental effects of the project in relation to a particular VEC and described the mitigation measures Shell will employ to minimize these adverse environmental effects. Any residual environmental effects that remained after the application of mitigation measures were evaluated for significance[2].

4. SUMMARY OF ENVIRONMENTAL EFFECTS ASSESSMENT

A complete and detailed description of the environmental effects assessment is available in the *Quest Carbon Capture and Storage Project: Environmental Assessment (November 2010)*. The following sections provide a brief summary of the environmental effects assessment:

4.1. Atmospheric environment

4.1.1. *Air Quality*:

The air quality assessment focused on the CO_2 capture infrastructure component because it produces most of the air emissions. Project environmental effects on air quality occur primarily, when the CO_2 capture infrastructure is operational. Potential air quality changes associated with the Project were also evaluated on a cumulative basis. The CO_2 capture infrastructure will result in a decrease of CO_2 emissions to the atmosphere.

Shell identified that the Project may result in an increase in the thermal generation of oxides of nitrogen (NO_X) emissions due to CO_2 capture infrastructure. As NO_X emissions are considered a precursor for secondary particulate matter ($PM_{2.5}$) formation, potential acid input (PAI) deposition, nitrogen deposition, ozone formation and regional haze, it is predicted that the increased NO_X will also lead to slight increases in the formation of $PM_{2.5}$ particulate matter, PAI Deposition, nitrogen deposition, ozone formation and regional haze. These effects are expected to be negligible. The CO_2 capture infrastructure does not result in changes to other emission components.

Shell has committed to install low NO_X burners as a mitigation measure. In addition, Shell has committed to the use of flue gas recycle (FGR) technology that is expected to further reduce the NO_X emissions associated with the Project. Shell has committed to continue evaluating the effectiveness of this technology and discuss its implementation with the Government of Alberta and Environment Canada.

With the application of mitigation measures, the adverse environmental effects associated with air emissions will be minimal and not significant. An air emission monitoring program (Shell 2010c) will be implemented by Shell to monitor emission predictions and the performance of the flue gas recycle technology. This will be included as part of the Follow-Up program.

4.1.2. *Sound quality*:

Environmental effects of noise from the CO_2 capture infrastructure during normal operation would be localized (within 3 km of the source). Ten residences were identified within 3 km of the capture infrastructure and are considered locations where there may be adverse environmental

[2] Significance of residual adverse environmental effects is defined in *Quest Carbon Capture and Storage Project: Environmental Assessment (November 2010).*

effects resulting from noise. During operation, new noise emission sources associated with the CO_2 capture infrastructure are expected to result in a minor increase in sound levels at the Scotford Upgrader. Additionally, activities associated with construction and decommissioning of the Project will result in an increase in noise levels, however, these will be temporary. Shell has committed to implementing standard and best management protocols to minimize potential adverse environmental effects of noise. Mitigation measures include: limiting timing of construction to daylight hours (i.e. 07:00 to 20:00h), employing equipment with noise suppression systems and placing barriers to block sound. A noise impact assessment undertaken by Shell confirmed that the Project should comply with the requirements of Directive 38.

With the implementation of mitigation measures, adverse environmental effects of noise are expected to be minimal. In Alberta, the Energy Resource Conservation Board (ERCB), Directive 38, regulates sound levels generated by energy-related facilities[3]. According to Directive 38, monitoring noise impacts is complaint driven. As such Shell will implement a complaint monitoring program, which will allow them to address noise complaints as appropriate.

With the application of mitigation measures, including best management practices, adverse environmental effects to the atmospheric environment are not significant.

4.2. Groundwater resources

Generally, groundwater in the area is topographically driven and is characterized as moderately fresh however in deeper areas groundwater containing higher levels of sodium-potassium is prevalent. Construction activities may interact with groundwater resources, primarily if dewatering is required to manage any locally high water tables. However, dewatering would occur only during construction and would be at a local scale, of short duration and low magnitude. Changes to groundwater flow near the horizontal directional drill (HDD) crossing would be localized to the area immediately adjacent to the CO_2 pipeline, and at a regional scale would not be measurable.

During operations, no interaction between the injected CO_2 and the area above the base of groundwater protection (BGWP) is predicted due to the depth of injection and the presence of multiple subsurface barriers. The injection of CO_2 into the storage area might cause gradual subsurface vertical strain (heave) due to increased pressures within the BCS of up to 0.06 m over the life of the Project (25 years). However, based on the predicted change in groundwater levels resulting from surface heave, the potential environmental effects on groundwater quantity will be low.

With the application of mitigation measures, including best management practices, adverse environmental effects of the Project on groundwater resources will be not significant. A groundwater monitoring program will be implemented during the operation as part of Shell's Measurement, Monitoring and Verification (MMV) program. The results of this monitoring program will be reviewed by NRCan and included in the Follow-Up program for the Project.

[3] ERCB: Directive 038: Noise Control (February 2010).

4.3. Aquatic environment

There are 18 watercourse crossings along the pipeline right-of-way (ROW), which range from ephemeral field drainages to the North Saskatchewan River. Field studies found only five crossings which occur on four fish-bearing watercourses that have fish habitat potential: Astotin, Beaverhill and Namepi Creeks and the North Saskatchewan River.

The study area of the North Saskatchewan River where the crossing will occur contains habitat that may be suitable for lake sturgeon spawning. Lake sturgeon is listed as a Species at Risk by Alberta and is listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Potentially, lake sturgeon could spawn in the rapids downstream of the crossing and rear in the vicinity of the crossing; however, there are no unique or critical habitat components for this species in the area within the study area.

Lower Namepi Creek contains suitable habitat for some spring spawning species but not sport fish. The area close to the crossing is predominantly fine substrate (80% fines) that would not be suitable for spawning by either sucker or sport fish species. The creek has limited habitat at other times of the year due to low water levels. The habitat is ranked marginal. The other crossings (Beaverhill, Astotin and Upper Namepi Creeks) have habitat suitable for forage fish and are ranked as marginal habitats.

Shell predicted that the CO_2 pipeline and well pads have the greatest potential to interact with the aquatic environment, especially during the construction phase as watercourses are crossed. Shell is proposing to cross the North Saskatchewan River using HDD. All remaining watercourses will be crossed following the DFO Operational Policy Statements which include using various methods such as: open cut when dry or frozen, trenchless and isolated trenching.. Fording of watercourses may be required.

Potential adverse environmental effects on fish and fish habitat in the North Saskatchewan River will be avoided by using HDD. Sedimentation will also be avoided. In the event that the HDD crossing is not feasible, a trenched method will be used. Shell will employ sediment control measures until all disturbed ground has been permanently stabilized, so that suspended soil particles in the river and surface runoff water are limited or trapped to reduce turbidity in the aquatic environment. Erosion and sediment control during construction and after the reclamation of the crossing will be achieved through a combination of physical, operational and scheduling measures. A monitoring plan will be implemented to measure total suspended solids (TSS) during construction. Any adverse effects from a trenched crossing are anticipated to be not significant.

For the remaining watercourses, including Lower Namepi Creek, construction outside the period when fish may be spawning or migrating in the watercourse (the restricted activity period) will avoid any potential environmental effects to habitat used during sensitive life stages. Additionally, construction during the fall or winter when the watercourses are dry or frozen will reduce vegetation damage and allow the bed and banks to be restored to preconstruction conditions to limit changes to fish habitat. If flowing water is present, using an isolated crossing technique will prevent downstream transport of sediment and prevent downstream dewatering of fish habitat. Isolation of the Beaverhill, Astotin and Namepi Creeks crossings will be considered only as a contingency method, if the trenchless method is unsuccessful, or if the watercourse is not dry or frozen. With planned mitigation, isolation of these crossings may still result in some fish mortality or stress. Fish stranded within the isolated area can be removed as

the dewatering process takes place. Isolation concentrates the fish in a small area and increases the number able to be captured. The fish capture and release decreases the likelihood of the loss of a large number of individuals. The environmental effects of such potential mortality are, therefore, not significant.

The crossing methods outlined above will follow DFO Operational Statements for High-Pressure Directional Drilling and Isolated or Dry Open-cut Stream Crossings, as appropriate. With the implementation of mitigation measures, including protocols outlined in Operational Statements, the Project will result in minimal net loss of fish habitat, minimal discharge of sediment or similar substances to fish habitat and have minimal effect on critical habitat of species listed in Schedule 1 of the *Species at Risk* Act. Therefore, in consideration of planned mitigation, of the Project environmental effects on the aquatic environment are not significant.

Shell is committed to providing DFO and Transport Canada with a contingency plan for the crossing of the North Saskatchewan River using a trenched crossing, in compliance with Alberta Environment and Water Code of Practice for Pipelines and Telecommunication Lines Crossing a Waterbody under the *Water Act*. The contingency plan will include the assessment of effects, mitigation measures and methodology summary. A monitoring plan for each crossing will also be submitted to DFO for review before construction. In the unlikely event that a crossing causes a harmful, alteration, disruption or destruction that requires DFO authorization, Shell would adhere to the requirements of the authorization and provide fish habitat compensation as required under DFO's No Net Loss Policy so that no residual environmental effects on fish habitat will occur. Any fish habitat compensation plans will also be submitted to Transport Canada for review, to assess any potential impacts to navigation.

4.4. Terrestrial environment

4.4.1. Soils and Terrain:

Project interactions with soils and terrain are expected to occur during construction and during decommissioning and abandonment of the pipeline and well pads. Activities occurring during operations are not expected to interact with soils or terrain resources. During construction of the pipeline and injection wells, activities such as topsoil stripping, grading, trenching and backfilling may cause an adverse environmental effect on soil capability and terrain stability by altering the morphological and physical properties of terrain and soils.

Adverse effects to soil quality and soil loss were considered in the EA. Soil loss is often effectively limited when best management practices are correctly applied. Erosion-sensitive soils may still exhibit soil loss, despite the implementation of best management practices. Development of the Project occurs on agricultural land, which may result in a reduction in land available for agricultural uses. Shell intends to use a variable width ROW during construction, allowing some ROW sections to be as narrow as 10 m. Soil handling management techniques, such as using three-lift handling or a wider stripped area, will be implemented to reduce the potential for admixing, compaction and rutting. These management techniques will reduce environmental effects from Project construction on soil loss and quality.

Terrain stability and loss of unique terrain features were also considered in the EA. Under natural conditions, the likelihood of bank slope failure is low for the Astotin and Beaverhill Creeks crossings, moderate for the North Saskatchewan River crossing and high for the Namepi Creek crossing. Mitigation (using rip-rap to prevent slope toe erosion) should improve

the natural stability of the slopes by providing better drainage and by protecting naturally eroding river banks. With these improvements, the likelihood of failure at the crossings is considered low. As the sand dunes of the Beaver Hills–Sand Hills dune field are closely spaced and the Project development area crosses areas of dense dune populations, it is not possible to avoid disturbing them when constructing and maintaining the pipeline. Mitigation measures, including reclamation and dune stabilization, will be implemented to prevent dune loss and damage.

With the application of mitigation measures, including best management practices, adverse environmental effects to soils and terrain are expected to be not significant.

4.4.2. *Vegetation and Wetlands*:

Six environmentally sensitive areas (ESAs) were identified in the study area, one of which, the North Saskatchewan River Valley, is bisected by the pipeline ROW. Generally, the area is dominated by agricultural land. All plant species identified in the Project area are common and are well represented elsewhere in the region (i.e., they are not considered provincially rare species), except for one rare vascular plant: the leather grape fern (*Botrychium multifidum* var. *Intermedium*). Additionally, several noxious and introduced species, which are of concern to the Counties of Strathcona, Sturgeon, Lamont and Thorhild, were identified during vegetation field surveys. Clubroot, an agricultural pest, has been found within the Counties of Strathcona, Sturgeon and Thorhild.

The EA considered environmental effects related to changes to landscape diversity (fragmentation), community diversity and species diversity. Although the ROW bisects one ESA, native vegetation within this ESA will not be affected by fragmentation because much of the ROW is parallel to, or intersects, ROWs for existing pipelines. Large native vegetation patches will persist, and diversity will likely be maintained.

From a community diversity perspective, there were no rare ecological communities identified in the local assessment area. As such, although some land units (i.e., upland areas, wetlands, agricultural land) will be lost or reduced, this will not have an effect on community diversity. Areas that require the infilling or removal of wetlands will be compensated for through the Alberta Environment wetland compensation program. Environmental effects in areas along the ROW, lateral pipelines and temporary workspace will be reversible and mitigated through the implementation of best management practices such as: constructing along existing ROW, locating Project components on areas with non-native vegetation as much as possible, avoidance of rare plant populations where possible and translocation these populations where avoidance is not possible, and implementing a weed management plan. Shell has identified one rare vascular plant, the leather grape fern, which may be adversely affected by the Project. Mitigation for the predicted effects to leather grape fern will be to transplant individual plants to a suitable location as close as possible to the disturbed area. Additionally, Shell has committed to implementing a Weed Management Plan and Clubroot Management Plans as a mitigation measure to reduce the increase of non-native and invasive species and agricultural pests in affected areas.

Taking into account the implementation of mitigation measures, including best management practices, planned compensation and management plans, the adverse environmental effects to vegetation and wetlands are predicted to be not significant. A reclamation and re-vegetation monitoring program will be implemented for all disturbances (upland and wetland) for a

minimum of three growing seasons following construction, or until vegetation establishment is complete. A monitoring plan to ensure transplant success for the leather grape fern will be implemented and included in the FollowUp program. The success of the Weed Management Plan and the Clubroot Management Plan will be verified through the Follow-Up program. Shell will conduct baseline surveys for any new areas of the PDA that have not yet been identified, such as pipeline laterals, new well pads, access roads and borrow areas.

4.4.3. *Wildlife and wildlife habitat*:

The Project has the potential to impact three provincially designated wildlife management areas (WMAs): the Edmonton, Vermillion and St. Paul WMAs. The pipeline also crosses ESA 690, which consists of the North Saskatchewan River valley and some forested tributaries. The North Saskatchewan River valley contains diverse riparian and valley habitats, functions as a wildlife corridor and is a key wintering area for ungulates and other wildlife.

The EA examined changes to habitat availability, mortality risk and habitat connectivity. Generally, Project components are located in a highly fragmented landscape dominated by agricultural land however Project construction will require the removal of wildlife habitat, which may result in changes to habitat availability connectivity. Given the limited geographic extent of key habitat, few mortality events are predicted. In order to minimize the effects, Shell has proposed mitigation measures such as: using existing roads and ROW as much as possible, constructing the pipeline route parallel to existing infrastructure and linear corridors, observing timing windows, using setbacks around wetlands and active nests or dens, limiting clearance in sensitive areas, reclaiming work areas immediately after construction and providing “escape ramps” for wildlife for areas with open trenching. In addition, Shell has committed to several mitigation measures proposed by Environment Canada such as:

- using existing roads and rights-of-way to reduce disturbance where possible
- constructing the route parallel to, or overlapping, the ROW of existing linear corridors
- constructing pipelines and other infrastructure in disturbed or less sensitive areas to avoid disturbance of suitable habitat for Species at Risk and other wildlife species.
- using setbacks and timing windows if construction interferes with potential habitat for species at risk. The *Petroleum Industry Activity Guidelines for Wildlife Species at Risk in the Prairie and Northern Region* (2009)(with addendum) and the *Activity Setback Distance Guidelines for Prairie Plant Species at Risk* (2009) will be referred to for a list of species appropriate setbacks.
- Within 7 days of construction commencement, a predisturbance survey for active nests or dens or potential hibernation habitat will be required, if habitat clearance and site preparation is required within the recommended construction timing windows. This includes:
    - ensuring that habitat destruction activities (e.g. vegetation clearing of any sort, trenching, mowing, herbicide application, reclamation, maintenance of right of way, etc.) avoid at minimum the period between May 01 and July 31.
    - any nests found will be protected with species appropriate buffers (minimum 30m for songbirds and 100m for water birds and waterfowl) until the young have fledged. Where possible, setbacks from wetlands will be, at minimum,100m. Additional restrictions apply for the presence of Species at Risk (see aforementioned documents in bullets above)

- following best management practices for construction, including mitigation for areas of saturated lands and areas with high potential for erosion
- protecting wetlands, creeks and the North Saskatchewan River, and compensating for wetlands where required.
- Wetlands attractive to breeding migratory birds (e.g. those containing water) will not be cleared/destroyed at minimum between April 1 and August 31, noting that Canada geese and Mallards may nest early and broods of waterfowl and waterbird species are dependent upon wetlands throughout August and beyond.
- limiting the size of permanent and temporary workspace to the extent possible, and reclaiming work areas immediately after construction

With the implementation of mitigation measures, adverse environmental effects to wildlife and wildlife habitat are predicted to be not significant. Shell will ensure to conduct baseline surveys for any new areas of the project area that have not yet been identified, such as pipeline laterals, new well pads, access roads and borrow areas.

4.5. Historical Resources and Land Use

4.5.1. *Archaeological and Heritage Resources*:

A Historical Resources Impact Assessment (HRIA) was conducted as part of the EA. The HRIA identified 10 sites within the study area. Nine of these sites were rated to have a low heritage value; as such additional studies were not required under the *Historical Resources Act* (HRA). The tenth site (a historic structure) was given a moderate heritage value and was documented (mapping, photographing, detailed description).

The Project area is underlain by bedrock of the Belly River Group, which has a high palaeontological potential for dinosaurs, other reptiles, plants and invertebrates. Field surveys found surface scatters of dinosaur material at the North Saskatchewan River (east side) and in the vicinity of Namepi Creek.

Potential Project interactions with historical resources occur during the construction of the pipeline and storage facilities, and include:

- site clearing and preparation, pipeline trenching, access upgrades and facility construction, which have the potential to alter or remove individual historical resources sites;
- increased vehicle traffic, which can cause compaction or displacement of soil, resulting in damage or loss to archaeological sites; and
- increased access to the Project area, which can result in secondary effects, such as illegal artifact collection.

The Project is subject to the policies of Alberta Culture and Community Spirit (ACCS), which issues requirements for mitigating identified historical resources sites, and issues HRA clearance for the Project to proceed relative to historical resources.

Consequently, the effects of the Project-specific environmental effects on historical resources are continually mitigated to the standards set by the Alberta government. In this context, after

implementing mitigation measures, including following standards set by ACCS, there are no residual effects to archaeological and heritage resources.

4.5.2. *Land use*:

Land use in the area is primarily agricultural with some industrial and transportation corridors and small areas of natural vegetation. The EA considered the impacts of the Project on the agricultural land base and transportation and industrial activities. Construction of the pipeline and well pads will temporarily remove lands from agricultural use during construction and will cause a disruption to agricultural, transportation and industrial activities. However, this direct loss of land from the agriculture land base will be reclaimed during operations. After reclamation is complete, a small gain of agricultural land will occur in the assessment area, due to some upland areas and cleared or burned areas being converted to agricultural land. Examples of mitigation measures include: Salvaging topsoil for reclamation of agricultural lands, seeding topsoils remaining in storage to minimize erosion and weed establishment, relieving subsoil compaction prior to replacing topsoil, consulting with municipalities to identify land use and zoning requirements and using existing access roads where possible.

With the implementation of mitigation measures, the effects of the Project-specific environmental effects on current land use practices in the area are not significant.

4.6. Health and Socio-economics

4.6.1. *Health Effects*:

In order to determine the effects of the Project environmental effects on health Shell conducted a human health risk assessment (HHRA), which is a quantitative, chemical-specific evaluation of potential health effects related to the Project and other emission sources in the region. The CO_2 capture infrastructure may increase the thermal generation of NO_X, which is the main air emission change associated with the Project. The increased NO_X emissions associated with operation of the CO_2 capture infrastructure may also result in an increased production of secondary $PM_{2.5}$. As no operational releases to water or soils are expected, the HHRA focuses on the inhalation of emissions only. The Project has the potential to contribute to effects on public health, indirectly through the environmental effects of air emissions on human receptors.

The key findings of the HHRA are as follows:

- Minor exceedances of health-based acute inhalation exposure limits are predicted for NO_2 at two industrial receptor locations. In all cases, existing sources contribute the most to predicted exposures, and minimal incremental change is attributable to the Project. Examination of these exceedances suggests that their occurrence would be intermittent and infrequent;
- The maximum predicted concentrations of hourly NO_2, although in exceedance of the United States Environmental Protection Agency human exposure limit, are below levels at which adverse health effects have been observed in exposed individuals; and
- Concentrations of $PM_{2.5}$ are expected to remain below guidelines set for both short-term (i.e., 24-hour) and long-term (i.e., annual) averaging times.

There are no mitigation measures proposed to minimize the health effects directly however the mitigation measures proposed to minimize air emissions also assist to reduce potential impacts

to human health. The results of the HHRA are that adverse health effects from predicted Project-related concentrations of NO_2 and $PM_{2.5}$ are expected to be not significant. A monthly monitoring program for NO_X emissions for each hydrogen manufacturing unit (HMU) stack and monthly reporting to Alberta Environment and Water will be implemented. Additionally, Shell will conduct two stack surveys per year for each HMU stack and continue to participate in the Fort Air Partnership ambient air quality monitoring program.

4.6.2. *Socio-Economics*:

Shell conducted a socio-economic analysis as part of the EA. The spatial boundaries for the socio-economic analysis include:

- the Edmonton Census Metropolitan Area and the urban municipalities within its boundaries; and
- the Counties of Thorhild, Lamont, Smoky Lake, Athabasca and Westlock and the urban municipalities within their boundaries.

The regional assessment area as a whole has well developed business, wholesale, retail, social, education, health and government services sectors. Most of these services are located in Edmonton, the urban core of the region. Strathcona County has refinery developments and other heavy industry along the eastern border with Edmonton; Shell Scotford is within AIH boundaries. Industrial activity in the region dates back to the middle of the last century. The Counties of Lamont Thorhild, Smoky Lake, Westlock and Athabasca are predominantly rural. These Counties have energy developments, including pipelines and oil and gas wells.

Interaction between the Project environmental effects and the socio-economic environment will occur primarily during construction. Key issues include employment and income effects, and population, infrastructure and service provider effects. The Project will generally result in benefits to the socio-economics environment. The Project's environmental effects will have a minimal impact on socio-economic aspects and are considered to be not significant.

4.7. Effects of the Environment on the Project

Potential effects of the environment on the Project were identified for construction, operation, decommissioning and abandonment of the Project. Several climatic factors could affect the Project, ranging from delays in construction to damage to operational facilities, including:

- severe weather, such as heavy precipitation, blizzards and thunderstorms;
- flooding;
- wildfires;
- seismicity; and
- climate change.

Severe weather conditions, flooding and wildfires have the potential to slow or stop construction activities. Mitigation measures, such as suspension, modification or addition of specific construction activities will ensure any potential effects on the Project from severe weather, flooding or wildfires are not significant.

Because of the low-risk location of the Project, seismicity is not expected to have an effect on the Project. The MMV Plan will continually monitor CO_2 storage through a variety of monitoring

systems and technology, while a supervisory control and data acquisition (SCADA) system will monitor pipeline integrity.

Shell will implement adaptive management and prevention, detection and mitigation programs so that potential effects on the Project from climate change are not significant.

5. CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT

Cumulative environmental effects are defined as the effects of a project that are likely to result when a residual effect acts in combination with the effects of other projects or activities that have been or will be carried out. The cumulative effects assessment was scoped to focus on the identified VECs and residual environmental effects of the Project when considered in association with environmental issues of regional concern, and the effects of past, present, and future actions or projects that have been or will be carried out in the region.

Shell assessed the cumulative environment effects of the Project, in combination with existing facilities and other reasonably foreseeable projects, for each VEC. The detailed information related to the cumulative environmental effects assessment can be found in the *Quest Carbon Capture and Storage Project: Environmental Assessment (November 2010) (see Shell 2010a, 2010b, and 2010c)*.

For a list of past, present and reasonably foreseeable future projects and activities assessed by Shell (as of June 2010), see the Project Inclusion List in the Application, Volume 2A, Table 2-1.

With the implementation of mitigation measures, the Project is not expected to result in significant adverse cumulative environmental effects. Monitoring will be undertaken through the MMV program.

6. ACCIDENTS, MALFUNCTIONS AND UNPLANNED EVENTS

Accidents, malfunctions and unplanned events (AMUEs) are conditions that are not considered part of routine Project activities during any Project phase. Even with the best planning and application of mitigation, AMUEs could occur as a result of abnormal operating conditions, process upsets, acts of nature, extreme weather events, human error, equipment failure, and other possible causes.

Three AMUE events were fully assessed in the EA:

1. Process upsets in CO_2 capture infrastructure:

Upsets within the CO_2 capture infrastructure could result in CO_2 being diverted to the CO_2 vent or result in a loss of containment, which could result in adverse environmental effects to air quality and potentially lead to impacts to health and safety. However, the likelihood of a process upset resulting from venting was estimated to be less than 2% of the operating time and the likelihood of loss of CO_2 containment in the capture infrastructure is approximately 0.001 events per year (i.e., one event per thousand years). This is based on an analysis of experience with similar types of service and facility configurations.

As a mitigation measure the CO_2 capture infrastructure includes a CO_2 vent stack, which would safely vent the wet CO_2 stream from the amine regeneration area during a CO_2 compressor trip or temporary outage. An accidental release and resulting CO_2 plume would be localized (generally within the Shell Scotford fenceline), short in duration and reversible. Potential environmental effects will be further limited by the implementation of Shell's Emergency Response Plan (ERP).

2. CO_2 pipeline rupture or injection well head failure:

Captured CO_2 will be transported under pressure by the shallow buried CO_2 pipeline to a series of CO_2 injection wells, which, while unlikely, could result in the release of a plume of CO_2 from pipeline or well head failure. If CO_2 is accidentally released to the atmosphere it could result in adverse environmental effects to air quality, and indirectly affect public health and safety.

Rupture of a pipeline beneath a water body could result in the release of CO_2 beneath that water body with possible adverse environmental effects to water quality, fish and/or fish habitat. A pipeline rupture occurring beneath, or adjacent to, a watercourse could cause a lowering of pH and an increase in CO_2 concentrations. For small watercourses, such as Beaverhill Creek, the fish community known to occur is tolerant of a wide range of water quality parameters and is unlikely to be affected by a reduction in pH. A release into the North Saskatchewan River would be diluted and is unlikely to have a measurable environmental effect on the pH of the river.

Releases of CO_2 from pipeline ruptures are likely to have limited interaction with shallow groundwater because CO_2 would undergo a rapid phase change to the gaseous state, quickly disperse, and have little opportunity to interact with groundwater. At locations where a high groundwater table exists, interactions with groundwater could still be limited due to the high rate of release, where the vast majority of escaping CO_2 would enter the atmosphere and not have the time to dissolve or otherwise interact with groundwater. Further, localized endothermic effects from the sudden depressurization of CO_2 from the pipeline or well head may freeze groundwater in the immediate vicinity of the release, thus limiting broad interactions with groundwater.

A rupture of the CO_2 pipeline could also alter soil pH and cause increased soil acidity. Much of the land use within the Project area is agricultural, and crop productivity could decline if pH levels decrease below acceptable levels. However, potential environmental effects on soil chemistry can be mitigated by addition of amendments such as agricultural lime. In addition to affecting agricultural productivity, a change in soil pH could affect the availability of nutrients and potentially mobilize toxic concentrations of mineral elements such as aluminum and magnesium. These environmental effects may result in a loss of native vegetation, and could also increase levels of total dissolved solids (TDS) in wetlands. Because wetlands naturally emit CO_2 and methane, low levels released from pipeline failure may not be discernable or measurable (Oldenberg and Lewicki 2005).

Large releases from the CO_2 pipeline or injection well sites could lead to toxic environmental effects or asphyxiation of humans and wildlife in the immediate vicinity of the release (Price et al. 2007; Williams et al. 2007). In most cases, CO_2 would dissipate quickly and not pose a danger. People residing close to the pipeline will be inside Shell's emergency planning zone. Therefore, any potential risks to those individuals would be limited through effective implementation of the ERP.

Shell's mitigation and preventative measures for a CO_2 pipeline rupture or injection well head failure include:

- Implementing an ERP, including notification of the public and coordination with local authorities;
- Implementing a pipeline integrity management plan including corrosion mitigation and monitoring and leak detection. As part of the leak detection program, aerial pipeline surveys will be conducted to detect unforeseen releases along the pipeline route;
- Implementing leak detection requirements, as specified in the Alberta *Pipeline Act* and *Pipeline Regulation*, and in compliance with the Recommended Best Practice for Liquid Hydrocarbon Pipeline System Leak Detection, as shown in CSA Z662-7, as applicable for high-vapour pressure pipelines. Leak detection will be done through the use of line break valves, metering facilities and a SCADA monitoring system;
- Implementing the MMV Plan, which will verify storage performance and containment of CO_2;
- Situating above-ground emergency shutdown line block valves s at least every 15 km along the pipeline and at watercourse crossings and other notable crossings (i.e., wetlands, road or railway crossings), where appropriate;
- Metering facilities consisting of a pressure-regulating valve and flow meters to detect changes to pressure;
- SCADA system which will collect and transmit data from the pipeline back to the Shell Scotford control room, for central control and monitoring of the line break valves; and
- Completing all injection wells with a down-hole safety device.

The event frequency for a CO_2 pipeline failure is estimated based on failure rate statistics from the ERCB (ERCB 2007). The ERCB classifies CO_2 pipelines within a substance code denoted as OT (other), which has an estimated frequency of 0.00054 failures per km per year. The event frequency for an injection well failure is 0.000136 failures per well per year (ERCB 1990).

3. Release of CO_2, BCS brine or CO_2 saturated brine from the storage complex or injection wells:

There is a potential for either casing failure of an injection well or loss of containment from the storage area to result in a release of CO_2, BCS brine or CO_2-saturated brine. Although highly unlikely, migration of these fluids from the storage complex may still occur and, if uncontrolled, may cause potential environmental effects on, for example, groundwater, surface water and the terrestrial and atmospheric environment.

A release of injected CO_2, BCS brine, or CO_2-saturated brine from the BCS storage complex could affect groundwater and aquatic resources by lowering pH, mobilizing trace elements and increasing salinity. Dissolved metals already present (in some cases under baseline conditions, above water quality guidelines) could also contribute to elevated concentrations of these parameters. Increases in these groundwater parameter concentrations could lead to an increased risk to ecological and human receptors.

The magnitude of the changes to groundwater quality parameters would be influenced by the volume of the release, the rate of release, brine/CO_2 mix ratio and the chemical and physical conditions of the aquifer. The duration of a release is expected to be brief due to the implementation of the MMV Plan (which focuses on detection and response), and any changes

in groundwater quality are expected to be local in scale due to slow groundwater flow velocities in the assessment area. Any potential environmental effects will be further limited by the implementation of Shell's ERP.

Such a release from the BCS storage complex could also affect soil quality by affecting salinity. However, remediation standards for brine spills are described in the Salt Contamination Assessment and Remediation Guidelines (AENV 2001c), which are expected to restore soils to baseline conditions.

Changes in soil and groundwater quality such as a change in pH, conductivity, presence of cations and higher TDS, may be sufficient to cause a reduction or loss of native vegetation or crop productivity as well as altering species assemblages in wetlands. Additionally, migration of BCS brine into the soil will increase its salinity and introduce contaminants transported from the BCS. However, with implementation of Shell's ERP and MMV Plan, environmental effects on wetlands and vegetation are expected to be not significant.

A release of CO_2 can potentially cause direct mortality to wildlife through asphyxiation (Beaubien et al. 2004; Price et al. 2007), and may also indirectly affect wildlife through reduction of native vegetation and associated loss of wildlife habitat (Price et al. 2007). However, seepages from naturally occurring CO_2 reservoirs within sedimentary basins usually result in minimal, local environmental effects on ecosystems (Beaubien et al. 2004). Any potential environmental effects will be limited by the implementation of Shell's ERP and MMV Plan. As a result, the potential residual environmental effects are predicted to be not significant.

Many passive mitigation measures are included in the Project's design by nature of the site selection process. For example:

- Shell selected a BCS storage complex for the injected CO_2 that is situated approximately 1.7 km below ground surface and approximately 1.4 km below the BGWP.
- The storage site has three regionally extensive geological seals directly overlying the BCS storage complex and shows no evidence of faults extending from the BCS through any of the three geological seals inside the storage complex.
- The Project is isolated from other potential CO_2 injection operators, thus limiting the potential for interactions resulting from third-party activities, etc.

Active mitigation measures include operational practices and monitoring systems, as well as preventative controls that could be implemented should the monitoring systems indicate potential leakage from the BCS. Examples of these active mitigation measures include:

- Real-time monitoring of injection rates, down-hole pressures and temperatures;
- Cement bond logging of all CO_2 injection and MMV casings for integrity of annular cement seals;
- CO_2 injection wells with three layers of fully cemented casing, the use of corrosion resistant well casing materials and the use of inhibitor fluids in the casing annulus; and
- Regular groundwater monitoring within the Winnipegosis Formation, seismic monitoring of the CO_2 plume, and Interferometric Synthetic Aperture Radar monitoring of the AOI.

Should the monitoring indicate potential leaks or unexpected plume behavior, injection controls could be implemented. Potential injection controls include: redistributing CO_2 injection to

alternative wells, drilling new injection wells, extracting BCS fluids to reduce pressure and stopping injection at a given well location..

With the implementation of mitigation measures, including Shell's ERP and MMV Plan, the Project environmental effects related to accidents, malfunctions and unplanned events are expected to be not significant.

7. PUBLIC AND ABORIGINAL CONSULTATION

As part of its Project development, Shell implemented a stakeholder consultation program. The results of this program are described in the *Quest Carbon Capture and Storage Project: Environmental Assessment (November 2010)*. Additionally RA's conducted public and Aboriginal consultation activities.

7.1. Public Consultation Activities:

On August 20th, 2010, in accordance with section 18(3) of the *Canadian Environmental Assessment Act*, Responsible Authorities included a description of the scope of the Project, the factors to be taken into consideration in the screening and the scope of those factors on the Canadian Environmental Assessment Registry Internet site (http://www.ceaa-acee.gc.ca/050/details-eng.cfm?evaluation=55916).

The RAs also invite the public and Aboriginal Groups to examine and comment on this screening report.

7.2. Aboriginal Consultation Activities:

The Crown has a duty to consult Aboriginal groups, and where appropriate accommodate, when it has knowledge that its proposed conduct might adversely impact an Aboriginal or Treaty right. Aboriginal consultation is also undertaken more broadly as an important part of good governance, sound policy development and decision-making. In addition to the Crown's broader obligations, CEA Act requires that all federal EAs consider the effect of any change in the environment caused by the Project, as well the effect of that change on current use of land and resources for traditional purposes by Aboriginal peoples. CEAA also requires consideration of the effect of any Project-induced change in the environment on 'physical and cultural heritage', as well as 'any structure, site or thing that is of historical or archaeological significance', such as sites historically occupied by Aboriginal peoples.

For the purposes of this screening, the Agency served as Crown Consultation Coordinator to facilitate the whole-of-government approach to consultation. Once the RAs make their final environmental assessment decision about the Project the Agency's role as Crown Consultation Coordinator is complete and the federal Aboriginal consultation responsibilities are transferred to the RAs.

The three Aboriginal groups that were contacted and invited to participate in consultations were Saddle Lake First Nation, Alexander First Nation and Métis Nation Region 4 as they were identified as having an interest in the Project. Their interests were related to their proximity to Project components, their past or current interest in similar projects, and the Project's potential impacts to Aboriginal or Treaty Rights.

The Agency contacted Aboriginal Groups through letters, on several occasions, to provide general information about the environmental assessment of the Project, to obtain information and comments and to provide opportunities for the Aboriginal Groups to meet directly with federal representatives to discuss the Project.

7.3. Summary of Comments Received:

The Agency has not received any comments from the public or Aboriginal Groups regarding the Project.

This screening considered, where relevant, any comments received by Alberta Environment and Water during the environmental assessment process and Shell through their Aboriginal Consultation activities.

The RAs will consider all comments filed prior to taking a course of action decision under section 20(1) of the CEA Act.

8. CONCLUSION

Pursuant to section 20(1)(a) of the CEA Act, after considering the information presented in EA documentation and advice provided by FAs, NRCan and CTA, as the RAs, have determined that with the implementation of appropriate mitigation measures, the Project is not likely to result in significant adverse environmental effects.

RA's are satisfied that that mitigation measures identified will be ensured through requirements included under federal authorizations and approvals as well as provincial statutes and regulations.

Pursuant to section 38(1) of the CEA Act, NRCan and CTA have determined that a Follow-Up program is required to verify the accuracy of the environmental assessment and determine the effectiveness of mitigation measures.

9. FOLLOW-UP PROGRAM

RAs have determined that a Follow-Up program, to verify EA predictions is required for the Project. Pursuant to section 17(1) of the CEA Act, RAs are delegating the design and implementation of the Follow-Up program to Shell. This section provides the basis, or framework, for the follow-up program. The full program will be designed and implemented, following the RAs section 20(1)(a) decision and prior to construction. The Follow-Up program will be designed and implemented in consultation with Environment Canada and other federal authorities, the Government of Alberta and Aboriginal groups as appropriate. It will include, at a minimum, the components outlined below.

Follow-Up Framework:

The Follow-Up program will be designed to verify the predictions related to, at a minimum the following VECs:

- Air Quality;
- Water Quality (Ground and Surface Water);
- Fish and Fish Habitat; and
- Vegetation and Wetlands
- Wildlife and Wildlife Habitat

To the extent possible the MMV Plan will be used to satisfy the requirements of the Follow-Up program. If a component of the Follow-Up program is not covered by the MMV, Shell will design measures to ensure that EA predictions are verified. A brief description of the MMV is included below.

Measurement, Monitoring and Verification Plan:

As part of the Project, Shell is implementing a MMV Plan to verify storage performance, including conformance and containment, of the site chosen for CO_2 storage. Storage performance assumes containment under normal operating conditions and conformance to the predicted storage performance. The MMV Plan focuses on ensuring containment and conformance through early warning detection and implementation of prompt control measures.

Shell's proposed Follow-Up and monitoring program, including the MMV Plan, will be an important component in verifying the environmental predictions described in the EA. The MMV Plan applies a systematic risk-based approach, through the identification of key threats to storage performance associated with loss of containment. The MMV Plan will include monitoring of the injection wells (surface and down-hole measurements), groundwater wells, soil, and air quality in the Project development area to monitor for CO_2 storage conformance and containment.

NRCan and CTA, with assistance from Environment Canada, other federal authorities and the Government of Alberta, will review the results and implementation of the Follow-Up program, and the MMV Plan and as necessary will provide input to Shell regarding the potential implementation of adaptive management measures as appropriate.

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