MILESTONE 1: SCOPING REPORT

Strategic Environmental Assessment of Wood Buffalo National Park

DRAFT

Independent Environmental Consultants (IEC)
70 Valleywood Drive, Suite 200,
Markham, ON, L3R 4T5

SLR LT STRATOS RAMBOLL ENVIRON Clifton Associates

August 2017

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This report outlines the key issues to be addressed in the Strategic Environmental Assessment (SEA) and the approach that will be used to undertake the assessment. This SEA is in response to a request from the World Heritage Committee (WHC). The Mikisew Cree First Nation submitted a petition to the World Heritage Committee in late 2014, which was accepted in a WHC Decision (39 COM 7B.18, Bonn, 2015) requesting the State Party of Canada to invite a joint World Heritage Centre/IUCN reactive monitoring mission to assess the state of conservation of the property and potential threats to its OUV. As part of the response to the WHC decision and reactive monitoring mission, Parks Canada agreed to undertake this SEA. The role of the SEA is to define on a preliminary basis the results of investigations to date with respect to understanding key impact pathways that may impact elements of Wood Buffalo National Park (WBNP) Outstanding Universal Values (OUV). Once refined and finalized the scoping report will be the basis for further detailed assessment of the key pathways of concern; and the resultant draft final SEA report will be prepared and sent out for review and consultation before being finalized.

1.2 OVERVIEW OF WOOD BUFFALO NATIONAL PARK ECOLOGICAL INTEGRITY AND OUTSTANDING UNIVERSAL VALUES

Wood Buffalo National Park of Canada (WBNP) spans the Alberta/Northwest Territories boundary and at 44,807 square kilometres, it is the largest national park in North America (**Error! Reference source not found.**).

The park was created in 1922 to protect the last free roaming herds of bison in northern Canada, in part to ensure continued access to bison by indigenous peoples (Parks Canada, 1984). Today it protects the herds of bison and more, including the last remaining natural nesting area for the endangered whooping crane; the Peace-Athabasca Delta (PAD), one of the largest inland freshwater deltas in the world; some of the finest examples of gypsum karst landforms in North America; unique salt plains and vast undisturbed expanses of boreal wilderness. Because of these resources WBNP was designated a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site in 1983. The PAD and the whooping crane nesting area were also designated as Ramsar Wetlands of International Importance, a designation by the Ramsar Convention which focuses on identification and protection of important habitat for migratory birds.

World Heritage Sites are designated based on several criteria which express the Outstanding Universal Value (OUV) the site represents. OUV is the basis for a site's inscription on the World Heritage List and is defined by UNESCO as "*natural significance, which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. As such, the permanent protection of this heritage is of the highest importance to the international community as a whole*". WBNP meets three of the criteria:

- **Criterion vii: to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;**

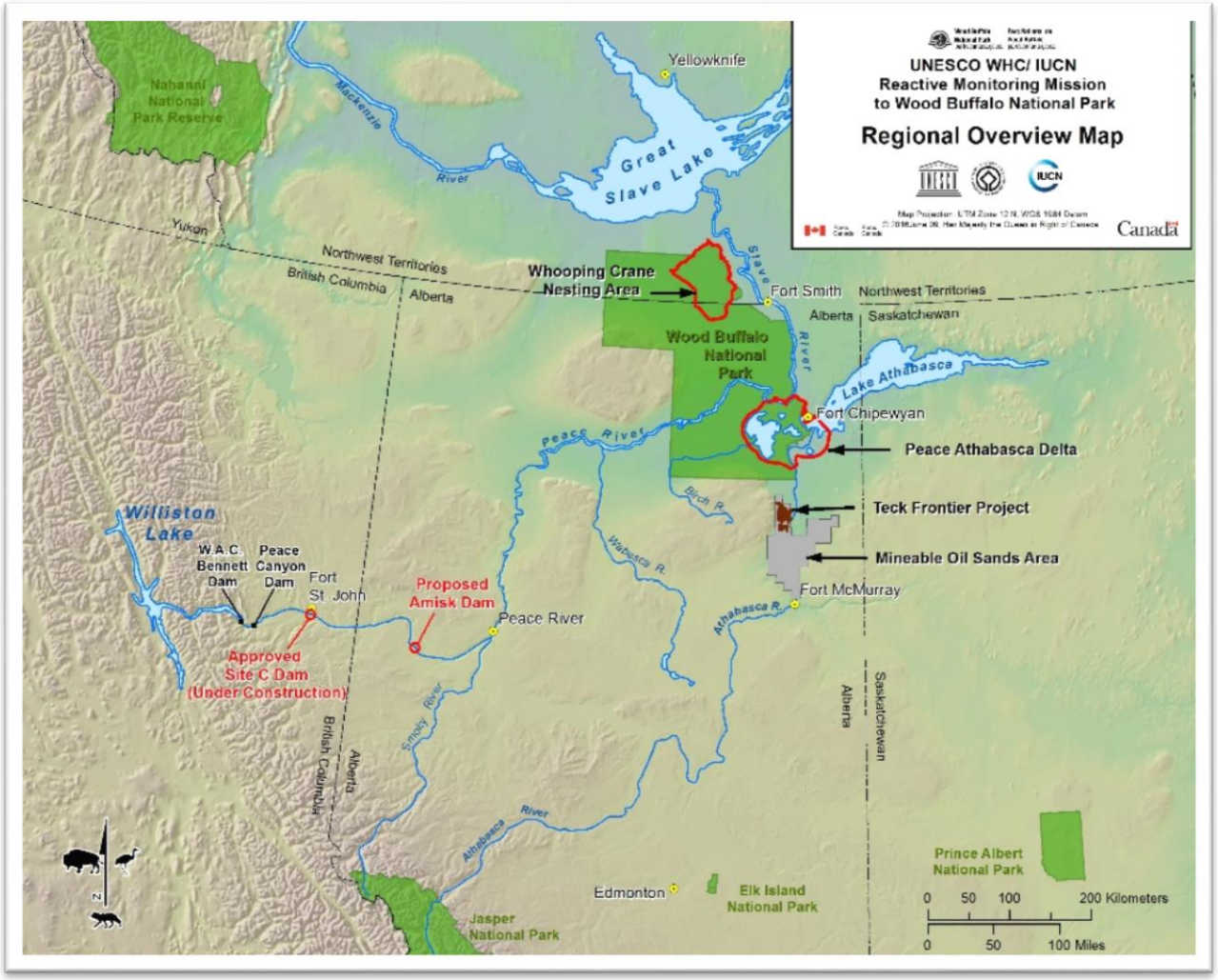

Figure 1 – Wood Buffalo National Park Location Map (From Parks Canada, 2016)

The great concentrations of migratory wildlife are of world importance and the rare and superlative natural phenomena include a large inland delta, salt plains and gypsum karst that are equally internationally significant.

- **Criterion (ix): to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;**

  Wood Buffalo National Park is the most ecologically complete and largest example of the entire Great Plains-Boreal grassland ecosystem of North America, the only place where the predator-prey relationship between wolves and wood bison has continued, unbroken, over time.

- **Criterion (x): to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation**.

  Wood Buffalo National Park contains the only breeding habitat in the world for the whooping crane, an endangered species brought back from the brink of extinction through careful management of the small number of breeding pairs in the park. The park's size (4.5 million ha), complete ecosystems and protection are essential for in-situ conservation of the whooping crane.

These world heritage values are important elements of the park's ecological integrity. The Canada National Parks Act (CNPA or the Parks Act) defines Ecological Integrity as a "first priority" which is notable both as a conceptual framework and as a legal obligation. The CNPA defines Ecological Integrity as;

> *"a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes".*

Parks Canada monitors Ecological Integrity and reports findings in the State of the Park Reports. A summary of relevant information from the most recent 2009 State of the Park Report for WBNP is provided in Section 2.1.

1.3 INDIGENOUS PEOPLES AND WBNP

Indigenous peoples have inhabited the area of WBNP and the surrounding regions for thousands of years. The eleven indigenous communities with historic and on-going traditional use of the WBNP lands are the Mikisew Cree First Nation, the Athabasca Chipewyan First Nation, the Fort Chipewyan Metis Local 125, the Little Red River Cree Nation, the Salt River First Nation, the Fort Smith Metis Council (NWT), the Smith's Landing First Nation, the K'atlodeeche First Nation, the Deninu K'ue First Nation, the Hay River Metis Government Council (NWT) and the Fort Resolution Metis Council (NWT) (**Figure 2**).

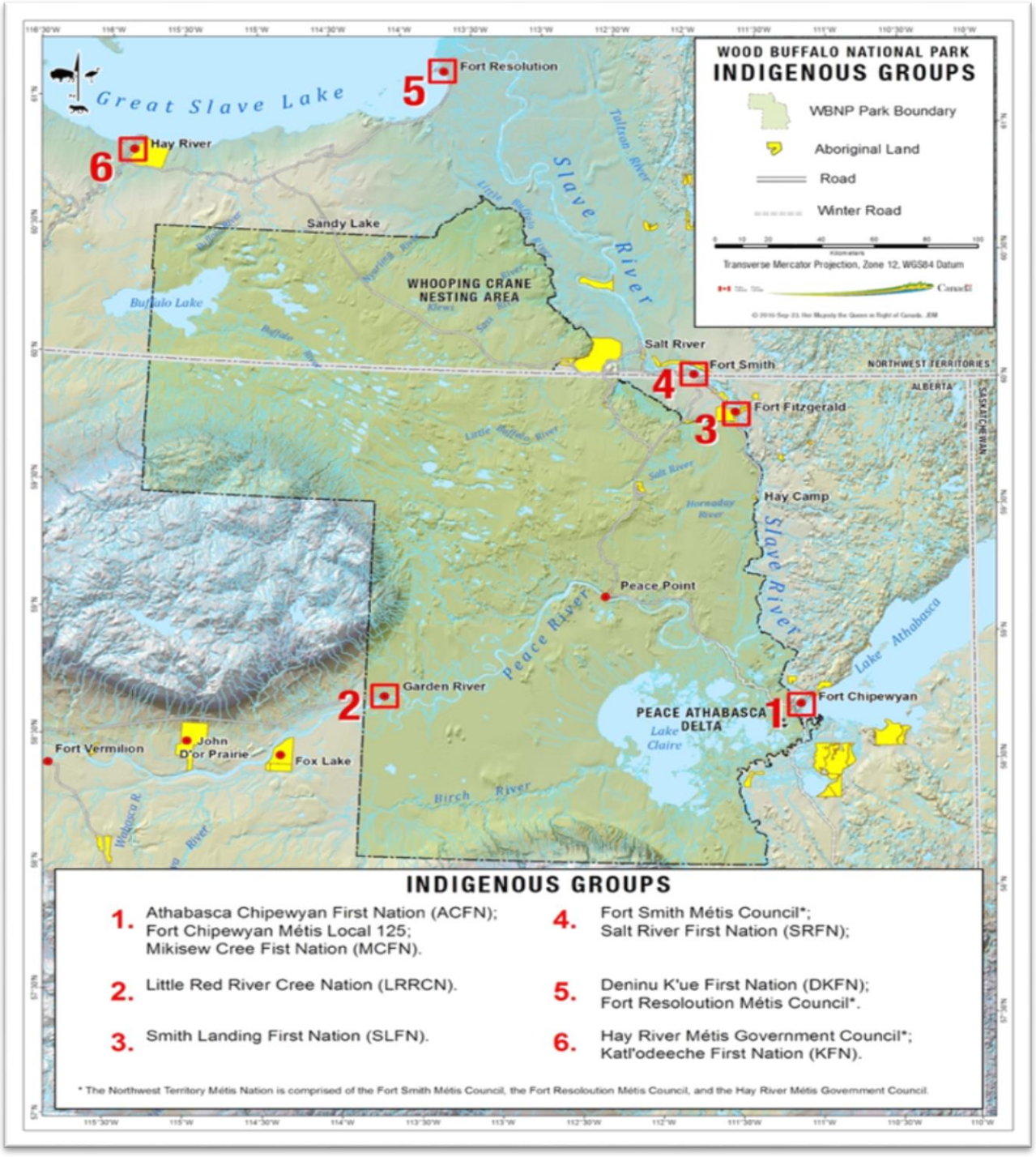

Figure 2 – Wood Buffalo National Park Indigenous Groups

The park is within Treaty 8 territory. Treaty 8 was signed on July 13, 1899, on the northwest shore of Lake Athabasca in Fort Chipewyan. Treaty 8 guarantees the hunting, fishing and trapping rights of indigenous peoples in order to support and maintain traditional livelihoods.

As noted above, both Indigenous communities and historic park reports note that WBNP was established for Indigenous communities as a game reserve to protect against white hunting (Parks Canada, 1984). This report acknowledges that Indigenous peoples are knowledge holders on their own lands. We have begun preliminary conversations with the Mikisew Cree First Nation, Little Red River First Nation, and the Kátł'odeeche First Nation. In those conversations, we have learned of challenges that the communities are facing, particularly in terms of food security related to the park. Declining moose populations has been a concern echoed by all three communities. Studies conducted by Mikisew echo the concern for food security across food sources, including berries, fish, muskrats, and birds.

In Mikisew Cree's cultural assessment, they clarify the meaning of security to them, in particular translating it to the Cree word for confidence, Kistinawi, (literally, to be "tied up, or made secure," also used to refer to something that is known definitely). In the report, it is stated that "Having confidence in wild foods and water includes not only the ability to reliably harvest an adequate quantity and quality of resources, or water, in particular places and at particular times, but also a wider confidence or security in the ability to survive, adapt and help others through dependable relationships to lands, waters and resources". Within the cultural assessment, Kistinawi, also relates to a spiritual understanding of the environment, as observed impacts from industry move traditional areas for harvesting medicines, hunting, fishing, trapping or spiritual significance from a place "environment trust and safety" to a place of "distrust and risk" (Candler, Gibson, Mallone, Firelight Group Research Cooperative, & Mikisew Cree First Nation, 2015).

The Cree and Dene people have depended upon WBNP ecosystems as an integral part of their identity, culture and well-being for thousands of years. Within the park, maintaining a functional ecosystem is critical for the cultural, spiritual and physical health of these communities (Candler, Olson, DeRoy, & Firelight Research Cooperative, 2010). This scoping report acknowledges that these ecosystem components are critical to supporting and maintaining traditional livelihoods.

This report acknowledges that the impacts discussed within this report not only affect the site's OUV, but the way of life of indigenous communities. Knowledge from indigenous knowledge holders will be treated with great respect and properly sourced.

1.4 OVERVIEW OF MATERIAL REVIEWED TO DATE

Scientific reports, academic articles, project level environmental assessments, park documents, and traditional knowledge documents were reviewed to inform this scoping document. The OUV were the primary focus of our research and are of interest to the WHC. The size of the park and the scale of industrial development in the region resulted in methodological challenges for comprehensive analysis. The OUV were assessed to determine which are under stress from pressures external to the park and which are relatively stable such that the SEA could be focused on the OUV under stress. However, by focusing on the OUV as the foundation of the SEA, the valued ecosystem components (VCs) upon which the assessment would focus, were more readily identifiable. These VCs are examined in terms of their historic and current baseline conditions, stressors and trends.

The data gathered to date provides a good understanding of the ecosystem complexity present in WBNP however the focus of this Scoping Document is the protection of the OUV.

2.0 REVIEW OF CURRENT CONSERVATION STATUS OF PARK

2.1 WBNP State of the Park Reports

The State of the Park Report (2010) was reviewed and a summary of the information is provided below as it relates to the OUV of WBNP. There are a number of ecological integrity indicators that relate to the OUV for WBNP and they include those measures related to the delta, grasslands, wetlands and streams and rivers.

The State of the Park report summarized the key opportunities and concerns for WBNP. For the purposes of this report, the key findings were related to the declining health of the PAD. On the PAD, the report states, "*Peace River flow regulation is impacting delta hydrology and ecology and declining Athabasca River flows and increasing trends in nutrient levels are a concern. Ecological changes in turn impact the delta's cultural landscape and cultural heritage*."

As noted in the State of the Park Report and other information reviewed, the key stressors on the park ecosystem are:

- climate change;
- water withdrawals;
- dams; and
- pollution.

It is clear that anything that affects the complex hydrology of the PAD creates cumulative effects to the park resources and the ecology of the delta.

2.2 Reactive Monitoring Mission (RMM) Report Summary

Reactive Monitoring is defined in Paragraph 169 of the *Operational Guidelines for the Implementation of the World Heritage Convention* (first published in 1977 and continually revised) as being "*the reporting by the World Heritage Centre, other sectors of UNESCO and the Advisory Bodies to the World Heritage Committee on the state of conservation of specific World Heritage properties that are under threat*".

The Mikisew Cree First Nation submitted a petition to the World Heritage Committee in late 2014, which was accepted in a World Heritage Committee Decision (39 COM 7B.18, Bonn, 2015) requesting the State Party of Canada to invite a joint World Heritage Centre/IUCN reactive monitoring mission to assess the state of conservation of the property and potential threats to its OUV. The scope of the mission was to assess:

- Current effects of flow regulation on the Peace River;
- Potential (cumulative) impacts of the planned Site C Hydroelectric Dam on the PAD;
- Effects of existing and proposed oil sands projects in the Alberta Oil Sands region, including as the various projects related to Aboriginal Peoples; and
- Any other relevant issues that may negatively impact the OUV of the property [which included other stressors such as forestry]

More specifically, the mission scope required the mission to review and assess the following:

- *"The current effects of Peace River flow regulation activities associated with operation of the W.A.C. Bennett Dam and Peace Canyon Dam, on the OUV of the property;*
- *The potential (cumulative) impacts of the planned Site C Hydroelectric Dam on the hydrological regime of the PAD that could impact the OUV of the property,*

and the ecological processes as they relate to the OUV of the property, also taking into account the effects of climate change;

- *The impacts of existing and planned oil sands projects in the Athabasca Oil Sands Region, as well as their associated tailings ponds, on the OUV of the property, including the impact on movement of migratory birds, and discuss the development and implementation of monitoring programs with the relevant authorities and stakeholders; and*
- *The above-mentioned developments on the ecosystems that support some of the traditional ways of life of indigenous communities."*

The mission was further tasked and mandated to *"review any other relevant issues that may negatively impact the OUV of the property, including its conditions of integrity and protection and management"*. The mission met with a wide range of federal and provincial government officials, First Nations and Metis leaders, advisors and community members, university researchers and NGOs.

2.2.1 Issues

The RMM Report (2017) identifies 7 categories of issues affecting WBNP:

1) Governmental relationships with First Nations and Métis

- On-going tensions and conflicts with First Nations and Métis communities in relation to WBNP, related to access restrictions despite permissive hunting access, limited (past) consultation and lack of involvement in decision-making directly or indirectly affecting First Nations and Métis; and,
- Aboriginal representatives acknowledged important and credible efforts to improve relationships on the part of PCA, including the Aboriginal Committee for the Cooperative Management of WBNP.

2) Governance of impact assessment and environmental monitoring

- Concerns about both regulatory failure were consistently brought forward during the mission;
- Concerns about impact assessments, including limited mandates of panels set up to review proposals of very large and complex projects and absence of adequate assessment and management of cumulative effects;
- Limitations in coherent, adequate and independent monitoring under the Joint (Alberta – Federal) Oil Sands Monitoring System (JOSM) including gaps in the ability to differentiate natural sources of contaminants from impacts caused by bitumen mining and upgrading; and, a lack of transparency and involvement of Aboriginal communities in monitoring; and
- Deficiencies in functional mechanisms to manage water across jurisdictional boundaries despite longstanding efforts and a wealth of existing information, including specific recommendations for enhancing governance, for example under the Mackenzie River Transboundary Water Master Agreement (MRTWMA).

3) **Changes in capacity and focus of Parks Canada Agency**

- Lack of scientific capacity within PCA (to implement and monitor the implementation EI framework adequately); and
- An excessive focus on tourism promotion.

4) **Overarching concerns about climate change**

- As part of a high latitude wetland-dominated landscape, WBNP and the PAD are highly vulnerable to the effects of climate change.

5) **Pressures and risks from industrial development - hydropower development and industrial resource extraction (Alberta oil sands region, forestry and pulp and paper)**

Hydropower

- A series of existing and proposed dams on the Peace River have impacted and create potential for further impacts on the PAD;
- The Mission cites compelling evidence of dam impacts along the Peace River, most notably the changes in both the timing and magnitude of seasonal flows measured at Peace Point;
- It is noted that proponents for the Site C and the proposed Amisk Projects concluded that Peace Point, upstream of the PAD, was the furthest reach of any potential impact of these projects – the RMM finds this scientifically indefensible given that existing large hydropower projects along the upper Peace River appear to have had effects on the PAD and given the high likelihood of cumulative impacts of additional flow regulation; and
- The mission endorsed the technical points and recommendations made in PCA's submission to the Joint Review Panel established for Site C (Parks Canada Agency).

Oil Sands

- The report summarizes major impact types citing Kelly et al. (2010), Timoney, 2013 and Schindler (2015). With respect to the Frontier Oil Sands Mine project EA, these are:
  - Tailings water ponds and contaminants causing risks of direct exposure to fish and wildlife, that can be transported downstream towards the PAD;
  - Water withdrawals by oil sands operators from the Athabasca River that may be affecting in-stream flows towards the PAD;
  - Atmospheric deposition of particles containing contaminants such as polycyclic aromatic hydrocarbons (PAHs), nitrous oxides, and sulphate;
  - Avoidance of this highly industrialized region by migratory birds en route to WBNP or on their way south, including the endangered Whooping Crane; and
  - Encroachment into the documented habitat of the Ronald Lake Bison Herd of Wood bison potentially limiting the herd's habitat and placing the actively mined oil sands region

ever closer to the southern boundary of WBNP.

- The proposed Frontier Oil Sands Mine project would clear about 30,000 ha south of WBNP and diminish the existing de facto "buffer zone" between the Alberta Oil Sands region and WBNP to less than 30 km.

Forestry and Pulp and Paper

- Forestry is a major land use in the region;
- Noting the absence of a formal buffer zone the mission considered forestry to be one of several industries potentially conflicting with conservation values of WBNP

6) Cumulative Effects

- Mineral exploration and extraction potentially adds individual and cumulative impacts to an already complex setting, including past uranium mining near the shores of Lake Athabasca;
- Outside the PAD, the report summarizes Timoney (2013) which documented potential sources of agricultural, industrial, and municipal sources of contaminants to the Peace and Athabasca Rivers that may be affecting the health of the PAD ;
- Inside the PAD, land-use and management decisions have had varying degrees of impact on the system;
- The report identifies the need for a systematic analysis of a pre-regulation condition (historic or reference condition), an existing base condition (with current projects and operations), a future without projects, and a future with project conditions to build an understanding of cumulative impacts; and
- Assessment of impacts on PAD needs the incorporation of other competing water uses and impacts within the basin as well as climatic drivers and climate change that may affect the net availability of water and the timing of that water in the basin.

7) Boundary Configuration, Neighbouring Areas and Land Use Planning

- There is no buffer zone around the park boundary. In the wording of the Operational Guidelines (OG) guiding the implementation of the World Heritage Convention (UNESCO / Intergovernmental Committee for the Protection of the World Cultural and Natural Heritage, 2015), "a buffer zone is an area surrounding the nominated property which has complementary legal and/or customary restrictions placed on its use and development to give an added layer of protection to the property" (paragraph 104);
- The report identifies the potential for de facto "adaptation" of WBNP boundaries by harmonization of WBNP management with existing or planned contiguous provincial and/or territorial protected areas;
- There is a need for management of the buffer zone particularly at the southern boundary with the potential of the Teck Frontier oil sands project; and
- The report identifies the importance of land use planning and in particular the critical nature of Alberta Lower Athabasca Land Use Plan for effective management of WBNP. The Mission heard from stakeholders about various

shortcomings of LARP including the identification of potential protected areas within LARP being seen as a by-product rather than the result of systematic conservation assessment and planning.

2.2.2 Stressors

The mission concluded that significant past, ongoing and potential new stressors on the PAD ecosystem exist from development around and upstream of the park (including oil sands development, hydroelectric projects, commercial logging, pulp and paper industry, past uranium mining, expanding agricultural region, and intense resource development in the Peace River watershed. The report highlights concerns about cumulative effects of several current proposals on top of existing pressures.

The RMM finds that the multiple stressors stemming from industrial development are of exceptional scale, pace and complexity. While located outside of WBNP's boundaries, in some cases at large distance, the report states that it is undeniable that industrial development has changed the quality, quantity and flow of water of the two major rivers feeding the PAD, with additional concerns about air quality. New threats stem from recent approval and multiple proposals for additional and major projects joining an ever more intense and quickly advancing development frontier, including the proposed Site C hydroelectric dam and Teck Frontier mine projects.

2.3 RELEVANT MONITORING PROGRAMS

Monitoring in WBNP WHS related to the elements of OUV is undertaken by Parks Canada, Environment and Climate Change Canada (ECCC), Alberta Environment and Parks, MCFN Community-based Monitoring Program, and the Peace Athabasca Delta Ecological Monitoring Program (PADEMP). Monitoring measures include wood bison abundance, whooping crane productivity, river and lake water quality, river discharge (Peace, Athabasca, and Slave rivers), PAD water extent, PAD vegetation change, PAD water bird abundance, PAD muskrat abundance, air quality, contaminants in wildlife, contaminants in colonial water bird eggs, and contaminants in snow. These measures reflect concerns about the potential impacts on elements of OUV of climate change, pollution, water withdrawals and flow regulation, landscape alteration and invasive species. Some of the measures have been monitored for many years and have generated long-term datasets (bison, whooping cranes, river discharge, waterfowl abundance, etc.) while other measures are relatively new.

3.0 ASSESSMENT APPROACH

The overall objective of this SEA is to assess the cumulative impacts of all developments (including hydroelectric dams, oil sands development, and mining) on the OUV of WBNP. The resultant information with inform the preparation of an environmental management framework(s) and as the Action Plan for a region. In this regard, this SEA is intended to accomplish the following objectives:

- improve the management of cumulative environmental effects;
- increase the effectiveness of Parks Canada's review of project-level environmental assessments; and
- identify strategies and priorities for the future management and protection of the ecosystem integrity and OUV of WBNP and its designation as a World Heritage Site.

Cumulative effects analysis, as with predictive analysis in all kinds of EA, is an exercise of applied systems analysis (see Beanlands, Duinker, Canada. Federal Environmental Assessment Review Office, & Dalhousie University. Institute for Resource and Environmental Studies, 1983; Holling, 1978; Munn, 1979). The goal is to understand the mechanisms by which multiple stressors, both natural and anthropogenic, affect a VC and/or our ability to achieve the desired outcomes. This understanding would then be used to adjust the stressors through mitigation/collaborative management etc. so that the sustainability and integrity of the VC is not compromised by x``human action (Duinker & Greig, 2006). This is the primary focus of the proposed approach to undertaking the SEA for WBNP.

The assessment approach proposed to complete this SEA for the WBNP is as follows (and an overview provided in the paragraphs below):

- Identify past, present and reasonably foreseeable future projects and activities with the potential to affect the OUV for WBNP;
- Identify the geographic and temporal boundaries for the assessment;
- Determine the relevant OUVs and VCs for the Park; our focus is on the impact of surrounding development on the WBNP;
- Describe the existing baseline, stressors and trends for each VC;
- Set desired objectives and outcomes for each VC to protect OUVs of the Park; and
- Assess potential cumulative impacts on the VCs from existing and planned projects.

3.1 PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE PROJECTS AND ACTIVITIES WITH POTENTIAL TO AFFECT WBNP

Based on the review of reports to date, the following major existing and proposed projects and activities have been identified and will be assessed as part of the cumulative effects assessment.

Hydropower – Peace River

- Site C hydroelectric project – approved;
- Glacier Power (Dunvegan) – not constructed;
- Amisk hydroelectric project – under EA review; and
- W.A.C. Bennett Dam – operating since 1960's.

Oil Sands in proximity to WBNP

- Frontier Oil Sands Mine – under EA review;
- Joslyn North oil sands mine – approved, on hold; and
- Jackpine Mine Expansion Project – approved, construction not started.

Forestry and Pulp and Paper

- Five mills are operating on each river upstream of the PAD and WBNP (Glozier et al. 2009);
- Past forestry activities in and around WBNP; and
- Current and planned forestry activities around WBNP.

Superimposed upon all past, present and reasonably foreseeable future projects and activities are the changes being brought about as a result of climate change. Information reviewed suggests that climatic changes have already affected the complex ecology and hydrology of WBNP particularly as it relates to the PAD. Climate change is an overriding issue that must be addressed in the SEA/CEA. It will be addressed by looking at how climatic change may have contributed to past baseline conditions, how it may be contributing currently, and future climate change scenarios will be overlaid with the future development scenarios.

3.2 OUTSTANDING UNIVERSAL VALUE AND VALUED COMPONENTS

In order to focus the assessment, the OUV have been scoped with respect to their underlying structural elements. WBNP was inscribed on the World Heritage List under natural World Heritage criteria (vii), (ix) and (x). The three (3) criteria for WBNP listed in the statement are broken down into constituent key elements in the table below. This approach follows the guidance of Jon Day (2015) and is aimed at understanding the factors associated with individual criteria whose condition helps determine the current conditions and trends. The content in this table is benchmarked against the 1983 inscription date of WBNP World Heritage Site.

To address if a OUV element should be considered as part of the SEA (the last column), the following questions and criteria are considered:

<u>Questions</u>

- What physical environmental changes are causing stress to the OUV?
- Are stressors linked to OUV elements in the Park, the Park vicinity or a greater distance from the Park vicinity?
- Are there other existing or planned activities that may contribute to or cause stress on the OUV element?
- Are there any natural forces and/or phenomena affecting the OUV element?
- Are there social or cultural values associated with the OUV element?

<u>Criteria</u>

- The OUV element is in good or very good condition and trends are stable or improving. It does not need to be addressed as part of the SEA;
- The OUV element is in poor or very poor condition and trends are stable or declining. It should be addressed as part of the SEA; and
- There is no demonstrable linkage between the OUV element and the effects of past, existing or reasonably foreseeable projects and activities. It

does not need to be addressed as part of the SEA.

The responses to these questions and criteria result in recommendations of the OUV elements being scoped in or out of the SEA. Valued components (VCs) will then be defined for those OUV elements to be addressed in the SEA and, where possible, should related to the stressors or pathways causing stress to the OUV elements. Table 1 presents the screening of the elements of the OUV.

Based on the screening presented in the table, the SEA will be focused on the PAD and particularly the hydrology, impacts from upstream development and the impact of climate change. Encompassed within this element are the ecosystems and species that rely on the PAD for their life stages.

From the review of relevant information for the WBNP, VCs were identified that measure the changes to the PAD. The identification of VCs was guided by the following principles:

- Workable – pragmatic and realistic;
- Relevance to OUV;
- Feasible with respect to availability of data;
- Cognizant of public concern;
- Potential to address gaps in knowledge or data; and
- Amenable to collaborative management procedures.

Thus, the VCs for the WBNP SEA, as they relate to protecting the OUV of the Park, were determined to be the PAD. The VC is described below with respect to its importance, historic and current baseline conditions, stressors and relevant trends. This information will be the focus of the SEA/CEA.

3.3 IDENTIFY GEOGRAPHIC AND TEMPORAL BOUNDARIES FOR THE SEA

The identification of geographic and temporal boundaries for the SEA poses a number of challenges given the history of WBNP, the change in land use surrounding the park and influencing the OUV and the diverse issues to be addressed for the VC. It is further complicated by the need to overlay the effects of climate change on the assessment. Based on the review of information to date the following geographic and temporal boundaries are proposed for the PAD.

Geographic Boundary: The geographic boundaries of the PAD are well defined The PAD is fed by both the Peace and Athabasca rivers which lay largely outside WBNP boundary. For this assessment, the PAD itself and these two rivers systems are included as part of the PAD system.

Temporal Boundary: Traditional Ecological Knowledge (TEK) reported in project level assessments and academic literature indicate the important temporal boundary to be pre-1968, before operation of the Bennett dam. Relevant hydrological monitoring records for the Athabasca River are from the 1950s onward. Commercial oil sands mining started in the Fort McMurray region in the 1960s. Therefore, the temporal boundary is proposed to start in 1950 and extend 30 years into the future (2050) to reflect realistic bounds of climate projections that science can reasonably predict.

3.3.1 The Peace Athabasca Delta – Baseline, Trends and Stressors

The PAD is the site where two of Alberta's largest rivers, the Peace and the Athabasca, meet. The Athabasca River has mean annual flow of 650 cubic metres per second and flows into the delta

from the south. The Peace River carries a mean annual flow of 2,100 cubic metres per second and flows west to east flowing into WBNP from the north. Overall, the Peace River has a much larger influence on the PAD's flood regime than the Athabasca (Parks Canada, 2010).

Maintaining the PAD's flood regime is essential for healthy ecosystem function. The delta is flat, meaning that changes to water depth will impact the wetted coverage area. Delta water levels are impacted by climatic factors, such as precipitation and evaporation, and flow contributions from river systems, particularly the Peace River. On average, evaporation exceeds precipitation in the region. Flow rates are comparatively more variable and have been impacted by regulation. Flow rates, in particular, contribute to the frequency and intensity river flood events on the PAD (Parks Canada, 2010; Peters, Prowse, Pietroniro, & Leconte, 2006; Prowse et al., 2006; K. Timoney, 2006; Wolfe et al., 2008).

Floods in the PAD are the product of:

- ice jams, where a complex ice regime on the Peace River raises water levels enough to create flow reversals in some of the delta channels and refreshing lakes and wetlands; or
- peak summer flows with melt from the mountain snow packs and regional rain fall which increase peak flow on the rivers.

Perched basins are slightly elevated portions of the delta landscape. Peak summer flows in channels, lakes and adjacent wetlands are unable to reach perched basins. In order for these perched basin areas to be recharged, over bank flows from ice jam events are required. Ice jams are essential for maintaining water cover in the higher elevations of the delta (S. Beltaos et al., 2006; Spyros Beltaos, Prowse, & Carter, 2006; Parks Canada, 2010; Peters et al., 2006; Prowse et al., 2006; K. Timoney, 2006).

The PAD is a unique delta ecosystem that has supported indigenous communities for thousands of years. Indigenous peoples particularly value the PAD as it is the habitat for diverse species harvested in hunting, trapping, gathering and fishing; its waterways are crucial means of transportation; and as a place of spiritual and cultural significance (Candler et al., 2010). The PAD contains 219 species of birds, 300 species of invertebrates, 22 species of fish and 43 species of mammals. Due to this diversity and complexity, the delta has been designated a Ramsar site and contributes to UNESCO's World Heritage Site status as part of the WBNP (80% of the PAD is within the park).

The PAD is a crucial nesting, resting and feeding areas area in the spring and fall for 1.5 million migratory birds, particularly waterfowl such as snow geese, white-fronted geese and Canada geese, whistling swan, diver ducks, and seven species of North American grebes. The PAD is the second-largest freshwater delta in the world and is the only region in North America that is known to attract birds from all four of the continental flyways. These birds pass through the PAD during spring and fall migrations on their way to and from their breeding grounds on the Mackenzie River lowlands, Arctic river deltas, and western Arctic.

The PAD has served as an important staging area for migratory waterfowl throughout history and has played a crucial role for local indigenous communities. Indigenous community members hunt waterfowl in the migration seasons, including mallard, common goldeneye, and Canada goose. Loons are considered sacred by the Dene First Nation and oral histories from

Table 1 – Screening of the Elements of the OUV

Criterion – OUV Statement (verbatim text)	OUV excerpts of primary importance	Listing of Individual OUV Elements for this criterion	Interpreted meaning	Desired Outcomes	Assessment of Current Condition and Trend	Indigenous Interests and Issues	Potential Key Factors Affecting the Current Condition and Trends	SEA Scope and Supporting Rationale
Criterion (vii): ***"The great concentrations of migratory wildlife are of world importance and the rare and superlative natural phenomena include a large inland delta, salt plains and gypsum karst that are equally internationally significant."***	1. Great concentrations of migratory wildlife of world importance.	i. Great concentrations of migratory wildlife of world importance	Migratory wildlife means migratory bird populations who make seasonal use of portions of WBNP Migratory water-birds from four continental flyways converge in great numbers on the PAD for staging and breeding habitat.	Great concentrations of viable, healthy populations of migratory bird species continue to make seasonal use of WBNP. The habitat continues to fulfil all key life cycle stages for these species while present in WBNP. Typical life cycle stages and associated activities that take place within WBNP on an annual cycle include immigration from wintering grounds, pair bonding, nest building, reproducing, incubating, brooding, rearing, fledging, foraging, and emigrating to wintering habitat outside of WBNP.	Condition: **Good** Condition Trend: **Declining** ⬇ Confidence in Condition: ● Confidence in Trend: ● Dataset from 1955 of the abundance of representative species of water-birds in the delta (nesting and staging).	From *An Urgent Call:* "Mikisew members have observed a decline in the populations of migratory birds since oil sands activities along the Athabasca River began to increase. They have also observed a shift in the routes used by migratory birds in the PAD with more birds travelling further east and west around oil sands mine areas. Traditional knowledge links these negative trends to the impacts from oil sands as well as to the drying of the PAD caused by flow regulation." Migratory birds have cultural significance, as tern and gull eggs are a traditional Indigenous food source	Quantity and quality of migratory bird habitat within WBNP, on the migration route, and at wintering locations. Hazards encountered during spring and fall migrations (hunter harvest; infrastructure strikes; tailings pond landings). The abundance of some species is important to local people tends to decline as the time between flood events increases (flow regulation and climate change contribute to a decline in flood frequency, i.e. longer periods of time between flood events).	The use of the PAD by Migratory Birds for various life cycle stages are included in the SEA. Although the condition is relatively good it appears to be declining. The primary focus will be the impact of river regulation, and climate change on the nesting ground and habitat in the PAD;
	2. Rare and superlative natural phenomena include a large inland delta, salt plains and gypsum karst that are equally internationally significant	ii. Large inland delta (Peace – Athabasca Delta)	Portion of the Peace – Athabasca Delta within WBNP	The PAD ecosystem within WBNP remains intact and viable as a complex, large inland delta system. The physical and ecological systems are maintained and are likely to provide functional benefits into the future. Indigenous groups have expressed the desire that every reasonable effort is made to address human caused changes to the natural water regime of the the PAD.	Condition: **Poor** Trend: **Declining** ⬇ Hydrology Confidence in condition: ● Confidence in trend: ● Other aspects Confidence in condition: ⊘ Confidence in trend: ● There is a substantial body of science that addresses the impacts of flow regulation and climate change for both condition and trend. Data is more uneven and there is less consensus regarding contaminant issues and other aspects.	The MFN way of life is closely linked to the PAD ecosystem. The MFN holds traditional knowledge on how the PAD functions. The MFN believe the PAD no longer supports historic/ traditional levels of hunting, gathering and fishing activities, as well as water bird, muskrat, beaver and bison habitat. MFN believes that seasonal flood cycles have been disrupted and the Athabasca river water quality is declining, suggesting this is due to releases from industrial development.	Drying trend – climate change, and possibly flow regulation on the Peace River, and consumptive water extraction on the Athabasca River. Declining frequency of large flood inundation events and loss of wetland habitat, resulting in: Encroachment of woody vegetation and invasive plants (thistle) in some portions of the PAD Declines in abundance of keystone species (e.g, muskrat) Deposition of contaminants via air and water pathways as	There is substantial evidence that the condition is declining and the decline is linked to upstream development and climate change. WHC Decision directs State Party to assess the cumulative effects of flow regulation on the PAD. A body of literature exists that Peace River flow regulation is likely affecting portions of the PAD. The PAD is one of the world's largest freshwater deltas and a Ramsar Wetland of International Importance. Water quantity and quality are key concerns.

Criterion – OUV Statement (verbatim text)	OUV excerpts of primary importance	Listing of Individual OUV Elements for this criterion	Interpreted meaning	Desired Outcomes	Assessment of Current Condition and Trend	Indigenous Interests and Issues	Potential Key Factors Affecting the Current Condition and Trends	SEA Scope and Supporting Rationale
						MCFN believes that the PAD is drying out. Spring and summer are too dry and there are fewer ice jams in winter. Climatic changes are likely contributing. Boat access to portions of the PAD is more difficult or not feasible much more often than in previous decades of the mid 1900s (impact on traditional use)	result of upstream development	Since 1968, flow regulation has resulted in fewer floods over time for this flood-dependent ecosystem. The PAD is also vulnerable to the impacts of other upstream development (oil sands, agriculture, pulp and paper, etc.) and climate change.
		iii. Salt plains	Salt plains area within WBNP	The salt plains remain aesthetically, ecologically and geologically unique in Canada, providing habitat for salt tolerant plants, grazing bison and nesting / staging waterfowl.	Condition: **Very Good** Trend: **Stable**  Confidence in condition: ○ Confidence in trend: ○ Very little (if any) monitoring data available – this is largely an anecdotal assessment.	Unknown	There is some evidence of invasive plant species establishing populations in areas within in the Salt Plains.	There is no evidence that the condition is declining. The salt plain OUV element is not scoped and included within the SEA. The salt plain condition state appears to be stable and there is no linkage between river flow regulation or oil sands mining and refining activities and the salt plain resources.
		iv. Gypsum karst	Gypsum karst topography within WBNP	Gypsum karst topography in WBNP remains functioning within natural parameters and intact The karst landforms in the Park continue to provide some of the finest examples of collapse and pond sinkholes in the world.	Condition: **Very Good** Trend: **Stable**  Confidence in condition: ○ Confidence in trend: ○ Very little (if any) monitoring data available – this is largely an anecdotal assessment.	Unknown	none	There is no evidence that the condition is declining. The Gypsum karst OUV element is not scoped and included within the SEA. The gypsum karst condition state is good, the trend is stable, and there is no linkage between river flow regulation or oil sands mining and refining activities and the gypsum karst resources
Criterion (ix): ***"Wood Buffalo National Park is the most ecologically complete and largest example of the entire Great Plains-Boreal grassland ecosystem of North America, the only place where the predator-prey***	1. Great Plains-Boreal grassland ecosystem – the largest and most ecologically complete example in North America.	i. Ecologically complete Great Plains – Boreal grassland ecosystem	The vast sedge meadows of the PAD (the largest undisturbed grasslands in North America) and smaller but numerous meadows north of the Peace River	All species and community representatives of the Great Plains-Boreal grassland are present and functioning. These grasslands continue to provide important grazing and calving areas for Wood Bison.	Condition: **Good** Trend: **Stable**  Confidence in condition: ◐ Confidence in trend: ◐ Confidence: we have some monitoring data about the extent of grasslands with more in the delta than in the rest of the Park.	Pressures from expansion of agricultural land, deforestation, and climate change generate challenges for Park herds of Wood Bison that graze and calve on the grasslands. WBNP was established to preserve bison reserves for indigenous populations (Little Red River)	The extent of wet meadow habitat in the PAD appears to be decreasing, and the presence of invasive (thistle) and woody (willow) species increasing, as the time between flood events increases.	This OUV element is scoped and not included within the SEA. However, there are strong linkages with "Large inland delta" (PAD) listed above in Criterion (vii) "rare and superlative natural phenomena" therefore issues are related to impact of stressors on the PAD.

Criterion – OUV Statement (verbatim text)	OUV excerpts of primary importance	Listing of Individual OUV Elements for this criterion	Interpreted meaning	Desired Outcomes	Assessment of Current Condition and Trend	Indigenous Interests and Issues	Potential Key Factors Affecting the Current Condition and Trends	SEA Scope and Supporting Rationale
relationship between wolves and wood bison has continued, unbroken, over time."								Changes in the composition and structure of the vegetation community within the PAD from climate change or flow regulation activities may negatively impact the habitat quantity/quality in the PAD and its ability to support Bison population. Therefore, this is considered as part of the PAD OUV element.
	2. Predator-prey relationship between wolves and wood bison – the only place where this relationship has continued, unbroken, over time.	i. Intact predator-prey relationship between wolves and wood bison	Intact predator-prey relationship between wolves and wood bison	The predator-prey relationship between wolves and wood bison remains intact and within natural ranges of variation so populations of both species remain viable and evolve as naturally as possible	Condition: **Good** Trend: **Stable** ⟷ Confidence in condition: ● Confidence in trend: ● Bison surveys show a relatively stable population since 2000. Wolf abundance is not measured, so the evidence is anecdotal.	According to the MCFN Bison move out of the Park as the PAD wetlands dry out. Illnesses in Park bison are common. Wolf and bison populations are out of balance	Any factor which may increase the risk of disease transmission from WBNP herds to neighbouring disease-free wood bison and cattle herds could adversely affect this relationship (for example culling, or disease testing and removal of WBNP bison).	This OUV element is not included in scope of the SEA Evidence suggests that the predator-prey relationship remains intact. Evidence suggests that the condition is good, trends are stable and stressors do not appear to be related to activities outside of the Park beyond the indirect stressors to the PAD. Therefore, any effect to predator-prey relationships will only be explored as they related to the PAD OUV element.
Criterion (x): ***"Wood Buffalo National Park contains the only breeding habitat in the world for the whooping crane, an endangered species brought back from the brink of extinction through careful management of the small number of breeding pairs in the Park. The Park's size (4.5 million ha), complete ecosystems and protection are essential for in-situ***	1. Only breeding habitat in the world for the whooping crane.	i. Whooping Crane breeding habitat	Whooping crane critical habitat within the Park (Zone 1 Area), also identified as a Ramsar Wetland of International Importance. Includes habitat and population	Habitat continues to support increasing numbers of breeding pairs and demonstrates resilience to climate change impacts Whooping crane population continues to grow Recovery and downlisting from endangered status.	Condition: **Very Good** Trend: **Stable** ⟷ Confidence in condition: ● Confidence in trend: ● Habitat is assessed annually using surveys. Crane abundance and productivity is closely monitored. The breeding habitat supports increasing numbers of nesting pairs as the species continues to recover. There is evidence that each year additional pairs are using available breeding habitat outside of the Park.	MCFN suggests that Whooping Crane are being adversely affected by changes water quality, quantity, and timing of water flow in the PAD. They also expressed concern about the impact of tailings ponds on cranes during their migration.	Climate change impacts on the hydrology of the nesting area. Impacts to habitat on the migration route or on the wintering grounds.	This OUV element is not included within the SEA There is limited evidence that the Whooping Crane habitat condition and its use is declining. The primary threats to Whooping Crane exist during migration or within their wintering ground. WBNP has sufficient land available to the birds for mating and nesting.

Criterion – OUV Statement (verbatim text)	OUV excerpts of primary importance	Listing of Individual OUV Elements for this criterion	Interpreted meaning	Desired Outcomes	Assessment of Current Condition and Trend	Indigenous Interests and Issues	Potential Key Factors Affecting the Current Condition and Trends	SEA Scope and Supporting Rationale
conservation of the whooping crane."								

Explanation of Condition, Trend, and Confidence ratings used in the table (after Day, 2015[1]).

Condition:

Colour Swatch	Rating Category	Rating Category Descriptor
	Very Good	All elements necessary to maintain the OUV are essentially intact, and their overall condition is stable or improving. Available evidence indicates only minor, if any, disturbance to this element of OUV.
	Good	Some loss or alteration of the elements necessary to maintain the OUV has occurred, but their overall condition is not causing persistent or substantial effects on this element of OUV.
	Poor	Loss or alteration of many elements necessary to maintain OUV has occurred, which is leading to a significant reduction in this element of the OUV.
	Very Poor	Loss or alteration of most elements necessary to maintain the OUV has occurred and has caused a major loss of the OUV.

Trend:

- ⬆ Improving
- ⬇ Declining
- ⟷ Stable

Confidence in condition / trend:

- ● Adequate high-quality evidence and high level of consensus
- ⊘ Limited evidence, or limited consensus
- ○ Very limited evidence, assessment based on anecdotal information

[1] Jon Day, 2015. Understanding your Outstanding Universal Value (OUV) … how to break down OUV to more effectively manage and report on your World Heritage site.
Jon Day - ARC Centre of Excellence for Coral Reef Studies. James Cook University, Townsville, Australia. Presented to the World Heritage Committee WHC39, Bonn. Saturday, July 4th, 2015. Available http://www.39whcbonn2015.de/fileadmin/media/Dateien/OUV_talk_WHC39_JCD_040715.pdf

elders in the Dene community tell of loons that would communicate with the Dene people about the delta and the water (Cheskey, Wells, & Casey-Kefkowitz, 2011). In the late 1950s and early 1960s, estimates were as high as 320,000 pairs of breeding ducks. More recently, breeding estimates have been lower, with records showing about 120,000 pairs of dabbling ducks such as mallard, gadwall, American wigeon, and northern pintail and approximately 40,000 pairs of diving ducks such as canvasback, redhead, and lesser scaup in the PAD (IBA Canada, 2016). This change is affirmed by people in Fort Chipewyan, who have noticed declines in waterfowl over the last 40 years (Cheskey et al., 2011).

Bison make use of the grasslands in the PAD for grazing and calving. Bison within the WBNP have been managed in some form for 140 years. The population, genetic diversity and vectors for disease have been influenced directly and indirectly by humans in the region. The wood bison populations within WBNP are endangered and are a species explicitly listed within the OUV. Managing bison populations is complex and requires consideration of population levels, maintaining genetic differentiation and containing disease (Ball et al., 2016; Cronin et al., 2013; Mitchell, 2002; Parks Canada, 2010). Currently , approximately 40% of the wood bison within the park test positive for exposure to bovine tuberculosis (bTB; caused by Mycobacterium bovis) and brucellosis (caused by Brucella abortus) (Alberta Government, 2013; Ball et al., 2016). Herds outside of the park have been segregated from WBNP and managed since the early 1990s. Wood Bison herd numbers in the Park have generally been increasing since around 1988 and calf survival rates are stable (Parks Canada, 2010).

For the purposes of this assessment, bison will only be considered in relation to the PAD. One of the primary reasons for this bounding is due to the specific intent of the SEA, which is to consider historic and on-going threats from development on WBNP. In particular, the assessment will focus on the impacts of climate change and flow regime changes on the grasslands of the PAD which is bison habitat.

Stressors

The stressors on the PAD are flow regulation on the Peace River and water withdrawals on the Athabasca River from oil sands developments, as well as climate change. These stressors change the ecological function of the PAD which in turn effects habitat for migratory birds and bison who rely on the PAD for life cycle stages.

Over the past 100 years, the Delta has entered a drying cycle. The Peace River has been regulated since 1968 when the W.A.C. Bennett Dam in British Columbia was constructed. The Athabasca River is unregulated, but impacted by water withdrawal from industry upstream. Climatic change has also contributed to drying conditions.

In 1945, marsh cover reached its peak and since has varied significantly. Additionally, over the past 75 years, forest cover has increased slightly (Timoney, 2006). There is some debate among scholars as to what range of drying exists within a healthy and dynamic delta. However, the majority of scholars believe that anthropogenic factors, including regulation on the Peace River, withdrawal from the Athabasca for oil sand production, and climate change, all play roles in the drying of the region. In particular, the construction of the Bennett dam in 1968 on the Peace River drastically changed flow regimes on the river and the frequency and intensity of ice jams. Beltaos (2014) estimates that Peace River regulation accounts for nearly two thirds of the reduction in ice jams. At Peace Point, the

Bennett Dam has decreased summer flows by 31% and increased winter flows by 200%. Peace Point is a relevant flow measure point for the PAD because it is located immediately upstream of the deltaic reach of the river. Ice jams form downstream of this location and are crucial to the hydrological cycle. Drastic changes to flow rates can alter ice formation (Beltaos, 2014).

While river regulation on the Peace has changed flow rates, regional climatic change has increased evaporation. With climatic change, increased evaporation is expected, but warmer and drier conditions also decrease runoff required to stimulate spring and summer flooding. Subsequent regulation and development, when combined with climatic change, have been linked to further drying in the PAD (Spyros Beltaos, 2014; Parks Canada, 2010; Peters et al., 2006; Prowse et al., 2006; K. Timoney, 2006; Wolfe et al., 2008).

Flow regulation on the Peace River has increased fall and winter flows and decreased spring and summer flows. The increased winter flows have contributed to fewer ice jam flooding events in the PAD, which contributes to less recharge of perched water tables in the PAD. The lower spring and summer flows have generally contributed to lower water levels (water extent, water coverage) in lakes and wetlands of the PAD. Parks Canada reports that water extent has declined compared to pre-regulation; it has been in a relatively stable state of dryness post-regulation with a few short periods of increased extent after the few flood events. From the literature reviewed, it appears that there is no real consensus on whether the water extent in the PAD is actually stable or declining (AECOM, 2010; Parks Canada, 2010, 2016), however there is general agreement that both river flow into the PAD and flooding frequency in the PAD have been decreasing since the 1960s. River flow into the PAD from the Athabasca River has also been declining since the 1960s and nutrient loads in the river have been increasing in that time.

Interventions to the flow regime have been attempted, including the construction of outflow weirs on two channels to maintain lake levels, but prevent winter drawdown. Artificial ice jams were constructed in the mid-1990s. In 1996, BC hydro increased the Bennett Dam release that supplemented flooding in the PAD.

3.4 Identification of Objectives, Indicators and Desired Outcomes

To determine the current and potential cumulative impacts on the VCs, we have identified objectives, indicators and desired outcomes. Parks Canada is obligated to protect the OUV that resulted in WBNP's designation as a World Heritage Site. Objectives have been articulated that define the measurable conditions that must exist to protect the OUV and VCs. Desired outcomes are the thresholds that should be met to achieve these objectives. The indicators are the measurable conditions that can be monitored and assessed for trends to measure achievement of objectives and desired outcomes.

The preliminary set of objectives and desired outcomes and potential indicators have been defined in Table 2. This information will be used in the assessment of cumulative effects to determine if desired outcomes are likely to be compromised under various development and climate change scenarios.

Appendix A illustrates the current status and trends for the VCs. Further discussions with Parks Canada are necessary to determine which ecological integrity monitoring indicators and thresholds are most appropriate for use in this

Table 2 – VC Objectives, Desired Outcomes and Potential Indicators

OUV	VCs	Objective	Desired Outcome	Potential Indicators
vii	Peace Athabasca Delta (PAD)	▪ Protection of flow regime and water levels in the PAD ▪ Maintenance of traditional land uses (hunting, fishing, etc.) ▪ Provision of appropriate habitat for wildlife, birds, and vegetation in the PAD ▪ Resilience to climate change impacts	▪ Protect ecological features and functions within the PAD by maintaining flow regimes into and within the PAD within threshold/optimal values ▪ Ensure cycle of ice jams and flooding is appropriate to flood perched areas and ensure appropriate seasonal variation of water levels to maintain ecological function ▪ Healthy, stable populations of key species such as muskrat, waterfowl, bison, etc. ▪ PAD Indigenous groups able to continue sustained harvest of muskrat and other important species ▪ Adequate flow rates/levels to sustain supporting vegetation communities	▪ Maintain optimal river and lake ice levels at key locations ▪ Maintain optimal water extent in the PAD ▪ Maintain optimal river flow into the PAD ▪ Maintain optimum flow in the Peace, Slave and Athabasca Rivers ▪ Maintain optimal river water quality for rivers feeding into the PAD ▪ Maintain optimal muskrat population numbers ▪ Maintain optimal lake ice phenology ▪ Maintain optimal flooding frequency

study particularly with respect to information availability.

3.5 Identification of Scenarios for the Assessment of Cumulative Effects

Consistent with the recommendations of the RMM Report, in order to undertake a systematic assessment of cumulative effects the following scenarios will be analyzed at a coarse level of detail:

- Pre-regulation condition (historic or reference condition);
- Existing base condition (with current projects and operations);
- Future without projects only climate change; and
- Future with project conditions and likely climate change scenario.

The pre-regulation condition will reflect the state of the park and its environs around about 1950. This will capture the stressors on WBNP prior to oil sands development and the development of the Bennett Dam. The discussion of the baseline and stressors at this time will be structured around appropriate indicators. This will result in a qualitative description and assessment.

The existing base condition includes all of the past and existing projects and will reflect today's baseline condition. Much of the information that portrays this condition is already represented in the RMM report and this information will be synthesized with information available from Traditional Ecological Knowledge, academic literature, and other sources. Again, the description and assessment will be qualitative in nature.

The future scenarios both with and without likely projects will try to characterize the likely affects associated with climate change and those effects associated with likely projects at a coarse level of detail based on readily available information.

3.6 Cumulative Effects Assessment Methodology

Determinations regarding cumulative effects will use a "Weight of Evidence" approach, meaning that a combination of information from several different sources (if available) will be used to give sufficient evidence to fulfil an information requirement. This approach is beneficial in a cumulative effects assessment when,

- the information from a single piece of evidence alone is not sufficient to draw a conclusion. This could be, for example, due to clear deficiencies in one of the existing studies; and
- individual studies provide different or conflicting conclusions.

The weight given to the available evidence depends on factors such as the quality of the data or studies undertaken, the consistency of results or conclusions drawn, nature of effects, and the relevance of the information. Although the weight of evidence approach will require using the Team's professional judgment and relying on the professional judgement of others; as a general principle, the more information available, the stronger the weight of evidence is.

Where possible, information will be presented in a structured and organized way, outlining information gaps and uncertainties, to support and/or qualified a conclusion. Where available, TEK will be part of the information reviewed for each VC.

As part of the Weight of Evidence approach, it is proposed that the cumulative effects analysis be undertaken using several tools:

- Information provided through discussions with First Nation, Parks Canada representatives and others will be used to collect information about past, present, or planned development projects, current status and trends in VCs and opinions about where, why, and how cumulative effects may occur;
- Matrices will be used to present and organize information on the cumulative effects of a project and other physical activities on VCs. They will be used to identify the likelihood of cumulative effects on one or more VCs; and
- Network and systems analysis would be used to identify the pathway of cumulative effects using a series of links between past, existing and future projects, and a VC. Network diagrams would be "high-level" and would not necessarily represent specific scientific hypotheses, but rather would be used to illustrate linkages between a source of effect and the VC.

It is anticipated that the SEA will provide the substantive basis for Parks Canada, in collaboration with other federal and provincial agencies and Indigenous communities, to develop tools and management strategies. These tools and management strategies may be used by Parks Canada to inform comments on project specific approvals and to work collaboratively with other stakeholders to better manage the VCs and protect the OUV given the stressors and potential effects identified (Canadian Environmental Assessment Agency, 2014).

REFERENCES

AECOM. (2010, March). Synthesis of Ecological Information Related to the Peace-Athabasca Delta.

Alberta Government. (2013). *Managing Disease Risk in Northern Alberta Wood Bison-Outside of Wood Buffalo National Park*.

Ball, M. C., Fulton, T. L., & Wilson, G. A. (2016). Genetic analyses of wild bison in Alberta, Canada: implications for recovery and disease management. *Journal of Mammalogy*, *97*(6), 1525–1534. https://doi.org/10.1093/jmammal/gyw110

Beanlands, G. E. (Gordon E., Duinker, P. N., Canada. Federal Environmental Assessment Review Office, & Dalhousie University. Institute for Resource and Environmental Studies. (1983). *An ecological framework for environmental impact assessment in Canada / Gordon E. Beanlands and Peter N. Duinker*. Halifax, N.S: Institute for Resource and Environmental Studies, Dalhousie University and Federal Environmental Assessment Review Office.

Beltaos, S. (2014). Comparing the impacts of regulation and climate on ice-jam flooding of the Peace-Athabasca Delta. *Cold Regions Science and Technology*, *108*, 49–58. https://doi.org/10.1016/j.coldregions.2014.08.006

Beltaos, S., Prowse, T., Bonsal, B., MacKay, R., Romolo, L., Pietroniro, A., & Toth, B. (2006). Climatic effects on ice-jam flooding of the Peace-Athabasca Delta. *Hydrological Processes*, *20*(19), 4031–4050.

Beltaos, S., Prowse, T. D., & Carter, T. (2006). Ice regime of the lower Peace River and ice-jam flooding of the Peace-Athabasca Delta. *Hydrological Processes*, *20*(19), 4009–4029.

Canada National Parks Act S.C. 2000, c. 32

Canadian Environmental Assessment Agency. (2014, December). Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012: Appendix 3: Selecting the methods to be used. Canadian Environmental Assessment Agency. Retrieved from https://www.canada.ca/en/environmental-assessment-agency/services/policy-guidance/technical-guidance-assessing-cumulative-environmental-effects-under-

Candler, C., Gibson, G., Mallone, M., Firelight Group Research Cooperative, & Mikisew Cree First Nation. (2015). *Wîyôw'tan'kitaskino (Our Land is Rich): A Mikisew Cree Culture and Rights Assessment*. Fort McMurray, Alberta.

Candler, C., Olson, R., DeRoy, S., & Firelight Research Cooperative. (2010, November 26). As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change. Retrieved March 21, 2017, from http://www.parklandinstitute.ca/as_long_as_the_rivers_flow

Cassady St. Clair, C., & Research on Avian Protection Project (RAPP). (2014). *Final Report of the Research on Avian*

Protection Project (2010-2014). Edmonton, Alberta: University of Alberta.

Centre, U. W. H. (1977, July 1). The Operational Guidelines for the Implementation of the World Heritage Convention. Retrieved July 21, 2017, from http://whc.unesco.org/en/guidelines/

Cheskey, E., Wells, J., & Casey-Kefkowitz, S. (2011, October). Birds at Risk: the Importance of Canada's Boreal Wetlands and Waterways. Retrieved from http://www.borealbirds.org/sites/default/files/publications/Report-BirdsAtRisk.pdf

Cronin, M. A., MacNeil, M. D., Vu, N., Leesburg, V., Blackburn, H. D., & Derr, J. N. (2013). Genetic Variation and Differentiation of Bison (Bison bison) Subspecies and Cattle (Bos taurus) Breeds and Subspecies. *Journal of Heredity*, *104*(4), 500–509. https://doi.org/10.1093/jhered/est030

Day, J. (2015, July). *Understanding your Outstanding Universal Value (OUV)... how to break down OUV to more effectively manage and report on your World Heritage site.* Presented at the Presented to the World Heritage Committee WHC39, Bonn, Townsville, Australia. Retrieved from http://www.39whcbonn2015.de/fileadmin/media/Dateien/OUV_talk_WHC39_JCD_040715.pdf

Duinker, P. N., & Greig, L. A. (2006). The impotence of cumulative effects assessment in Canada: ailments and ideas for redeployment. *Environmental Management*, *37*(2), 153–161.

Environment Canada. (2007). Recovery Strategy for the Whooping Crane (Grus americana) in Canada. Environment Canada, Ottawa. Retrieved from http://www.sararegistry.gc.ca/virtual_sara/files/plans/rs_whooping_crane_final_1007_e.pdf

Gates, C., & Wierzchowski, J. (2003). A landscape evaluation of bison movements and distribution in northern Canada—addendum to the final report, December 2001. University of Calgary.

Government of Canada, E. C. (2011, April 27). Species Profile (Whooping Crane) - Species at Risk Public Registry. Retrieved March 12, 2017, from http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=34

Hechtenthal, S., Stanojevic, Z., & Komers, P. (2012, September). Avian Hazard Map-Shell Hearing Submission. Athabasca Chipewyan First Nation IRC. Retrieved from http://www.ceaa.gc.ca/050/documents_staticpost/59540/82080/Appendix_E_-_Part_14.pdf

Holling, C. S. (1978). *Adaptive Environmental Assessment and Management*. John Wiley & Sons. Retrieved from http://pure.iiasa.ac.at/823/

IBA Canada. (2016). Important Bird Areas(IBA) Canada: PAD. Retrieved July 5, 2017, from

http://www.ibacanada.com/site.jsp?siteID=AB002&lang=EN

Migratory Birds Convention Act, 1994 (S.C. 1994, c. 22)

Mitchell, J. A. (2002). *A landscape evaluation of bison movements and distribution in northern Canada*. University of Calgary.

Munn, R. E. (1979). *Environmental impact assessment: principles and procedures*. Published on behalf of the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions by Wiley.

Parks Canada. (1984). Wood Buffalo National Park Management Plan. Parks Canada.

Parks Canada. (2010). State of the Park Report: Wood Buffalo National Park. Parks Canada.

Parks Canada. (2016). *Operational Review of the Ecological Integrity Monitoring Program of Wood Buffalo National Park*. Gatineau, QC: Parks Canada.

Peters, D. L., Prowse, T. D., Pietroniro, A., & Leconte, R. (2006). Flood hydrology of the Peace-Athabasca Delta, northern Canada. *Hydrological Processes*, *20*(19), 4073–4096.

Prowse, T. D., Beltaos, S., Gardner, J. T., Gibson, J. J., Granger, R. J., Leconte, R., … Toth, B. (2006). Climate change, flow regulation and land-use effects on the hydrology of the Peace-Athabasca-Slave system; Findings from the Northern Rivers Ecosystem Initiative. *Environmental Monitoring and Assessment*, *113*(1–3), 167–197.

R. v. Syncrude Canada Ltd., 2010 ABPC 229

Timoney, K. (1999). The habitat of nesting whooping cranes. *Biological Conservation*, *89*(2), 189–197. https://doi.org/10.1016/S0006-3207(98)00121-9

Timoney, K. (2006). Landscape cover change in the Peace-Athabasca Delta, 1927–2001. *Wetlands*, *26*(3), 765–778. https://doi.org/10.1672/0277-5212(2006)26[765:LCCITP]2.0.CO;2

Timoney, K. P. (2013). *The Peace-Athabasca Delta: Portrait of a Dynamic Ecosystem*. University of Alberta.

Timoney, K. P., & Ronconi, R. A. (2010). Annual bird mortality in the bitumen tailings ponds in Northeastern Alberta, Canada. *The Wilson Journal of Ornithology*, *122*(3), 569–576.

Wolfe, B. B., Hall, R. I., Edwards, T. W., Vardy, S. R., Falcone, M. D., Sjunneskog, C., … van Driel, P. (2008). Hydroecological responses of the Athabasca Delta, Canada, to changes in river flow and climate during the 20th century. *Ecohydrology*, *1*(2), 131–148.

APPENDIX A

VC INDICATOR STATUS, TRENDS AND IMPACTS

Table A1 – VC Indicator Status, Trends and Impacts from Project Development

VC (& OUV)	Current Status of VC Indicator	Indicator Trends	Past & Current Impacts: Bennett Dam, Pulp and Paper Mills, Oil Sands, Agriculture, Municipal Sewage, Climate Change	Potential Future Impacts: Site C, Jack Pine, Joslyn, Teck Frontier, Dunvegan, Amisk, Climate Change
Peace Athabasca Delta (vii)	• River & lake ice levels at Peace Pt = TBD [1] • Water extent in the PAD = Good[1],**Fair [3,4]** • **River flow into the PAD = Fair[4]** • **Water flow dynamics in the Peace River = Good[1], Poor[3]** • **Flow in the Slave River = Good[1], Poor[3]** • Flow in the Athabasca River = Good[1,3] • Flow in Athabasca River = NA[2] • Water discharge rates for rivers feeding into the PAD = Good[1] • **River water quality for rivers feeding into the PAD = Fair[1,3]** • Athabasca river nutrient loads = NA[4] • River oxygen levels = Good[4] • Muskrat population numbers = Good[1], NA[3,4] • **Waterbird & amphibian abundance & occupancy rate = Poor[1]** • Migratory bird & waterfowl = Good[4] • Macroinvertebrate population numbers = Good[1] • Mercury levels in waterbird eggs = Good[1] • **Invasive plant species = Fair[1,4], Good[3]** • Air quality = Good 75-90% of the time[3] • Air quality = Good[4] • Lake ice phenology = TBD[1] • **Lake hydrology = Fair[1]** • **Flooding frequency = Fair[3], NA[4]** • Lake fish community = Good[3,4] • **Moose numbers in PAD = Fair[3]**	• River & lake ice levels at Peace Pt = NA[1] • **Water extent in the PAD = Stable[1], Declining[3], Stable[4]** • **River flow into the PAD = Decreasing[4]** • Flow in the Peace River = Stable[1], Stable[3] • Flow in the Slave River = Stable[1], Stable[3] • **Flow in the Athabasca River = Decreasing[1,3]** • Flow in Athabasca River = NA[2] • Discharge rates for rivers feeding into the PAD = Stable[1] • **River water quality for rivers feeding into the PAD = Stable[1], Declining[3]** • **Athabasca river nutrient loads = Declining[4] (i.e. increasing loads)** • River oxygen levels = Increasing[4] • Muskrat population numbers = NA[1], Stable[3,4] • Waterbird & amphibian abundance & occupancy rate = NA[1] • Migratory birds & waterfowl in PAD = Stable[4] • Macroinvertebrate population numbers = NA[1] • Mercury levels in waterbird eggs = Stable[1] • **Invasive plant species = Down[1], Declining[3,4] (i.e. increasing numbers & species)** • Air quality = Stable[3,4] • Lake ice phenology = NA[1] • Lake hydrology = Stable[3] • **Flooding frequency = Declining[3,4]** • Lake fish community = Stable[3,4] • Moose numbers in PAD = NA[3]	• 30% decrease in mean summer flow and 200% increase in mean winter flow on Peace River • Increased freeze up and reduced break up flows on Peace River • Fewer ice jam floods on Peace River, reduced reversal of flows into perched basins of PAD (since 70s) [large scale flooding of the delta has happened only three times between 1968 and 2009 (years 1974, 1996 and 1997). • Lower water levels in PAD • Decreased snowpack depth, decreased runoff, decreased flow rates on Athabasca River • Decreased water quality (TP, Na, Cl, TOC, Turbidity) in AR • Decreased sediment quality in Athabasca River	• Site C: No impacts on PAD (from EIS) • JackPine: No impact to air quality & metal deposition in PAD, frequency & depth of flooding in PAD, flow rates & water levels in the PAD, water quality & thermal regime in Athabasca Rriver, DO & sediment quality in the PAD (from EIS) • Teck Frontier: No impacts to air quality, groundwater quality & quantity, flow rates & water quality on Athabasca River, frequency of flooding & water quality in PAD (from EIS) • Dunvegan: unknown, no PAD assessment • Amisk: unknown, no PAD assessment • Joslyn: No impact to water quality & hydrology on Athabasca R (from EIS) • Climate change: Lower flows on Athabasca R and Peace R, delayed ice formation and thinner ice on Peace R, earlier spring break ups & fewer ice jams on Peace R, lower water levels & less flow reversal in PAD • Other water takings
Wood Buffalo (vii, ix, x)	• Range/control area = ?? • Bison Control Area = NA • Buffer zone = ?? • **Bison abundance in PAD = Fair[3]** • **Bison abundance in PAD = Poor[1]** • Bison abundance in Park = Good[3] • **Bison abundance in PAD = Fair[4]** • Calf survival rates = Good[1]	• Range/control area = ?? • Bison Control Area = NA • Buffer zone = ?? • Bison abundance in PAD = Increasing[3] • **Bison abundance in PAD = Down[1]** • Bison abundance in Park = Increasing[3] • Bison abundance in PAD = Increasing[4] • Calf survival rates = Stable[1]	• Limited impact from oil sands development • Low risk of habitat fragmentation impacts from other developments outside the Park	• Teck Frontier: No impacts to wildlife populations (from EIS) • None other documented • Climate change: Increased risk of fire, insect outbreaks from warming climate that may be new stressors

VC (& OUV)	Current Status of VC Indicator	Indicator Trends	Past & Current Impacts: Bennett Dam, Pulp and Paper Mills, Oil Sands, Agriculture, Municipal Sewage, Climate Change	Potential Future Impacts: Site C, Jack Pine, Joslyn, Teck Frontier, Dunvegan, Amisk, Climate Change
	• bTB rates = ??	• bTB rates = ??		
Whooping Crane (vii, ix, x)	• **Population and breeding pairs in nesting grounds = Poor[3]** • Crane nesting hydrology = Good[3]	• Population and breeding pairs in nesting grounds = Increasing[3] • Crane nesting hydrology = Stable[3]	• 1941- 21 birds • 1970- 57 birds • 1999- 260 (183 of which were members of the Wood Buffalo /Aransas flock). • 2005- 214 2005 (flock had increased by more than 35 % over the last ten years). • In total, whooping cranes have population growth of 3.7% per year. • 64% of the total February, 2006 wild population (215 of 338 individuals) had summered in Canada (Whooping Crane Recovery Plan, 2005).	• None documented • Climate change: Drier or drought conditions and lower water tables, as well as cold weather or precipitation after hatching would negatively affect the population • Potential/ unknown migratory Pattern concerns
Forests (ix, x)	• Index of primary productivity = Good[3] • Plant productivity and growing season = Good[1] • Normalized vegetation difference index (NDVI) = Good[1] • Fire frequency = Good[1] • **Forest insects and disease levels = Fair[1]** • Snowshoe hare populations = Good[1] • Forest composition = TBD • Annual area burned = Good[3] • **Moose community = Fair[3]**	• Index of primary productivity = Stable[3] • Plant productivity and growing season = Stable[1] • Normalized vegetation difference index (NDVI) = Stable[1] • Fire frequency = Stable[1] • Forest insects and disease levels = NA[1] • Snowshoe hare populations = NA[1] • Forest composition = NA[1] • Annual area burned = Stable[3] • Moose community = NA[3]	• None documented	• None documented • Climate change: Increased risk of fire, insect outbreaks from warming climate

Superscripts [1]: From WBMP EIM Program Review Report, Parks Canada, 2016; [2]: From "As Long As the River Flows", Candler, 2010; [3]: From the State of the Park Report, Parks Canada, 2009); [4]: From Synthesis of Ecological Information Related to the Peace Athabasca Delta (AECOM, 2010)