

8. Recommendations for Lease Stipulations and ROPs

The ROD and EIS/SEIS is tiered from due an admirable job of fulfilling its conflicting mandates for both supporting development and protecting the landscape from that development as it relates to permanent and semi-permanent installations, but they fall short when it comes to seismic operations. **Specifically, the central and overarching deficiency within the ROD is the lack of any meaningful or useful definition of significant harm by overland travel by seismic operations, rendering all lease stipulations and ROPs intended to protect the tundra from those operations as unenforceable.** Crucially, what is missing throughout the regulatory guidance is an understanding that the sensitivity of this terrain to seismic disturbance is tied to the current state of ongoing hydrologic reorganization and rapid ecologic transformation triggered by pervasive ice wedge melt on sloping terrain, such that climate warming over the next decades will continue to exacerbate these challenges. For example, there is as yet no science to determine minimum snow depths for seismic operations over terrain with this sensitivity to disturbance; even the excellent studies from the 1980s seismic work in the 1002 Area documenting impact as a function of snow depth minimums (Refs 34-37) is not sufficient because those minimums (which already exceed currently regulatory minimums) were made on ground that was substantially more resilient to impacts than it is today. **Therefore, as currently formulated, the Lease Stipulations and ROPs related to seismic exploration will likely lead to widespread, irreparable harm because they do not take into account the latest information on the sensitivity of terrain here, are not based on scientific tools available for over a decade, and have no definitions or enforceable metrics for what constitutes acceptable harm.** In this section, I review the current regulations and propose solutions to fill these gaps.

The first step is simply applying the protection protocols applied to infrastructure development to seismic operations, as seismic operations have not only same potential for adversely impacting protected hydrological resources and their associated ecology, but seismic operations are permitted to occur over the entire ~1.5 million acres of the 1002 Area whereas infrastructure impacts are limited to only 2000 acres. Without this understanding that the potential for harm is much greater for seismic operations than infrastructure development because risks are the same but the area is 750 times larger, there is little hope of developing new, efficacious mitigation. With that understanding, many new and useful mitigation strategies are easily imagined and implementable. For example, there are 18 ROPs (16-33) that require operators to study and protect ecology from adverse impacts caused by *exploratory drilling* -- the same study and protection guidelines need to also be mandated to also include *seismic operations* based on the

potential impacts described in this report, especially related to ice wedge melt, hydrologic reorganization, and resulting ecological transformations that impact all wildlife.

Additionally, the public has a right to oversee the Agencies overseeing these operations, as codified by law in the NEPA standards and §1002 of ANILCA. **Without independent evaluations of relevant data by the public, the public participation process within NEPA is made farcical.** Meaningful participation by the public in this NEPA process requires **all** data acquired as part of protecting these lands be made public. According to ANILCA §1002 (e) (2)(c), this also includes that **all seismic data** acquired by lease holders be made public so that concerned citizens, through their legislators, can make informed choices as to the governing laws based on their own determinations of risk/reward ratios; if Congress had desired these data to be kept secret for more than 2 years, they clearly had the opportunity to say so here. That is, by mandating the public availability of these data within the ROD, operators can base their financial investments already knowing the data will become public – it is not the role of the NEPA process to incentivize competitive advantages to corporations through trade secrets at the expense of public input but rather to level the playing field between all stakeholders per the law. For example, operators are required by regulation to pay for many ecological studies prior to their permits for construction being approved, sharing their seismic data publicly is just another study that should follow that precedent before approving construction of any new infrastructure presumably based on the implications of that seismic data.

Lease Stipulation 1 – Rivers and Streams. To “*minimize the disruption of natural flow patterns and changes to water quality [and] the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas, springs, and auffs*” we must first establish baselines on these flow patterns and physical characteristics and then track their natural variations (caused by climate warming) over time. The essential point not captured in the EIS/SEIS due to the new data presented here is that the ‘natural’ regime is *changing*, not static as presumed in those analyses (such as in the NHD) and because this ‘natural’ state is a constant state of change that we must track these changes over time to prevent interference or exacerbation of them, which fits perfectly with the founding themes of the Arctic Refuge as a place where nature unfolds without direct human interference. That is, background studies are required to understand the changing hydrologic dynamics for seismic operations in the same way that background studies are mandated for lake pumping or for protecting caribou, polar bears and birds habitats for infrastructure (i.e., ROPs 16-33).

Therefore:

- *Carter Creek must be added to the list of rivers requiring setbacks.* Carter Creek is perhaps the most vulnerable river in the 1002 Area due to the elevated thermal erosion within its watershed (eg, Fig. 185-186).
- *Stream gaging must be conducted each summer on all major rivers flowing from the mountains and studies conducted to track short and long term changes.*
- *Glacier volume change must be conducted annually for leases covering the Hulahula, Okpilak, and Jago Rivers to study impacts on fish and bird habitats (Fig. 204).* The decline of freshwater resources in those rivers must be tracked, as glacier loss will impact subsistence usage of fish habitats (particularly in the Hulahula River) and will change the natural flow and water quality on the freshwater delta ecosystems they form by gradually changing them into marine ecosystems.
- *All leaseholders must conduct annual airborne topographic mapping with co-registered RGB and NIR imagery of their leases at 50 cm or better resolution to create hydrological and ecological maps (ROP 28).* Such data are required to understand the changes to natural stream and river flow dynamics due to ice wedge degradation, lake drainages, and vegetative changes associated with them, as well as to form baselines for any planned or possible operational disruptions such as seismic or infrastructure development. Unless we have such maps, we cannot compare them to prior baselines to determine and track the current state of permafrost stability/vulnerability and hydrologic pathways through ice wedge networks.
- *Snow thickness must be mapped spatially at 50 cm or better over the entire lease area each spring for at least 3 years prior to seismic operations.* Such data are required to determine inter-annual variability to understand the natural flow patterns of snow melt, to understand the influence of snow thickness on terrain sensitivity, and to assess the spatially viability of reliably meeting snow depth minimum standards for overland travel such as for seismic or other operations.
- *Studies must be conducted by the lessees, prior to applying for seismic operations permits, to determine appropriate levels of snow thickness and density for protecting the underlying tundra.* Without a scientifically-derived relationship between impacts on this terrain as a function of the actual snow depths, tundra types, and current sensitivities to disturbance within that lease area, any prescribed snow depth minimums must be considered arbitrary.

Lease Stipulation 2 – Canning River Delta and Lakes. To “*protect and minimize adverse effects on the water quality, quantity, and diversity of fish and wildlife habitats and populations, subsistence resources, and cultural resources; protect and minimize the disruption of natural flow patterns, and changes to water quality; the disruption of natural*

functions resulting from the loss or change to vegetation and physical characteristics of floodplain and riparian areas; the loss of passage, spawning, rearing or overwintering habitat for fish; the loss of cultural and paleontological resources; and adverse effects on migratory birds” we must first establish baselines for these dynamics at **all** of the deltas and track these natural dynamics over time. While the Canning River delta has a long history, this delta is not the greatest concern here. The new data presented here, based on research ongoing for over decades, indicates that the Jago and Hulahula/Okpilak deltas will experience the greatest changes to water quality, flow patterns, natural functions, the passage of fish, and adverse effects on migratory birds due to the loss of glacial meltwater. Further, the increasingly ice-free Arctic Ocean is causing loss of habitat and changes to coastlines and barrier islands through increased coastal erosion.

Therefore:

- *The title of this Lease Stipulation must be changed to “River Deltas and Lakes”.* All river deltas must have equal status to the Canning River delta and must be studied along with coastal erosion annually to assess increases in the rates of loss of terrain and ecosystem habitats.
- *Planning must be conducted to predict the harm caused by seismic operations in deltas utilized as bird habitat prior to permit applications.* Deltas are particularly susceptible to direct impacts of seismic operations on bird habitats, including the impacts of vehicle ruts on disruption of the multi-year lifecycles of freshwater invertebrate ecology through direct impact or promoting sea water incursions as these deltas begin to shrink due to decreasing glacier sediment supply.

Lease Stipulation 3 – Springs/Aufeis. To *“protect the water quality, quantity, and diversity of fish and wildlife habitats and populations associated with springs and aufeis across the Coastal Plain”* we must monitor the volumes of aufeis annually and compare these to changes in stream discharge due to glacier melt, snow melt, and summer rain.

Therefore:

- *Any lease areas covering major aufeis fields, in particular on the Hulahula River, must conduct aufeis volume measurements annually.* To understand the natural flow and water quality variations caused by decreasing glacial meltwater discharge to ensure Dolly Varden fish passage, we must understand the discharge magnitudes of the springs here and compare this to the declining freshwater discharge from glaciers before permitting any use of aufeis for any industrial uses. Aufeis also shapes early-season location of rivers, directing their erosive force at new targets (eg, Fig 114-115),

so studies of industrial extraction must consider river channelization.

Lease Stipulation 7 – Porcupine Caribou Primary Calving Habitat Area. To “*minimize disturbance and hindrance of caribou or alteration of their movements in the south-southeast portion of the Coastal Plain*” we must be able to distinguish operational impacts from the non-operational impacts on habitat already ongoing due to climate change. Recent studies show that the primary nutritional forage plants for calving caribou here is decreasing rapidly due to the rapid transformation of the hydrology caused by melting ice wedges. Seismic operations have the ability to exacerbate this ongoing, rapid transformation of this landscape’s vegetation by replacing slow-moving, chaotic stream networks with efficient linear ones, thereby impacting the untouched grid interiors as well. Overland seismic operations may also have strong, direct multi-year impacts on those same forage species in tire ruts at about the same level of impact, regardless of hydrologic impacts. With a decreasing food supply on the order of tens of percent as is conceivable as documented here, caribou populations may decline or they may seek other habitats, altering their movements greatly and affecting subsistence users irreparably. Without an understanding of these natural factors affecting caribou migrations, our ability to assess the impacts of operational activities will be severely hampered.

Therefore:

- *Prior to any seismic operations, the current state of caribou habitat and forage sources must be studied and tracked using airborne mapping at 15 cm or better resolution (eg, ROP 28).* One of the many purposes of such maps is to determine the location of primary nutritional sources *at the resolution of individual tussocks* as this is where these impacts are occurring now. That is, broad-scale ecological mapping does not sufficiently capture the heterogeneity of vegetation at the disturbance level.
- *Plans must be created to meet measurable limits set to minimize the operational impacts of seismic activities on those forage sources.* Seismic operators need to justify their operational decisions relative to measurable limits of impact on caribou forage species such as by reducing grid density, working over increased snow thickness, using less impactful vehicles, or switching to a non-driven source method such as explosive.
- *Airborne and field measurements and analyses must be conducted to verify compliance and efficacy to operational impacts protecting caribou.* Operators need to use best practices to ensure that they are meeting the limits in such a way that their results are easily shared and verified.

Required Operating Procedure 3. To “*minimize the impact of contaminants from refueling*

operations on fish, wildlife, and the environment” we must both understand the locations of the current, actual hydrologic network pathways and understand that they are changing **annually**. The ROP states refueling equipment is not allowed within 100 feet of the active floodplain of any waterbody, as defined by the NHD. The NHD is not sufficient to define active floodplain or recharge areas of those waterbodies in this context as it is not updated frequently enough to track the changing hydrological pathways that feed into those waterbodies and their maps are not high-enough resolution to identify them. These requirements are equally if not more applicable to refueling operations by seismic operations in winter as such operations need to occur throughout the entire 1002 Area.

Therefore:

- *Any fuel storage facilities must identify the hydrologic pathways routed through the ice wedge network downstream of them.*
- *A spill response plan is required prior to operations with sufficient detail that operators on the ground will know the exact locations of which ice wedge channels require spill limitation measures, even if snow covered.*

Required Operating Procedure 9. To “*maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, birds, and aquatic invertebrates*” we must first recognize that the current natural state of these hydrologic regimes is a state of dynamic, rapid change and recognize that seismic operations have a much larger chance of disrupting these regimes because they operate over the entire ~1.5 million acres of the 1002 Area. That is, the creation of efficient linear hydrologic channels during this time of natural hydrological reorganization will cause draining and flooding which would not occur naturally on rapid timescales that outpace the natural system’s ability to evolve.

Therefore:

- *Seismic operations must be prohibited from any activities that may lead to full or partial lake drainage or alter the drainage pathways leading into these lakes, maintaining at least a 0.5 mile setback from all lakes over an acre in size as identified in ecological mapping (ROP 28). Exceptions may be granted on a per lake basis following studies that indicate sufficient safeguards can be implemented.*
- *Seismic operators must track and evaluate potential impacts from their activities over the following five years.* Though seismic activities may accelerate the already-rapid ecological changes occurring here, it still may take years for some of their impacts to manifest fully. Using airborne mapping and thermal/hydrological modeling of the

affected permafrost terrain, we can discover early clues to these impacts which gives us a head start in mitigating change there and in updating best practices to prevent further disturbance.

Required Operating Procedure 10. To “*protect grizzly bear, polar bear, and seal denning and birthing locations*” fully we must identify the locations of the polar bear dens better than we do now.

Therefore:

- *The NSO setbacks stipulated for rivers in Lease Stipulation 1 shall apply to seismic operations.* These setbacks include the bulk of the prime denning habitat, so the locations of any crossings of these rivers by overland travel shall be pre-approved based on current best practices. If new methods guarantee greater than 90% reliability in identifying den locations, these set back may be reduced or eliminated.
- *New NSO setbacks of 0.5 miles shall be placed on historic densities of likely polar bear habitats as determined by reliable blowing snow models.* Recent work has shown that potential denning sites for a particular year can be identified reliably using blowing snow models using high resolution terrain models (Refs 23-24). Use of even higher resolution terrain models would presumably increase the skill of these models further.
- *New NSO setbacks of 0.5 miles shall be placed around likely polar bear dens as determined by blowing snow modeling conducted using up-to-date weather data immediately prior to any seismic operations.* Polar bears choose their denning sites based on the snow thickness at the time of their denning. Through use of blowing snow models up until the date it is likely that den sites have already been selected, we can identify probable locations of dens immediately prior to seismic operations and target those locations for exclusion zones.
- *Airborne insar shall be explored as a complement or alternative to airborne FLIR.* Airborne insar has the ability to see through dry snow and reflect off liquid buried beneath it. Adult female polar bears contain enough such liquid in the form of blood and the snow walls of their dens may also have a sufficient film of liquid water, particularly in spring. Satellite, airborne, and modeling studies over the past 25 years indicates that not only can active polar bear dens be identified, but soil moisture, sub-snow hydrology, and depth of freeze/thaw may also be possible to measure here (Refs 25-32).
- *Once field methods demonstrate a den-detection accuracy of over 95% reliability, these NSO setbacks may be reduced in scope or eliminated.* The density of polar bear dens in the 1002 Area is much higher than further west where seismic operations have occurred in the past, so given the spatial density of likely seismic operations it is

inappropriate here to base decisions on the 50% detection-reliability currently demonstrated. Polar bears are intelligent creatures with long memories, if they are inadvertently harassed within their primary denning region at a time when sea ice is also no longer providing sufficiently reliable denning habitat, the result could be devastating to their populations.

Required Operating Procedure 11. To “*protect stream banks and freshwater sources, minimize soils compaction and the breakage, abrasion, compaction, or displacement of vegetation*” from overland travel in winter, we must first 1) understand the fragility of the landscape we are trying to protect, 2) scientifically to determine the relationship between snow depth and mitigating that fragility and 3) have the oversight tools required to ensure compliance to mitigate damage; none of these have been required as yet. This report has already addressed these three points in terms of technology, the next step is to put it into practice. In short, seismic operations have the potential to linearize surface hydrology, accelerating an ongoing rapid transformation of the ecology here, even in the untouched interiors of their grids. This ROP (and others) must demand every possible defense against that possibility.

Therefore:

- *A terrain sensitivity map shall be created using ecological and hydrological land classification maps (ROP 28) within the proposed seismic operational area prior to the permit application. These maps must be compared to prior maps (such as in this report) to identify current state of landscape sensitivity and trend analysis of climate warming impacts prior to operations. If operators do not understand what it is they are trying to protect against, the chances of them providing that protection by accident are low.*
- *The operator shall submit studies verifying the minimum snow depths required to prevent any changes in hydrologic connectivity on the range of slopes proposed for operations for every vehicle class proposed for use. Each vehicle class must be treated individually in terms of the snow depth required for impact prevention. For example, a rubber-tracked snow machine and a metal-toothed D9 tractor pulling a hotel require very different levels of minimum snow thickness for protection of the underlying tundra. If a single minimum value is to be used, it must be the one that provides protection from the D9, not the snow machine.*
- *Proposals for seismic operations must include studies documenting the interannual and spatial likelihood that proposed minimum snow depths will occur in the proposed operational area. Such studies should use computer modeling and airborne*

measurements, as described in this report and in Lease Stipulation 1. Knowing the minimum snow thickness derived through scientific analysis is not enough – operators must also justify their knowledge that such snow thickness exists consistently throughout their proposed operational area. They must then tailor their plans to the likelihood of snow depth minimums in a particular area so they can task their field teams accordingly. That is, until we have data indicating that blanket permitting of grids anywhere in the 1002 Area will likely succeed, we must proceed cautiously with the expectation that the unfavorable snow distributions shown in this report are common everywhere.

- *All proposed seismic mapping using vibroseis must detail exact travel routes, not uniform grids.* As indicated in this report, terrain sensitivity to disturbance is too heterogeneous for uniform grid segments to ensure they won't cause damage. Similarly, snow depth is also too heterogeneous to support uniform grids. Thus, both terrain sensitivity maps and snow depth maps must be used to determine individual travel lines, and the operator must demonstrate a capability at the permit stage that they have the capability to determine these lines operationally in the field as snow conditions change.
- *Seismic operations must reduce impacts on wetlands and perched water bodies by minimizing their footprint.* At the permit application stage, operators need to justify vibroseis coverage density and why methods that do not involve overland travel (such as explosives) are not suitable, in the same way that infrastructure is currently required to minimize its footprint (ROP 21).
- *A plan must be approved for how vehicles and camps surrounded by bare ground after a wind scour event will be extracted without damaging the tundra.* Strong winds that can scour snow down to the bare tundra are possible any day during winter. Without a plan or mandated mitigation strategy, the likelihood of tundra damage is greatly increased.
- *The operator shall submit a study as part of their permits verifying that there shall be no adverse impacts on caribou calving caused by damage to their primary forage sources.* As this report demonstrates, primary forage species for calving caribou can be affected both by hydrologic changes and by direct crushing by vehicles with the former being the most dangerous to caribou populations as it is essentially permanent. This study needs to combine all of the other studies required above to detail a plan that ensures caribou populations will not be impacted, in the same way that infrastructure is already required to minimize disruption of caribou movement (eg, ROP 23, Lease Stipulation 7) and many other species (eg., ROPs 16-33).
- *Operators must validate that their impacts fell below the objectively measurable thresholds in the five years following their operations.* Linear Impact Year Ratios (LIYRs) or any similarly objectively-measurable metric must be approved and compliance documented by the operator through airborne mapping including topography and

RGB/nIR imagery over the next 5 summers following operations, based on mapping in March/April of the operational year, with particular attention paid to caribou forage sources.

- *Seismic data must be made public as part of the permit application for new infrastructure construction.* These leases are specifically to promote oil development – how can the public provide proper oversight if they do not have reasonable assurances of the oil volumes expected at that location, such that they can properly weigh the risk/reward ratio? In the same way that other studies related to infrastructure location permitting are required (eg, ROP 33), seismic data must further justify the location choice against ecological disturbances in that location.
- *Operators shall submit a plan for an exact route of any needed snow/ice roads based on related studies (eg, ROP 28 and LS 1) at the permitting stage.* This report documented that snow and ice roads cause lasting impacts to the terrain and caribou forage species, thus operators need to indicate that they have found a route for ice roads that shall have no impact on surface hydrology and caribou forage or migration dynamics for NEPA review in the permitting process.
- *The use of tractors utilizing high-pressure, metal-bladed tracks shall be limited only to snow/ice roads.* Camp moves and related activities using such vehicles to tow large loads over the same unreinforced snow that low-pressure vibroseis use have been shown to cause predictable, severe damage in all prior studies of seismic operations.
- *Operators shall submit a plan detailing the long-term physical and ecological impacts of the use of the high-pressure vibroseis plate.* The plate lowered beneath the low-pressure vibroseis trucks uses nearly the entire weight of the truck to vibrate that plate violently to produce an acoustic signal that travels for kilometers through the ground, yet the physical and ecological impacts of this extremely high-pressure plate have not been captured in the EIS/SEIS or the resulting ROD.

Required Operating Procedure 28. To “*use ecological mapping as a tool to assess wildlife habitat before developing permanent facilities to conserve important habitat types*” that map must be of sufficient resolution and updated frequently enough to track the most important threat to wildlife habitats – the ongoing reorganization of hydrology and the rapid transformation of ecology it is promoting. As documented in this report, this requires the maps to be able to track disturbances at the ice-wedge and tussock scale, and for them to be updated annually.

Therefore:

- *Ecological land cover maps shall include topography at 50 cm posting or better and orthoimagery in RGB and nIR wavelengths at 15 cm GSD or better.* The current requirement states that the scale and resolution must be “adequate for detailed analysis of development alternatives” – this report demonstrates that all development alternatives must consider ecology on the scale of an ice wedge as that is the scale that the changes are taking place.
- *Prior to any infrastructure or seismic operations, a study of trends shall be conducted in the proposed operational area using these maps that will include terrain sensitivity, hydrologic reorganization, and ecologic changes caused by climate warming or previous operations.* The current requirement states “the map will be prepared in time to plan an adequate number of seasons of ground-based wildlife surveys needed” before facility construction is approved – **exactly the same standards in this ROP and ROPs (16-33) must be applied to seismic operations, as they are potentially much more destructive than nearly any construction project given that seismic operations have the potential to impact every square meter of the 1002 Area.**

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