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To: Environmental Assessment Branch
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Comments on the Focus Report submitted to Nova Scotia Dept. of Environment on Oct 16, 2009 by CHC Inc., Fundy Gypsum

CONTENTS

1. Introduction

I am writing to comment on the conclusions reached by CGC Fundy Gypsum in their Focus Report of October 16, 2009. I retired from Dalhousie University, where I was Professor of Biology, in 2008. Currently I am President of the Halifax Field Naturalists, Co-chair of the Woodens River Watershed Environmental Organization and serve on the board of the Nova Scotia Wild Flora Society. I am familiar with the Avon Peninsula from visits over the years to

friends in the area, to farms in the area in connection with my research in organic agriculture, and to forested areas in connection with natural history interests.

I wrote a letter to The Honourable Mark Parent on March 14, 2007 to express concerns about the impacts that the apparently impending mine (it was not yet registered) would have on the sustainable livelihoods in the area, the already severe stress it was causing to residents, and the poor record of Fundy Gypsum in protecting the environment. During the summer of 2007 when some of the residents were beginning to gain some optimism that Fundy Gypsum might not be proceeding with its proposal. I was invited to accompany several residents on a hike into the forested watershed commons and to discuss sustainable alternatives for the area; a short report, with photographs, is posted at http://versicolor.ca/misc/project. In response to the registration document of February 2008, I submitted a lengthy letter to the Environmental Assessment Branch on March 6, 2008 outlining some fundamental oversights and deficiencies in the proponents' analyses biodiversity and proposals for protecting it.

Given the large number of submissions including many from professionals in the areas of biodiversity and water management (including Department of Environment staff), the horrendous impact that the mine would clearly have on the water resources and biota of the area, and the all-party support of the Environmental Goals and Sustainable Prosperity Act, I was very surprised that the mine was not immediately rejected. Rather, the Minister of Environment and Labour requested responses to a number of specific questions. The proponents, after being given an extension beyond the one year normally required for a response, submitted their Focus Report on October 16, 2009. Superficially, it has the appearance of a polished document, with many maps, models, and lengthy literature reviews, all leading to assurances that the biodiversity and water resources of the area will be protected However, it is very doubtful that the scientific evidence and arguments supporting the proponents assurances could pass the scrutiny of a PhD thesis or of reviewers for a high level scientific journal.

In these comments, I outline some the major issues in regard to biodiversity conservation.

2. The Special Significance of The Avon Peninsula Watershed Commons For Biodiversity

The Focus Report responds to specific requests for more information by the previous Minister of Nova Scotia Environment and Labour in regard to CGC Fundy Gypsum's proposal in February, 2008, to establish an extension of the existing Miller's Creek site.

This "extension" would be an entirely new mine located in the centre of a mostly forested, upland "watershed commons" on gypsum-karst landscape which, to

date, has protected the water supply for rich farmland, residents and small industries on the Avon Peninsula. It also supports an unusually diverse flora with a high concentration of threatened species, small wetlands with rich amphibian and reptile populations and at least one bat hibernaculum. As acknowledged and further documented in the Focus Report, the flora includes a number of species-at-risk including ram's head lady's-slipper (red listed and legally protected under the N.S. Endangered Species Act); round-lobed hepatica and eastern leatherwood (red-listed under DNR's General Status of Species); black ash, yellow lady's-slipper, thimbleweed and Canada buffalo-berry (yellow-listed); and at least three rare lichens (*Solorina saccata, Collema cristatum* var. *cristatum* and *Leptogium lichenoides*).

That is a very uncommon assemblage of species and the area has long been recognized by naturalists as a hotspot of plant biodiversity in Nova Scotia as well as being especially valued by local residents for the large populations of yellow lady's slipper orchids. Earlier this year, several botanists and naturalist organizations endorsed the initiative of residents of the Avon Peninsula to recognize the area as the "The Lady Slipper Capital of the Maritimes".

Major factors contributing to the peculiar biodiversity of the area include:

1. The calcareous nature of the soils.
2. The karst topography which creates peculiar regimes of moisture stress and disturbance that prevent complete closure of the forest and reduce competition by plants otherwise not adapted to such regimes.
3. It is a relatively large gypsum-karst area that has not been clearcut, or cleared and cultivated or mined, except on a small scale.

The last mentioned factor is very important because size can buffer, to a certain extent, the increased potential for extirpation (local extinction) of native species that results from habitat fragmentation associated with human settlement, forestry and farming: larger residual areas support more species over the long term than smaller ones or, stated otherwise, smaller, residual, suitable habitats lose species more quickly than larger ones. Thus, while there are other patches of similar karst habitat in Nova Scotia, most are more restricted in area or have been subject to significant disturbances in the recent past and support fewer, if any, of the species cited above. None, to my knowledge, support an equivalent assemblage to that found in the mine footprint + conservation area.

In addition to the botanical diversity, conservation is required to protect

- wetlands supporting large populations of amphibians and reptiles including small wetlands/vernal ponds that abound in the area and are known elsewhere to support particular species and communities[1]
- at least one bat hibernaculum[2]
- upwards of 70 species of birds breeding in the area[3]
- likely, as yet undocumented rare beetles and other invertebrates associated with the karst[4]

Even within the larger maritime area, habitats of this sort are now extremely few as noted by Dr. Andrew MacDougall and others in 2008[5] and karst habitats are high priorities for protection globally because of concerns about both water resources and biodiversity – the two key concerns raised about the proposed mine. These concerns are well recognized in professional journals of earth scientists[6] and at least to some gypsum enterprises in N.S., headwaters are considered out-of bounds.[7]

Habitats and species assemblages found in the Avon Peninsula watershed commons are currently hardly represented at all in the province's Wilderness Protected Areas, Nature Reserves or in conservations easements and the like; certainly there are none equivalent to the area that would be destroyed by the mine. As I will elaborate in my comments, the proponents' Conservation Area simply cannot provide adequate conservation of the species-at-risk in the larger area. Their proposals for progressive reclamation, while they would likely be successful in establishing vegetative cover on the mine spoils, are highly dubious in regard to their potential for conserving species-at-risk. In the context of Nova Scotia's commitment to conservation of species and watersheds, the entire "watershed commons" should in fact be given the highest level protection possible, e.g. equivalent to that of a protected Wilderness Areas or Nature Reserve, certainly not largely obliterated by a strip mine.

3. Terms of Reference and Comments on The Proponents' Response

3.1 From the Terms Of Reference

Following are extracts from the Terms of Reference for The Focus Report that are particularly pertinent to biodiversity conservation and the comments herein.

> A conservation area is proposed by the Proponent that includes setting aside approximately 40 ha of mineable land which is host to an important assemblage of provincially and locally important plant species. No evidence is provided, however, to show how the ecological integrity of the conservation area will be maintained… In addition, species-at-risk would be lost with the current layout of extraction areas. A plan that illustrates a clear mechanism for protection must be provided.
>
> Provide the results of additional study to determine the required extent of the conservation area in order to protect species-at-risk and their habitat. The size of the conservation area shall be formally agreed upon with NSE and DNR, Wildlife Division.
>
> In addition, investigate the potential for private land conservation by consulting with local landowners to determine if the conservation area can be expanded to include neighboring properties.
>
> Reclamation planning must address knowledge deficiencies and uncertainties surrounding proposed practices to buffer impacts on species-at-risk and their habitats. Specifically, address appropriate distance/widths (amount of undisturbed habitat) and necessary reparation(s) to maintain effective, functional habitat and the time phase in

the project's operational development. Reclamation planning should provide details and an experimental framework to evaluate effectiveness of reclamation practices to repatriate native vegetation.

Given the proximity of more than 40 endangered Ram's-Head Lady Slipper plants to wetland #12, and the high potential for adverse effects resulting from changes to topography, vegetation and hydrology, DNR recommends that wetland #12 be fully captured within the conservation area and additional modeling using on-site data be undertaken to assess mitigation options to ensure plant survival.

3.2 The logic and claims and of the proponents case

Overall, the response to these requests in The Focus Report has involved a slight readjustment of boundaries to include, as requested, wetland #12. While the proponents document significant populations of other species at risk (i.e., legally endangered, red or yellow listed species) in the mine footprint area, they argue that these species can be adequately conserved within the Conservation Area + the reclamation area. This assertion rests on 4 major explicit or implicit claims or strategies:

1. The claim that "the Conservation Area will be undisturbed by the proposed Project".

2. The claim that if there are effects of the mine on environmental conditions in the Conservation Area, they can be mitigated.

3. The strategy to move (transplant) individual plants and whole populations from the mine footprint area into the Conservation Area

4. The claim/strategy that progressive reclamation will allow progressive recolonization of mine spill areas as these go out of service.

Each of these claims/strategies is seriously flawed.

3.2.1. Comments on claim that the Conservation Area will be undisturbed by the proposed Project

Claim No. 1 relies heavily on predictions from the consultants' surface water and groundwater models. The proponents repeatedly highlight their claim that there will be no significant effects of the mine on the habitat in Conservation Area. An example:

3.4 Conclusion
The CGC Conservation Area is a large, continuous expanse of calcareous habitat, which supports considerable populations of vascular plant and cyanolichen species of concern. None of the environmental conditions discussed in the previous subsections will be negatively affected by the development of a gypsum mine to the north of the proposed Conservation Area

- o Landscape position will not be affected;
- o Proximity to forest edges/exposure will not be affected;
- o Local climate will not be affected;
- o Soil moisture levels will not be affected;
- o Humidity regime will not be affected;
- o Ground and surface water quality will not be affected;
- o Acid rain and air quality will not be affected;
- o Temperatures will not be affected;
- o Soils and substrates physical characteristics will not be affected;
- o Soil and substrate pH values will not be affected;
- o Natural patterns in forest succession will not be affected;
- o Air quality will not be affected; and
- o Species interactions will not be affected.

The Conservation Area will be undisturbed by the proposed Project, and will be protected by CGC to ensure it remains undisturbed. It will never be logged, nor will further anthropogenic disturbances be permitted, unless required to protect species at risk.

At the same time there are significant hedges or direct contradictions to these claims within the documents, e.g., under 4.1.7, they say that

> …there are no predicted impacts to the ecology of the Conservation Area due to the lowering of the groundwater level during the extraction period of the mine life… [but] **The model predicts a rise in the groundwater level from the current (pre-mining) level after the reclamation phase of pit backfilling is complete, which may have implications on the Conservation Area.** A full assessment of this has not been completed at this stage, as the predictions would have a high level of uncertainty. The assessment of potential impacts to the Conservation Area after pit backfilling should be completed using the first 20 years of mine operation data and the surface water model and groundwater model. [bolding inserted]

How does the acknowledged uncertainty about changes during backfilling support the overall contention that “the Conservation Area will be undisturbed by the proposed Project”?

The proponents apparently accept without question the results of the modeling where they appear favourable to their case, thus they offer no qualifications to the predictions of no impacts associated with the initial extraction period. However, the hydrology of karst systems is the most complex amongst surface landforms in the world and this degree of confidence in the modeling is not justified. Leading authorities on hydrology of karst systems emphasize that modeling of karst systems is hypothesis-generating rather than predictive:

> At the outset, it is crucial to define the objectives of a groundwater assessment monitoring program before committing to the construction of a digital model. Two paramount questions emerge in karst aquifer problems: (1) What ere the rates and directions of contaminant transport through the aquifer? (2) What are the hydraulic response characteristics of the aquifer (Dreiss. 1989a,b)? Both demand predictions of system responses cast in terms of fluid travel times and directions. Is a digital model capable of yielding the desired results? Is the typical input data set adequate to construct the model, particularly if transmissitivities were developed using point sampling techniques? The answers to both are no, even as a first-order qualitative approximation.

> 'The data requirements to adequately model a karst aquifer, particularly unconfined systems. are so demanding that the questions posed necessarily will be answered by an adequate field data collection program before the model can be built. There are two reasons for this startling conclusion. First, to correctly model the aquifer; the transmissivity structure of the aquifer must be viewed holistically as a system which will require unusual care in delineating boundary conditions in the field. Second. The hierarchy, organization and hydraulic responses of the all important dissolved permeability pathways will have to be deduced. By the time data documenting these system attributes are collected in the field, system response already will be thoroughly documented and mudding will prove to be a redundant exercise. These conclusions were reached by Palmer (1992) and Teutsch and Sauter (1992).[8]

While modeling has improved since 1995 when that statement was made, the same limitations still apply, thus A.N. Palmer (one of the authorities cited above) in a 2006 paper on "Digital modeling in karst aquifers – successes , failures and promises" comments:

> Any groundwater system can be modeled accurately if there is sufficient available field information. In practice however, the model must be generalized by replacing the innumerable small scale complexities with large blocks that behave as hydraulic equivalents. Otherwise the details become overwhelming and render the model unworkable. But karst heterogeneity cannot be readily generalized, because even small karst features can have a hydraulic effect disproportionate to their size… The promise of karst modeling is not in their prediction, but in encouraging modelers to expand their understanding of karst aquifer behavior. NOTES

So even where the proponents' models predict no or only weak effects, these predictions are, at best. hypotheses. It's not hard to understand what that is so. One has only to walk through the karst area and observe the vegetation and soils and pattern of mud deposits, gullies, sinkholes (some with water some without), variously sized and configurations of caves/holes to appreciate the complexity of the system, and the peculiar conditions in which the species at risk survive and in some cases, thrive.

3.2.2. Comments on the claims that if there are effects of the mine on environmental conditions in the Conservation Area, they can be mitigated.

Three questions need to be answered to justify the mitigation argument in regard to species at risk:

- What variables will be monitored to determine if environmental conditions are changing?

- What are the thresholds for triggering a mitigation response?

- What is the response?

The approach taken is basically an agronomic one that has been applied successfully to domesticated species. However, these are (a) wild species and

(b) rare wild species, whose continued existence is dependent on a complex set of variables that affect the species directly (e.g., such as moisture falling below the permanent wilding point for the species + associated symbionts) and indirectly (particularly though effects on other species/competition, herbivores, pollinators, seed distributors etc.)

Were the approach that the proponents plan to take successful for such species at large there could be far less emphasis on the need to protect original habitats for conservation of biodiversity, and more emphasis by conservationists on mitigation/reclamation activities. It is important to make the distinction between mitigation/ reclamation in order to establish or maintain a functioning ecosystem of some sort that will provide cover, minimize erosion, provide some habitat for birds etc. and mitigation/ reclamation to conserve particular rare species. The former is not an issue. Indeed the reclamation activities they propose will help to accelerate vegetation of the mine spoils. However mitigation/reclamation to conserve native biodiversity (at genetic, population, community and ecosystem levels) and especially to conserve rare species as self-sustaining populations is a much larger challenge, rarely achieved anywhere.

The proponents say that they will monitor soil moisture and possibly humidity to protect certain species-at-risk or certain subpopulations of those species:

> Mitigative measures to ensure the ram's-head lady's-slipper population associated with Wetland 12 will be implemented, including silt fencing and soil moisture meters. Monitoring of the ram's-head lady's-slipper population will be conducted as part of the wetlands monitoring program and the conservation area monitoring. Mitigation measures to maintain hydrological inputs to wetlands will be implemented. The outline of a monitoring plan has been developed to assess the adequacy of mitigative options. The monitoring plan will be long-term, adaptable and statistically rigorous, and will be based on a measure of ecological integrity and wetland condition.
>
> As discussed in the Ecological Integrity section of this document, the proposed Project is predicted to have very little, if any, impact on species and habitats within the CGC Conservation Area. The one parameter which might potentially be affected is soil moisture levels in the northern portion of the CGC Conservation Area, as the slope providing runoff to Wetland 12 is mined away. As ram's-head lady's-slipper occur near the base of this slope, soil moisture levels in this area should be monitored to determine if there is a significant effect. These moisture levels would then be compared with measurements obtained from another ram's-head lady's-slipper patch within a drainage basin within the Conservation Area which has not been affected. Thus, for ram's-head lady's-slipper, soil moisture levels may be monitored in the long term using permanently installed soil moisture meters. CGC proposes to install piezometers and water level loggers near the ram's-head lady's-slippers in the Conservation Area to collect data on water table levels near this species before and after initiation of the Project.
>
> Potential changes in humidity levels near species of concern in the proposed Conservation Area could be monitored by installing humidity loggers near these specimens to obtain longterm humidity data both before and after initiation of Project activities.

The proponents focus on two variables that are easily measured (soil moisture, humidity.) At what point in change of those variables do they begin to take mitigative measures? On what basis? What is the reference? They say that they will monitor soil moisture at another, non-disturbed area. One? So will they maintain moisture levels equivalent to those at the one control site? There is not a simple unimodal relationship between soil moisture and survival of a species in the wild; complex patterns of changing soil moisture affect competitors, grazers… and these patterns differ at different sites. That's just the way it is (and why ecologists have been leaders in elucidating the dynamics of complex systems). How would they maintain the moisture at equivalent levels? With handheld watering cans, adjusted daily, weekly, monthly?

The proponents mention silt-fencing, I have seen the site to which they refer. There is a layer of silt which can be traced back to a hole near the base of a long karst outcrop, and was likely deposited during emergence of silt laden subterranean water during a storm event or during spring melt, perhaps repeatedly each year or repeatedly over shorter intervals. Whatever the exact process, it is evident that the local conditions (including the pattern of siltation spatially and temporally) favor the ram's head over their competitors. The water evidently emanates from wetlands &/or underground sources within the mine footprint area while part or all of the outcrop is within the mine footprint. There can be no doubt that the site-specific conditions that allow ram's head to prosper there will be altered by the mine; we can only have considerable doubt about the prospects of mitigating those effects, and that is only one population of one species at one site. The proponents are proposing to monitor only a very limited set of sites – clearly because it is unrealistic (costly) to attempt much more, and even if they were to do so, the same questions arise.

Similarly, what are the implications of rising water table for protecting species-at-risk within the conservation area? The proponents acknowledge this is likely to occur (although they fail to qualify their claims of no impacts in the highlighted summaries accordingly). The species at risk are not horticultural plants that can be uprooted, transplanted, held in pots and replanted at will, rather their maintenance is dependent on ecological integrity over time and space. How will the effects of the rising water table be mitigated for the species-at-risk? With extensive drainage installations?

The proponents have not adequately addressed the issue of mitigation to protect species at risk in the Conservation Area because they cannot do so. In fact that it is doubtful that a team of experts could adequately address the issue; they would almost certainly conclude that maintaining and protecting the entire watershed commons is the only option for conserving the species-at-risk.

<u>3.2.3. Comments on seed collection and transplanting as a strategy to salvage plants in the mine footprint area.</u>

Transplanting is discussed specifically for black ash and yellow lady's slipper; otherwise there is reference to transplantation of species at risk or just "vegetation". Seed collection is mentioned as a possibility for Black Ash; possibilities for other species are not discussed. The proponents acknowledge at points limitations to transplanting for orchids, but then at others cite transplantation of yellow lady's slipper as an important part of their strategy (e.g., in Table 5 of Appendix E).

> For species of concern located in the vicinity of approaching mining activity, known specimens will be protected by a buffer zone of undisturbed habitat until they must be removed…. Delaying the removal of these specimens until absolutely necessary will maximize their lifespan and reproductive potential. For species such as black ash, for which transplantation may be possible, this may result in production of additional seedlings which may then be transplanted to suitable habitat in the Conservation Area. Minimizing disturbance of specimens of species-at-risk to be removed until absolutely necessary increase the opportunities for these species to recruit naturally to areas outside of the planned extraction footprint.
>
> Transplantation is generally not planned for most species, particularly the lady's slippers, because they are known to have poor long-term survival rates post-transplantation. NSDNR generally does not recommend this option as mitigation for the loss of flora species of concern. Some experimental transplantation of species-at-risk specimens from areas to be disturbed to protected areas may possibly be conducted early in the life of the mine. Depending on the long-term success of these transplants (> three years for yellow lady's-slipper, two years for other species), additional transplantation may be attempted.
>
> CGC will also investigate the feasibility of transplanting patches of vegetation, via specially modified front-end loader, which can remove a 3m x 3m section of topsoil and root mat for immediate placement elsewhere, effectively transplanting it… Grafts would be planted at the same depth as they were originally situated, and would be watered well upon initial placement. Large patches of yellow lady's slipper could be transplanted in this way, with much less disturbance to plant roots than if they were transplanted individually. This would also increase the chances of successfully transplanting the root mycorrhizal fungi this species relies on, as a larger volume of soil would be transplanted along with the plants. Placing a mosaic of these grafts on an area to be revegetated would greatly increase the speed at which local species would colonize these areas.

While, in principle, transplanting patches of vegetation via specially modified front-end loaders seems plausible and works for some species, it is far from a proven technology for most rare species/species-at-risk. (The proponents do not provide a literature review of the area.) Areas of The Harriet Irving Botanical gardens at Acadia were constructed in this way, but they are hardly self-sustaining, many of the early established native species dying off and intensive weeding being required to keep invasives down. Dr. Dr. Andrew McDougall of the University of Guelph has commented on prospects for transplantation as follows[5]

> These ground flora species are also notoriously difficult to transplant and to propagate, for reasons that we do not fully understand. Common explanations include the presence of deep rooting systems that are inevitably destroyed when established plants are dug up. Propagation failure may derive from specialized nutrient and moisture requirements during germination, and possibly mutualistic associations with soil mycorrhizal fungi. Reclamation of these communities, therefore, may not be possible again highlighting the importance of protecting what is left.

Another difficulty with this approach – even if transplantation were initially successful for species risk - is that it based on the assumption that the Conservation Area has a higher carrying capacity for these species than is currently the case, i.e. that their numbers are propagule-limited and that we can salvage individuals from the mine footprint by transplanting them into the Conservation Area. Such increased carrying capacity is unlikely, at least over the long term. Perhaps, with special care, survival could be increased, however, that would make it essentially a botanic garden which, while valuable for research and education, is not equivalent to native, self-sustaining systems and would likely be prohibitively expensive.

3.2.4. Progressive reclamation as a strategy to conserve biodiversity

The proponents present fairly detailed plans for progressive reclamation of the areas directly impacted by the mine. These efforts are focused on getting a vegetative cover established by direct seeding, transplanting patches of vegetation before they are otherwise destroyed, and allowing/facilitating natural revegetation. They cite several examples where species-at-risk have colonized old mine spill areas.

I agree that this is an appropriate strategy for establishing vegetative cover as soon as possible, however, as a strategy to conserve species at risk and habitat presently in the mine footprint area, what could accomplished is very minimal. Here are some of the issues:

- Agreed, some species at risk have colonized some of the old mine spill areas, but most of the examples are from older, much smaller mines, thus there were many more propagule sources relative to the spoil areas.

- To extrapolate from historical recolonizaton of mines to the proposed reclamation schedule, quantitative aspects of the historical recolonization need to be considered: what proportion spill areas has been recolonized, over what time-frames? The time frame for reclamation of the Avon mine is much shorter than that which was likely involved in colonization of old mine spills, in the meantime source habitat is continually being destroyed.

- The proponents intend to transplant large blocks of material with species at risk from the mine footprint area before destroying those area. That might overcome spatial and temporal limitations cited above, but as discussed earlier, this is far from a proven technology for species-at-risk.

- The proponents stress that the calcareous nature of the soils will not be lost in the reclamation areas, however, they overlook the significance of the karst features that will be lost or be a very long time (perhaps centuries to millennia) in re-developing. The karst features and their effect on microclimate and edaphic conditions are as important for many of

these species at risk as the calcareous nature of the soil, largely though their effects on species competition.

- The proponents will be introducing exotic agricultural species as well as fertilizer. Many of these species, e.g., white clover, various grass species, are considered invasive outside their use in agriculture. This will set up conditions NOT favourable to the species-at-risk. Indeed, ecologically, practices designed to re-vegetate as quickly as possible are basically incompatible with practices that might create environmental conditions similar to undisturbed karst areas and that favour most species-at-risk.

3.3 Loss in natural habitat area

The proponents were asked to "Provide the results of additional study to determine the required extent of the conservation area in order to protect species-at-risk and their habitat".

In this regard, they have not discussed the factors that are considered the most important reasons for loss of biodiversity generally: loss and fragmentation of habitat area. I had expected that the proponents would come forth with a substantive redesign of the original plan with a smaller mine area and a much larger conservation area or a network of individually small conservations areas. In the Focus report there is no such redesign or consideration of redesign options, but rather the proponents offer a rationalization of the original plan with enhanced "protection" (security) for the Conservation Area and (dubious) strategies for establishing species-at-risk on reclaimed land. There is no indication in their literature reviews that the proponents have looked seriously at the conservation literature dealing with habitat fragmentation, its consequences and strategies for maximizing conservation in fragmented landscapes. (Alternatively, this literature was known to the consultants concerned but was deliberately omitted because it would require a very different mine configuration to accommodate, or simply strengthen the case for no mine at all.)

How significant is the loss of area factor? A well known rule of thumb in conservation biology predicts that a tenfold reduction in habitat results in approximately 50% reduction in the number of species an area can support. The number could be greater or smaller in practice, but it gives an indication of the order of magnitude of losses from loss in area. In the case of the proposed mine, the area of natural habitat will be reduced from 393 ha to 46, an 8.5-fold reduction. Regardless of the exact factor by which species carrying capacity would be reduced, it is clear that the Conservation Area cannot support species diversity equivalent to that supported by the larger area.

The proponents apparent lack of understanding of conservation biology science is illustrated by the ludicrous statement that "The potential benefits to the Nova Scotia ram's head lady's-slipper population due to the proposed Project far outweigh the potential risks". This is apparently based on the premises that (a) all

extant ram's head lie within the Conservation Area, (b) currently unoccupied, otherwise suitable, habitat is irrelevant and (c) the Conservation Area will be protected from clear-cutting, development etc, and thus will be more insulated from human activity than currently. In regard to (a) it is interesting that the proponents are aware of "non-seasonal dormancy" in ram's head (they may mean that it doesn't flower in some years) and cite that as a reason that they may not have been able to relocate a ram's head population on the existing Miller's Creek site (which would bolster their argument that the species will readily re-establish on old mine spoils), but insist that their surveys have confirmed that there are no ram's head in the mine footprint area. There could be more populations, but regardless of whether there are or are not, the mine footprint area will certainly contain potential habitat and over the long term, that is critical to the conservation of the species in the Avon area because of the dynamics of metapopulations.

A metapopulation consists of a network of subpopulations. The subpopulations are not static, but dynamic and are maintained by recurrent immigration and gene flow from other populations. Local populations go extinct in the short term for a variety of reasons (e.g., a local catastrophic event such as an intense fire) but over the longer term are maintained by recolonization from other populations; likewise they are sources of immigrants for other unoccupied but suitable habitat, which in turn acts as reservoirs for the local populations. Thus, over the long term unoccupied habitat are as important for maintenance of the species as the occupied habitats. This is especially true during a period of climatic change, when in the suitability of existing habitats may actually decline while other suitable habitats may open up. By confining the suitable habitats for ram's head to a single, small Conservation Area the risk of local extinction is greatly increased – hardly reduced! The argument that the Conservation Area will have greater security from human impacts is nebulous, as equivalent protection (e.g. as a Nature Reserve) could and, in this case, should be applied to the larger area.

The species-area considerations must also be applied to the reclamation arguments. Even if the reclamation efforts could be as successful for species-at-risk as the proponents suggest (which for reasons discussed above is highly unlikely), the mine extraction areas, amounting to 39% of the area, would become lakes, not potential habitat for recolonization by species at risk.

5. Conclusion

I have focused on major concerns related to the Minister's request to address outstanding questions related to species-at-risk.

There are many other points of detail and other major aspects of the Focus Report that deserve attention and I expect will be commented on by others making submissions in response to the Focus Report. It would, however, take a

good deal longer than the time afforded and a team of experts to thoroughly critique this document. Regardless, I think such a detailed review is not required to reject the mine; major reasons that this project is completely incompatible with species conservation and sustainable livelihoods on the Peninsula are glaringly obvious from a scientific perspective.

As well as being a critical issue for residents, farming and other sustainable enterprises on the Avon Peninsula, the decision regarding the mine has very significant implications for protection of biodiversity and headwaters over the province at large. If the case argued by the proponents that (a) there will be no serious environmental consequences from a large open pit mine in the centre of a watershed, (b) whatever issues arise can be mitigated, and (c) we can maintain protection of species even with an 8-fold reduction in habitat area, is accepted, then few headwaters or centres of biodiversity will be safe in Nova Scotia.

I urge the Minister of Environment and the Government to reject this project and put an end to the consternation it is causing us now and the loss of a wonderful heritage it would inflict on our descendents. Failing that, I urge that the proponents' evidence and arguments undergo a full, critical review by independent experts and a that full community consultation take place, with other options for the area on the table, before a final decision is made.

Respectfully,

David G. Patriquin

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5. Notes

1. In addition to the wetlands cited in the Focus Report and earlier Registration Document, the area is pockmarked by smaller wetlands, some with permanent standing water, some vernal in nature. These support large populations of amphibians overall and vernal ponds are recognized as important for conservation of a number of species specifically adapted to those environments. See Colburn, E.A. 2004. *Vernal Pools*. Saline, Michigan: McNaughton & Gunn

2. A bat hibernaculum was discovered in the mine footprint area during the last year (Matthew Smith, personal communication).

3. Bob McDonald, personal communication.

4. For example, *Quedius spelaeus spelaeus* Horn has been found in a

number of porcupine dung caves in Nova Scotia (M. Mosely et al., in *Zootaxa* 1226: 61–68, 2006); at least one such cave exists in the mine footprint area, but has not, to my knowledge, been investigated.

5. For example, Dr. Andrew McDougall of the Department of Integrative Biology at the University of Guelph commented as follows in a submission commenting on the registration document, March 5, 2008:

> The area in question has biological significance locally, to Nova Scotia, and to eastern Canada as a whole. Plant communities on calcium-rich soils are hotspots for floral diversity throughout eastern Canada, typically containing many species that are rare or absent elsewhere. In the Maritimes, these habitats are not widespread, with localized occurrences including parts of Cape Breton and the northern mainland of Nova Scotia, and Carleton and Albert Counties in New Brunswick. In all cases, these areas have been dramatically affected by human land use, including the Avon Peninsula site. Large percentages of forests associated with calcium-rich soils in the Maritimes have been lost to agriculture or mining. Reforestation has occurred where these activities have ceased, but the pre-disturbance floral community almost never re-establishes. Those forest fragments that escape disturbance are highly isolated, and have typically been repeatedly selective-logged for a century or more.
>
> As is discussed in the consultant's report (e.g., p 124), this level of cumulative habitat loss for calcium-soil plant communities has already been significant on the Avon Peninsula. This is typical for regions with this soil type, and argues in support of the unique status of remnant sites such as this one. Often these stands continue to support rare ground flora, although with small population sizes that may be especially vulnerable to the disruption of microclimate and microhydrology. These ground flora species are also notoriously difficult to transplant and to propagate, for reasons that we do not fully understand. Common explanations include the presence of deep rooting systems that are inevitably destroyed when established plants are dug up. Propagation failure may derive from specialized nutrient and moisture requirements during germination, and possibly mutualistic associations with soil mycorrhizal fungi. Reclamation of these communities, therefore, may not be possible again highlighting the importance of protecting what is left.

6. See, for example The Geological Society of America Special Paper 404: *Perspectives on karst geomorphology. hydrology, and geochemistry*. Edited By R.S. Harmon & C.M. Wicks (2006)

7. Excerpt from NS Standing Committee on Economic Development, Sept 2000:

> Rep from Georgia Pacific: Well, speaking for our company, I have done a lot of exploration in Atlantic Canada. I have looked at probably most of the deposits in Nova Scotia and some in New Brunswick and Newfoundland. I know our competitors, National and USG have done the same thing. I would say they are pretty well documented.
> MR. EPSTEIN: Yes, so at this point you are not really expecting any more gypsum mines to be proposed, is that right?
> Rep from GP: I would be surprised if you would see any more gypsum quarries developed in Nova Scotia forever.
> MR. EPSTEIN: That is my understanding, too.
> ...

Rep from GP: It is difficult to find a deposit of any size that is outside of a watershed or outside of a municipal population. To find a deposit of gypsum with 30 million or 40 million tons in it that you can develop in Nova Scotia is difficult, because as you know there are only limited areas where gypsum occurs.

8. Huntoon, P.W. 1995. Applying groundwater models to karstic aquifers. P 355 ff in *Groundwater models for resources analysis and management* (Aly I. El-Kadi – Ed) CRC Press.

9. Palmer, A.N. 2006. Digital modeling of karst aquifers –successes, failures and promises. Paper 20 In *Perspectives on Karst geomorphology, hydrology, and geochemistry*, Edited By R.S. Harmon & C.M. Wicks. Geological Society of America.