The Long-eared Owl is a secretive and generally quiet species that confines its hunting until after dark and roosts in dense conifers during the day. Long-eared Owls tend to nest in "thick evergreen woods", generally in nests constructed by another bird species (American Crow, Common Raven, hawk) or in thick growths of "witches broom" that afflict some spruces and Balsam Fir (Tufts, 1986). In Mr. Forsythe's opinion (he has worked with owls for almost 30 years) and as suggested by Tufts (1986), Long-eared Owls appear to prefer nest sites adjacent a "cleared space" (old orchards and fields, pastures, meadows) that can support high densities of their primary food, mice.

While the proposed pit site and adjacent areas do contain "edge" habitat with fields to the north and woodland to the south, the fields on this property are used for intensive agriculture (cash crops such as beans, carrots, potatoes) and these areas do not support high populations of mice. A search of the "edge" habitat on, and in the vicinity of, the proposed pit site revealed no obvious existing nest structures that might prove attractive to Long-eared Owls. The only nest structure observed that might support nesting Long-eared Owls is the one found during our systematic survey for Northern Goshawk nests. This site (co-ordinates N45° 02.458', W064°36.494') is approximately 150 m from the eastern boundary of the proposed pit site.

In summary, I believe there is little chance that Long-eared Owls nest within the proposed pit site and only a somewhat greater chance that they nest in areas immediately adjacent to the pit site. Many more attractive potential nesting sites exist within the patchwork of forest and agricultural lands in this part of the Annapolis Valley.

It appears that Long-eared Owls are tolerant of at least moderate levels of human activity. Bernard Forsythe has observed several instances where Long-eared Owls nested very close to dwellings, completely unbeknownst to the residents, and successfully reared broods.

Changes in the agricultural practices on the farmland of this property could make it more attractive to three bird species at risk: the Long-eared Owl, Bobolink and Vesper Sparrow. Conversion to hay crops, pastureland or old field could result in high mouse populations, making the area more attractive to Long-eared Owls. Large fields of hay or pastureland could attract Bobolinks. Scrubby, sparsely vegetated old fields could attract Vesper Sparrows.

Mammals

It is possible that all six bat species considered to be at risk in Nova Scotia could frequent the proposed pit site or adjacent woodland, streams, pond and agricultural areas during their nocturnal foraging.

There is, however, little information available concerning the distribution, numbers and habitat use of bats in Nova Scotia. Recent work by Hugh Broders (*in prep.*) confirms that, in southwestern Nova Scotia, the two *Myotis* species (Little Brown Bat and Northern Long-eared Bat) are the most common species and the Eastern Pipistrelle may be locally common. Broders suggests that the small numbers of observations recorded for the other three species (Hoary, Red and Silver-haired Bats) in Nova Scotia might represent extralimital occurrences.

Of the four bat species that are solitary during June and July, when the young are reared, three species (Silver-haired, Red and Hoary Bats) roost singly in trees during daylight hours. Noise from the aggregate extraction operations could cause these bats to change their day roost sites. Alternate roost sites would probably be found easily and the potential for impact on these species is probably minimal. The fourth species, the Eastern Pipistrelle, roosts in caves. There are no known caves on or adjacent to this property.

The females of the two *Myotis* species often form "maternity" colonies where the young are reared. Disturbance of these colonies could impact the survival of the young. Although maternity colonies of both species can be in hollow trees, female Little Brown Bats show a decided preference for buildings and Northern Long-eared Bats for caves (Peterson, 1974). In southern New Brunswick, Broders (*in prep.*) found that female Northern Long-eared Bats that had maternity colonies in hollow trees showed a very marked preference for shade tolerant hardwood trees in mature hardwood dominated stands. Conversely, the males of both the Northern Long-eared Bat and the Little Brown Bat showed a marked preference for roosting sites in softwood trees in softwood stands or softwood dominated mixed stands. Since the only hardwood dominated stand in the vicinity of the pit is some distance to the west of the site, and is only of moderate age, it would appear that the pit site and adjacent woodlands would provide much better habitat for roosting males than for maternity colonies of females. Alternate roost sites for singly roosting male Northern Long-eared and Little Brown Bats would probably be easily found.

While it was previously thought that the Southern Flying Squirrel was restricted to southwestern Nova Scotia, in the mid-1980's this species was found in Kings County. Recent studies have shown this species to be more wide spread with scattered records from various locations in the Annapolis Valley and elsewhere (Amanda Lavers, unpublished). Southern Flying Squirrels have been recorded as close to the proposed pit site as Kentville (~ 11 km).

This secretive nocturnal species is generally associated with older mixed forests where snags and holes in old living trees provide it with shelter, and fungi from the forest floor and mast crops from Red Oak and American Beech, before most succumbed to "beech bark disease", provide a food supply. Current thinking is that the two essential elements of habitat required to support a Southern Flying Squirrel population in Nova Scotia are the presence of hollow trees and acorn-producing Red Oaks (Tom Herman, *pers. comm.*). Red Oak exists on the proposed pit site mainly as scattered saplings. Only a single Red Oak tree (dbh ~ 15 cm) was noted within the proposed pit site and only a single large old Red Oak was recorded in the area immediately adjacent to the proposed site. Red Oak is not a significant element of the mature forest to the east of the proposed pit site. I therefore believe it is most unlikely that Southern Flying Squirrels inhabit either the proposed pit site or areas immediately adjacent to it.

Summary

1. Because of the lack of appropriate breeding habitat, the one amphibian species at risk in Nova Scotia, the Four-toed Salamander, is not believed to occur on this property.
2. None of the three reptile species at risk in Nova Scotia are believed to occur on this property.
3. Although good potential nesting habitat for the Northern Goshawk exists adjacent to the proposed pit site, systematic searches of this habitat within 0.5 km of the proposed site revealed no Northern Goshawk nest structures. Although marginal nesting habitat for long-eared Owls exists on and adjacent to the proposed pit site, it is unlikely that this species would nest here.
4. None of the mammal species at risk in Nova Scotia are believed to use either the proposed pit site or habitats immediately adjacent to the site.
5. Given their apparent lack of use of the proposed pit site and adjacent habitats, none of the species at risk in Nova Scotia should be impacted detrimentally by this proposed pit operation.

RECOMMENDATIONS FOR IMPACT MITIGATION

It is unlikely that Lawson Bennett Trucking Ltd.'s proposed pit expansion would currently pose a threat to individuals of any amphibian, reptile, breeding bird or mammal species considered at risk in Nova Scotia. This site is, however, located adjacent to a stand of mature forest that could provide good potential nesting habitat for the Northern Goshawk although no Northern Goshawk nest structures were found within 0.5 km of the proposed pit site. Areas on and adjacent to the site could also provide somewhat marginal nesting habitat for Long-eared Owls. At some future time, should either of these species be found nesting near the pit site, mitigativemeasures might be necessary. These measures could involve the relocation or curtailment of certain (e.g. crushing), or even all, activities at the pit site to minimize disturbance to these birds during their early nesting period (April and May) when they are most sensitive.

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Nova Scotia Department of Natural Resources - http://www.gov.ns.ca/natr/wildlife/

Nova Scotia Museum of Natural History - http://museum.gov.ns.ca/mnh/

University of Michigan, Museum of Zoology - http://www.ummz.lsa.umich.edu/

U.S. Forestry Service - http://www.fs.fed.us/database/feis/

Herptofaunal Atlas - database - http://landscape.acadiau.ca/herpatlas/

APPENDIX 1

COMMON AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS CITED IN THIS ANALYSIS

Trees

Common Name	Scientific Name
American Beech	*Fagus grandifolia*
Balsam Fir	*Abies balsamea*
Eastern Hemlock	*Tsuga canadensis*
Paper Birch	*Betula papyrifera*
Poplar species	*Populus spp.*
Red Maple	*Acer rubrum*
Red Oak	*Quercus rubra*
Red Pine	*Pinus resinosa*
Red Spruce	*Picea rubens*
Sugar Maple	*Acer saccharum*
White Ash	*Fraxinus americana*
White Birch	*Betula papyifera*
White Pine	*Pinus strobus*
White Spruce	*Picea glauca*
Yellow Birch	*Betula alleghaniensis*

Amphibians

Common Name	Scientific Name
Four-toed Salamander	*Hemidactylium scutatum*

Reptiles

Common Name	Scientific Name
Blanding's Turtle	*Emydoidea blandingi*
Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*
Wood Turtle	*Clemmys insculpta*

Birds

Common Name	Scientific Name
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis tristis*
Arctic Tern	*Sterna paradisaea*
Atlantic Puffin	*Fratercula arctica*
Bicknell's Thrush	*Catharus bicknelli*
Black-capped Chickadee	*Poecile atricapilla*
Black-crowned Night Heron	*Nycticorax nycticorax*
Blue Jay	*Cyanocitta cristata*
Bobolink	*Dolichonyx oryzivorus*
Brown Creeper	*Certhia americana*
Common Loon	*Gavia immer*
Common Raven	*Corus corax*
Common Tern	*Sterna hirundo*
Downy Woodpecker	*Picoides pubescens*
Eastern Bluebird	*Sialia sialis*
Eastern Meadowlark	*Sturnella magna*
Golden-crowned Kinglet	*Regulus satrapa*
Hairy Woodpecker	*Picoides villosus*
"Ipswich" Savannah Sparrow	*Passerculus sandwichensis princeps*
Long-eared Owl	*Asio otus*
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*
Northern Goshawk	*Accipiter gentilis*
Peregrine Falcon	*Falco peregrinus*
Pine Siskin	*Carduelis pinus*
Piping Plover	*Charadrius melodus*
Purple Finch	*Carpodacus purpureus*
Purple Martin	*Progne subis*
Razorbill	*Alca torda*
Red-breasted Nuthatch	*Sitta canadensis*
Red-tailed Hawk	*Buteo jamaicensis*
Ring-necked Pheasant	*Phasianus colchicus*
Roseate Tern	*Sterna dougallii*
Ruffed Grouse	*Bonasa umbellus*
Sharp-shinned Hawk	*Accipiter striatus*
Short-eared Owl	*Asio flammeus*
Vesper Sparrow	*Pooecetes gramineus*

Mammals

Common Name	Scientific Name
American Beaver	*Castor canadensis*
American Marten	*Martes americana*
American Porcupine	*Erethizon dorsatum*
American Red Squirrel	*Tamiasciurus hudsonicus*
Coyote	*Canis latrans*
Eastern Cougar	*Felis concolor*
Eastern Pipistrelle	*Pipistrellus subflavus*
Fisher	*Martes pennanti*
Gaspe Shrew	*Sorex gaspensis*
Hoary Bat	*Lasiurus cinereus*
Little Brown Bat	*Myotis lucifugus*
Long-tailed Shrew	*Sorex dispar*
Lynx	*Lynx canadensis*
Moose	*Alces alces*
Muskrat	*Ondatra zibethicus*
Northern Long-eared Bat	*Myotis septentrionalis*
Raccoon	*Procyon lotor*
Red Bat	*Lasiurus borealis*
Silver-haired Bat	*Lasionycteris noctivagans*
Striped Skunk	*Mephitis mephitis*
Southern Flying Squirrel	*Glaucomys volans*
Varying Hare	*Lepus americanus*
White-tailed Deer	*Odocoileus virgianus*

5.3.2 Faunal Analysis of a Proposed Pit Expansion – Supplement

Cambridge, Kings County, Nova Scotia
W. George Alliston, Ph.D. – 8 August 2003

INTRODUCTION

This report, together with a previous report (*Faunal Analysis of a Proposed Pit Expansion, Cambridge, Kings County, Nova Scotia. 31 Dec 2002*), assesses the use by amphibians, reptiles, breeding birds and mammals considered at risk in Nova Scotia of an aggregate pit expansion site proposed by Lawson Bennett Trucking Ltd., and the woodlands and agricultural lands adjacent to this site; the possible impacts that aggregate extraction might have on these species, and possible mitigative measures that might be taken. This report presents new information collected in the spring of 2003 and focuses mainly on amphibians, reptiles and breeding birds.

METHODS

In my previous report I used the Province of Nova Scotia species rankings of red (endangered) and yellow (threatened) to define terrestrial, amphibian and reptile, breeding bird and mammal "species at risk". In this report I have expanded the definition of species at risk to include all species of the above-mentioned taxa that are currently ranked as being "extremely rare" (S1), "rare" (S2) or "uncommon" (S3) in the Province of Nova Scotia by the Atlantic Canada Conservation Data Centre (ACCDC) and those species that occur in Nova Scotia that have been designated as "endangered", "threatened" or of "special concern" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This has not led to any increase in the number of reptile and amphibian species considered at risk but has increased the number of mammal species by two and the number of breeding bird species by 39.

An approved list of bird species of high conservation priority for Bird Conservation Region 14 is not currently available; however, a tentative, unapproved, listing of "species of conservation concern" being prepared by Partners in Flight - Maritimes was obtained (see Appendix 1) and consulted in the preparation of this report.

The common names of plant and animal species are used in this report. The common and scientific names are listed alphabetically in Appendix 2.

During the spring and summer of 2003 the proposed pit expansion site and adjacent areas were visited by the author on six occasions. While information was gathered on all taxa being investigated during each visit, the primary focus varied among visits.

14 May 2003 (19:00 hrs to 22:00 hrs; overcast, calm) – The purpose of this visit was to survey the proposed pit expansion site and surrounding areas for nocturnal species of birds (mainly owls), mammals and amphibians. The author was accompanied by Bernard Forsythe. We first searched the site for nest structures that could be used by long-eared

owls. We next visited the nest site that we had found on an adjacent property during our autumn work to see if it was occupied. We then proceeded along the northwest edge of the wood surrounding the pond looking for nest structures that might be used by nesting Long-eared Owls. As darkness descended we proceeded back along the pond, around the periphery of the proposed pit expansion site and west along the scrub/woodland edge to the west boundary of the property. During this last phase of the survey, calls of Barred Owls, Long-eared Owls and Northern Saw-whet Owls were made periodically in the hopes of eliciting a response should any of these species be present. Imitations of rodent sounds were also made periodically; this can sometimes cause owls to approach the source of the sounds.

23 May 2003 (14:45 hrs to 17:40 hrs; hazy, calm) -- The main purpose of this visit was to search the banks of the pond, a portion of the stream feeding the pond, and a portion of a second stream that runs northwest of the proposed pit expansion site to find any basking Wood Turtles that might be using the area. Wood Turtles are well known for their tendency to bask on the embankments of watercourses in the weeks following their emergence from winter hibernation in mid to late April. The survey of the pond was conducted by proceeding along the southeast shore using a zoom telescope (20 to 45X) on a tripod to examine the steep northwestern bank of the pond as well as the area ahead along the southeast shore. The streams were walked and the banks examined using 8X binoculars.

7 June 2003 (5:10 hrs to 11:15 hrs; sunny, calm) – The main purpose of this visit was to conduct a survey of the breeding birds using the proposed pit expansion site and adjacent areas. The author was again accompanied on this survey by Bernard Forsythe. A substantial section of the interior of the proposed pit expansion site had been logged so the survey of the site consisted of traversing the boundary recording separately the species and numbers of birds using the site (where the habitat was still intact) and those in the area immediately adjacent the site. Additional surveys were conducted in other areas adjacent to the site. Birds were identified mainly by their songs and calls. The survey was conducted in the early morning when frequency of bird song is the greatest.

9 June 2003 (16:00 hrs to 16:30 hrs; sunny, windy) – The purpose of this visit was to gather additional information regarding two bird species at risk believed to be nesting in the agricultural lands on the property. High winds, a high level of agricultural and trucking activity and little bird song resulted in this attempt being abandoned.

21 June 2003 (9:55 hrs to 11:05 hrs; sunny, calm) – There was no human activity on the agricultural lands of the property and Mr. Forsythe and I were able to survey all these lands for two bird species at risk. The survey consisted of driving and walking the roadways listening for singing males and, where possible, finding and mapping the location of their singing perches.

27 July 2003 (14:05 hrs to 17:20 hrs; overcast, drizzle) – The main purpose of this visit was to map, using a Garmin GPS76, several areas adjacent to the proposed pit expansion site.

AGGREGATE PIT OPERATIONS

Please see this section in the previous report. We noted only one change in 2003; under the heading "Site Description". In the late spring of 2003, the property owner (Lawson Bennett Trucking Ltd. does not own, but leases, the proposed pit expansion site.) logged the site removing most of the timber. A map of habitats, based on forest cover, of the proposed pit expansion site and adjacent areas as they were prior to the logging of the site is presented in Figure 1.

SPECIES OF FAUNA RECORDED DURING 2003 SITE VISITS

(May 2003 - July 2003)

Amphibians and Reptiles

No amphibian or reptile species at risk was recorded during our site visits.

The four amphibian and one reptilian species recorded during the 2003 site visits are listed in Table 1.

Only two species of amphibians, the Spring Peeper and the American Toad, were recorded on the proposed pit expansion site.

The only reptile species observed during our study was the Eastern Painted Turtle. These animals were observed, sunning themselves on floating logs, in the pond adjacent to the pit site. No Wood Turtles were observed in our 23 May 2003 survey of the pond and the two streams (see Figure 2). This survey was conducted to document the possible presence of basking Wood Turtles.

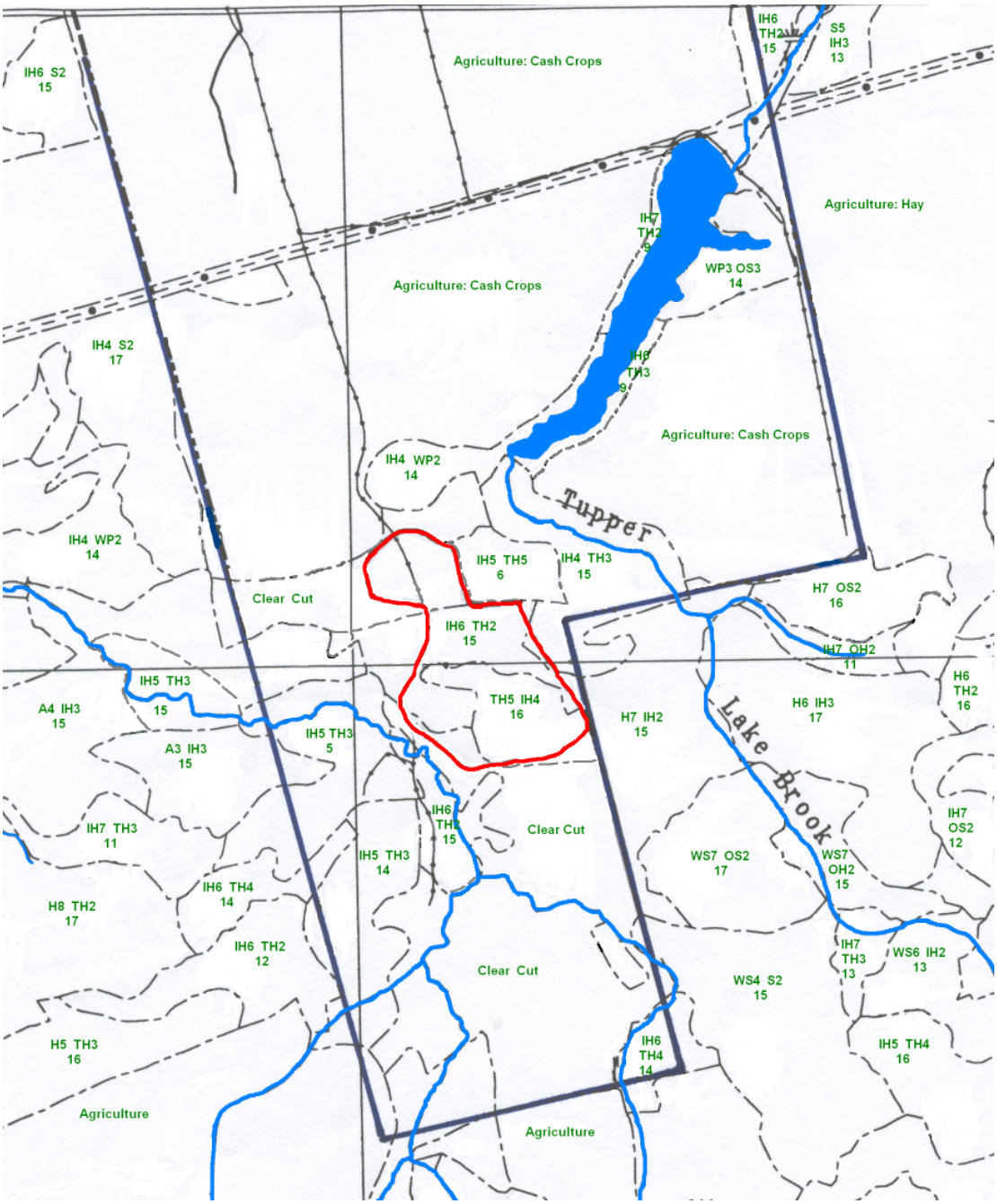

Figure 1. Habitat map based on forest cover.
(For Legend, see following page.)

Legend - Figure 1, Habitat map based on forest cover.

Dominant forest cover tree species

A	Aspen
H	Hemlock
IH	Intolerant Hardwoods
OS	Other Softwoods
S	Red or Black Spruce
TH	Tolerant Hardwoods
WP	White Pine
WS	White Spruce

Forest Stand Description Example

H5 IH3 = Hemlock 50% Intolerant Hardwoods 30%
15 = Height (m)

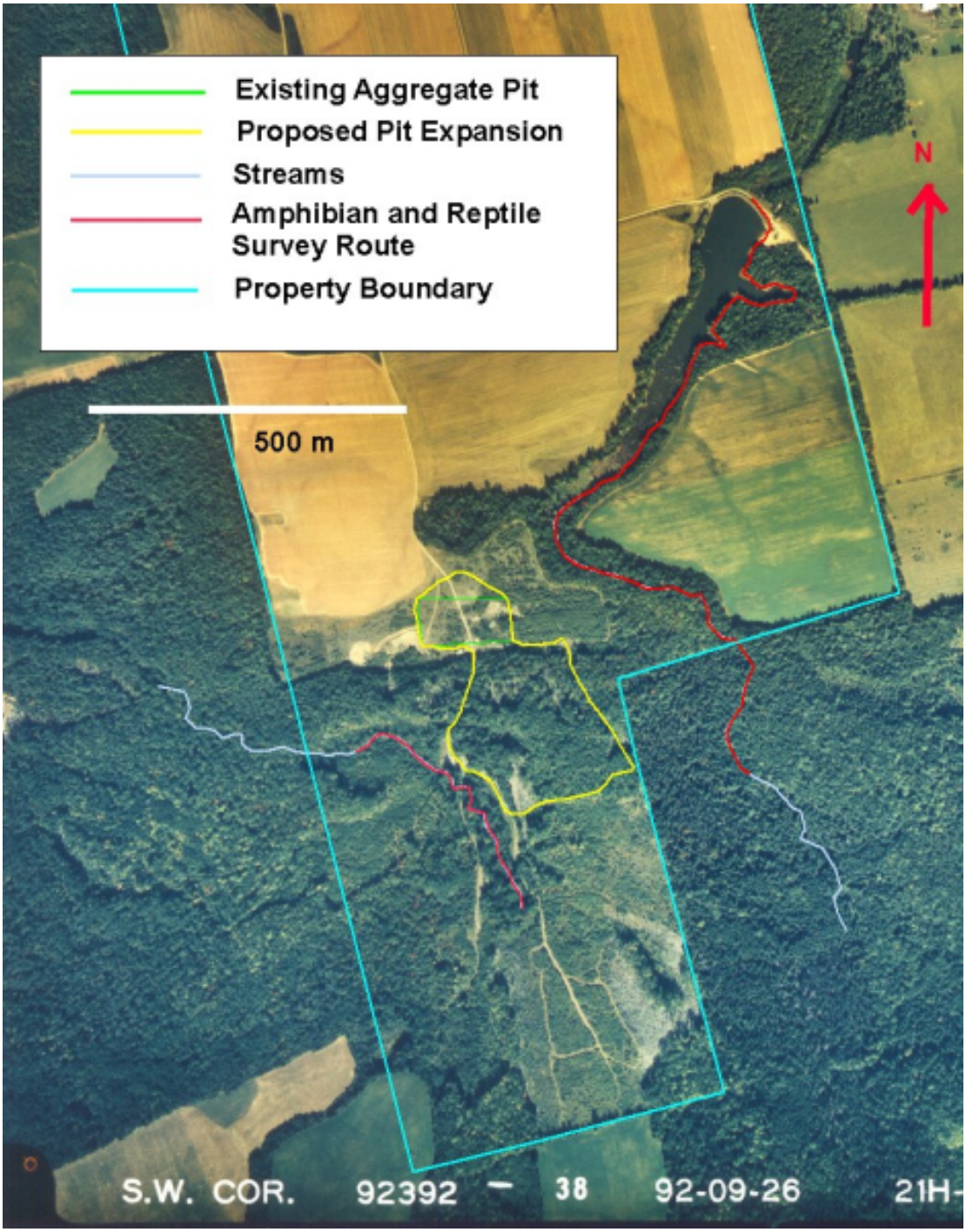

Figure 2. Survey routes taken during amphibian and reptile survey, 23 May 2003.

Table 1. Amphibians and Reptiles				
	On Proposed Pit Site		Adjacent to Proposed Pit Site	
Species	Seen	Heard	Seen	Heard
American Toad	1	√	1	√
Spring Peeper		√		√
Green Frog			6	√
Pickerel Frog			1	
Eastern Painted Turtle	-	-	6	

Breeding Birds

While no breeding bird species at risk was found on the proposed pit expansion site, two species considered at risk by the Province of Nova Scotia authorities (Vesper Sparrow and Bobolink) and a species considered at risk by the ACCDC (Horned Lark) were observed in areas adjacent to the site.

Most of the information gathered on breeding birds was from the survey conducted on 4 June 2003. The routes taken during this survey are shown in Figure 3. When this survey was conducted, a substantial portion of the interior of the proposed pit expansion site had been logged so the survey of the site consisted of traversing the boundary recording separately the species and numbers of birds within the periphery of the site, where habitat was still intact (see Table 2, survey route A1), and those in the area immediately outside the site (Table 2, survey route A2). A similar approach was taken in surveying the existing pit site (Table 2, survey routes B1 and B2). Surveys were also conducted in other habitats adjacent to the site: the woodland surrounding the pond (survey route C), the mature forest to the east (survey route D), the field/forest edge to the west (survey route E) and a small shrubby area along the road to the pit (survey route F). When Vesper Sparrows and Horned Larks were discovered using the agricultural lands immediately north of the pit site, our survey was extended and a preliminary survey of all agricultural land on this property was conducted. Additional information was gathered on 21 June 2003 in a survey that focused entirely upon locating and mapping territorial Vesper Sparrows and Horned Larks.

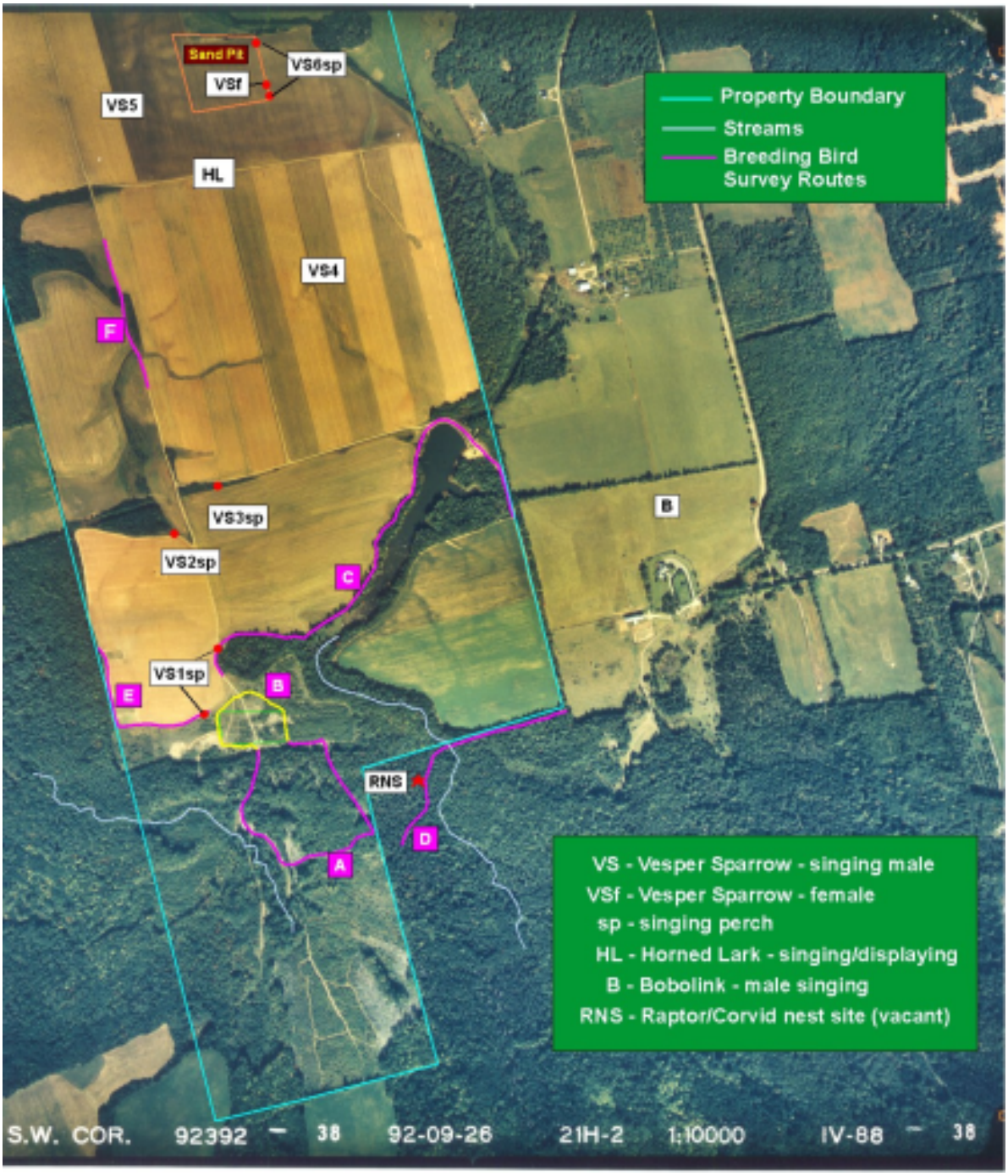

Figure 3. Survey routes taken during 4 June 2003 breeding bird survey and locations of bird species at risk observed.

Table 2. Breeding bird survey of proposed pit expansion site and adjacent habitats, 4 June 2003. (Also see Figure 3.)

Common Name	Survey Routes A1[a]	A2[b]	B1[a]	B2[b]	C	D	E	F	Total	Notes
American Black Duck					2				2	Note 3
Red-tailed Hawk								1	1	Note 2
Ring-necked Pheasant	1	1						1	3	
Spotted Sandpiper					2				2	
Barred Owl		2							2	Note 1
Belted Kingfisher					1				1	Note 3
Northern Flicker				1	1				2	
Downy Woodpecker		1		2			1		4	
Hairy Woodpecker	4					1			5	
Pileated Woodpecker						1			1	
Eastern Wood-Pewee	1	1				3			5	
Alder Flycatcher							1	3	4	
Least Flycatcher							1	1	2	
Horned Lark								2	2	
Blue-headed Vireo	2					3			5	
Red-eyed Vireo		2		1	6	2	1		12	
Blue Jay	2	1			1	4			8	
American Crow		3			4		1		8	
Common Raven		3					1		4	
Black-capped Chickadee					1	2			3	
Red-breasted Nuthatch		1				3			4	
Veery	4	7							11	
Hermit Thrush	2	3				1			6	
American Robin	9	6	1	2	5	5	5	2	35	
Cedar Waxwing							2		2	
European Starling					5				5	
Northern Parula	1	4				2			7	
Chestnut-sided Warbler								1	1	
Yellow-rumped Warbler	2	2			3		2		9	
Black-and-white Warbler		4							4	
Blackburnian Warbler						6			6	
Black-throated Green Warbler	5	2			1	6			14	
Yellow Warbler								2	2	
Ovenbird	11	6		2	2	5	3	1	30	
Northern Waterthrush		1				1			2	
Common Yellowthroat					1			1	2	
American Redstart								2	2	

continued on next page

Table 2. Breeding bird survey of proposed pit expansion site and adjacent habitats, 4 June 2003 (continued). (Also see Figure 3.)

Common Name	Survey Routes A1[a]	A2[b]	B1[a]	B2[b]	C	D	E	F	Total	Notes

Song Sparrow				2	12			2	16	
Vesper Sparrow					2				2	
White-throated Sparrow	1				1				2	
Dark-eyed Junco	6	1		1		3			11	
Bobolink					1				1	
Common Grackle				1	4		2		7	
Brown-headed Cowbird					1				1	Note 2
Purple Finch						1			1	
Red Crossbill						24			24	
White-winged Crossbill						15			15	
Pine Siskin							1		1	
American Goldfinch				8	9		3	3	23	
Evening Grosbeak				3					3	
TOTALS	51	51	1	23	65	88	24	22	325	

[a] - A1 and B1 - observations made within the proposed pit expansion site and the existing pit, respectively.

[b] – A2 and B2 - observations made outside the boundaries of the proposed pit expansion site and the existing pit, respectively.

Note 1 - mated pair.
Note 2 - 21 June
Note 3 - 23 May

During our May and June visits, 50 bird species were documented with 14 species observed within the existing pit and the proposed pit expansion site and all 50 species in the areas adjacent to the site (Table 2). Two of the species recorded, the Red Crossbill and the White-winged Crossbill, are unlikely to have nested in the area (see below). A third species, the Brown-headed Cowbird, is an obligate parasite and, technically speaking, never nests but lays its eggs in the nests of other birds, leaving other species to rear its young. It would therefore appear that at least 47 species of birds may have used the areas adjacent to the proposed pit expansion site for nesting in 2003.

While no breeding bird species at risk was found on the proposed pit expansion site, the species at risk that was found closest to pit-associated activities was the Vesper Sparrow. In our preliminary look at the agricultural lands on 4 June 2003, we documented four singing male Vesper Sparrows. On our 21 June 2003 visit, which was dedicated to censusing this species and Horned Larks, seven Vesper Sparrows were recorded: six singing males and a seventh bird, in close proximity to one of the singing males, believed to be a female (see Figure 3). We thus believe that at least six Vesper Sparrow territories were established on these agricultural lands in 2003. Singing perches were identified for four of the six singing males and the other two were heard/seen singing in recently planted fields. Three of the singing males used perches near the tops of trees or shrubs;

one used the top of a pile of overburden removed for a sand pit operation. Annotations of our observations are included in Appendix 3.

When conducting the two surveys of the agricultural land on this property, Horned Larks were observed and/or heard in the same location on both visits (Figure 3). Two Horned Larks were seen flying together and singing on 4 June 2003. While not seen on 21 June 2003, the song of a Horned Lark was heard at that same location. We therefore believe that at least one pair of Horned Larks may have attempted to nest in the agricultural lands in 2003.

One Bobolink was heard on survey route C. The song came from a hay field on the adjacent property to the east. The approximate location of this territorial male Bobolink is shown on Figure 3.

On our survey of the mature woodland to the east of the proposed pit expansion site, we encountered a mixed flock of about 39 Red Crossbills and White-winged Crossbills feeding on the cones of coniferous trees. Flocking behaviour is not characteristic of these birds during breeding, which can occur any time from January to July. The presence of this flock did not suggest breeding by these species in the vicinity of the proposed pit expansion site.

On our evening survey for nocturnal species (14 May 2003), we identified only one owl species, the Barred Owl, in the vicinity of the proposed pit expansion site. Two male Barred Owls were heard calling, one from the mature woodland area to the east of the site and another some distance to the southwest of the site. We believe that these two territorial males probably represented two nesting pairs. The females would have been incubating at this time making these cavity-nesting birds difficult to hear at a distance. During our 4 June 2003 survey, a pair of Barred Owls was heard vocalizing near the eastern boundary of the proposed pit expansion site.

Our 14 May 2003 search of the proposed pit expansion site and the woodland surrounding the pond again produced no nest structures that might be uses by Long-eared Owls. The nest structure found during our systematic nest search in the autumn of 2002 was not being used in 2003. No birds were seen on the nest and a search around the site revealed no evidence of activity (pellets, down, fecal material). A search within about a 100m radius of this nest site revealed no new nest structures. Our Long-eared Owl calls received no response.

Mammals

No mammal species at risk was observed during our 2003 site visits.

Table 3 lists the nine mammal species whose presence was documented either on or adjacent to the proposed pit expansion site during our 2003 site visits. These observations generally confirm our observations in the autumn of 2002. One new species was added,

the American Chipmunk. One species that was observed in the autumn, the Muskrat, was not observed in the spring. Tracks and sightings suggested a good population of White-tailed Deer in the area. Varying Hare populations seemed to be very low. There was much evidence of American Beaver activity at the pond. No bats were observed during our nocturnal survey or on any of our visits.

Table 3. Mammals and Mammal Sign Observed

	On Site		Adjacent Site	
Species	Observed	Sign	Observed	Sign
Varying Hare	-	-	-	√ (little)
American Red Squirrel	1	√	6	√
Eastern Chipmunk	-	-	1	√
American Beaver (much)	-	-	3	√
American Porcupine	-	√	1	√
Coyote	-	√	-	√
Raccoon	-	√	-	√
Striped Skunk	-	√	-	√
White-tailed Deer	-	√ (much)	3	√ (much)

AMPHIBIAN AND REPTILE, BREEDING BIRD, AND MAMMAL SPECIES AT RISK IN NOVA SCOTIA

Derivation of Species at Risk Lists

As indicated above, I have derived species at risk lists for amphibians, reptiles, breeding birds and mammals from three sources: the General Status of Wild Species in Nova Scotia as defined by the Province of Nova Scotia, the Nova Scotia (sub-national) rankings defined by the Atlantic Canada Conservation Data Centre (ACCDC), and the Canadian rankings as defined by the Committee of the Status of Endangered Wildlife in Canada (COSEWIC).

I have considered all species designated by the Province of Nova Scotia as colour ranks Red and Yellow as "species at risk". The definitions of the Province of Nova Scotia colour rankings are as follows:

"BLUE (Extirpated/Extinct) – Species that are no longer thought to be present in the province or in Canada, or that are believed to be extinct. Extirpated species have been eliminated from a given geographic area but may occur in other areas. Extinct species are extirpated worldwide (i.e. they no longer exist anywhere). Species listed by COSEWIC

as extinct or nationally extirpated automatically receive an Extirpated/Extinct general status rank. This rank applies at the national level and in whichever province or territory the species formerly existed. Nationally Extirpated/Extinct species are not considered part of Nova Scotia's species richness.

RED (At Risk or Maybe at Risk) – Species for which a formal detailed risk assessment has been completed (COSEWIC assessment or a provincial equivalent) and that have been determined to be at risk of extirpation or extinction and are therefore candidates for interim conservation action and detailed risk assessment by COSEWIC or the Province.

YELLOW (Sensitive) – Species that are not believed to be at risk of immediate extirpation or extinction, but which may require special attention or protection to prevent them from becoming at risk.

GREEN (Secure) – Species that are not believed to be at risk, or sensitive. This category includes some species that have declined in numbers but remain relatively widespread or abundant.

UNDETERMINED – Species for which insufficient data, information, or knowledge is available to reliably evaluate their status."
(http://www.gov.ns.ca/natr/wildlife/genstatus/background.htm)

For further information on the Province of Nova Scotia status assessment process, see the above Government of Nova Scotia web site.
I have also considered all species designated by the Atlantic Canada Conservation Data Centre as sub-national (S) ranks S1, S2, S3 for the Province of Nova Scotia as "species at risk". The sub-national rank definitions used by ACCDC are as follows:

"S1 – Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.

S2 – Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.

S3 – Uncommon throughout its range in the province, or found only in a restricted range, even if abundant in some locations. (21 to 100 occurrences).

S4 – Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the Element is of long-term concern (e.g. watch list). (100+ occurrences).

S5 – Demonstrably widespread, abundant, and secure throughout its range in the province, and essentially ineradicable under present conditions.

S#S# - Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the Element (e.g., S1S2).
SH - Historical: Element occurred historically throughout its range in the province (with expectation that it may be rediscovered), perhaps having not been verified in the past 20 - 70 years (depending on the species), and suspected to be still extant.

SU – Unrankable: Possibly in peril throughout its range in the province, but status uncertain; need more information."

Qualifiers for these ranks include:

"B – Breeding: Basic rank refers to the breeding population of the element in the province.

? – Inexact or uncertain: for numeric ranks, denotes inexactness, e.g. SE? denotes uncertainty of exotic status. (The ? qualifies the character immediately preceding it in the S rank)." (http://www.accdc.com/products/lists/ranks).

In addition, the ACCDC provides both national (N ranks) and global (G ranks) for those species. The N and G rank definitions are similar to the S ranks but applied at a national or global level. For more information on the ACCDC ranking system, see the above web site.

I have also considered those species which occur in Nova Scotia that have been designated by COSEWIC as being endangered (E), threatened (T) or of special concern (SC). The definitions for the designations used by COSEWIC are as follows:

Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)	A species for which there is insufficient scientific information to support status designation.

(http://www.cosewic.gc.ca/eng/sct0/index_e.cfm)

COSEWIC's mandate is at the national level so its rankings may vary from the other two sources that take a provincial viewpoint. Further information can be obtained regarding COSEWIC at the above web site.

The following lists include the common name of each species at risk, their status rankings by the Province of Nova Scotia, the ACCDC and COSEWIC and an assessment of their possible occurrence at or immediately adjacent to the proposed pit expansion site. Assessments of the occurrence of each species is based on our survey work, the known distribution of the species and its habitat preferences.

Amphibians and Reptiles

	Status			
	Prov. of N.S.	ACCDC	COSEWIC	
Amphibian Species	Colour Ranking	N.S. S Ranking	Canadian Ranking	Possible Occurrence At or Adjacent to Site
Four-toed Salamander	yellow	S3	NAR	highly unlikely

	Status			
	Prov. of N.S.	ACCDC	COSEWIC	
Reptile Species	Colour Ranking	N.S. S Ranking	Canadian Ranking	Possible Occurrence At or Adjacent to Site
Blanding's Turtle	red	S1	T	highly unlikely
Wood Turtle	yellow	S3	SC	unlikely
Northern Ribbon Snake	yellow	S2S3	T	highly unlikely

Breeding Bird Species	Status: Prov. of N.S. Colour Ranking	Status: ACCDC N.S. S Ranking	Status: COSEWIC Canadian Ranking	Possible Occurrence At or Adjacent to Site
Peregrine Falcon	red	S1B	T	highly unlikely
Piping Plover	red	S1B	E	n/a
Roseate Tern	red	S1B	E	n/a
Common Loon	yellow	S4B	NAR	highly unlikely
Black-crowned Night Heron	yellow	S1B	-	highly unlikely
Northern Goshawk	yellow	S3B	NAR	possible
Common Tern	yellow	S3B	NAR	n/a
Arctic Tern	yellow	S3B	-	n/a
Razorbill	yellow	S1B	-	n/a
Atlantic Puffin	yellow	S1B	-	n/a
Long-eared Owl	yellow	S1S2B	-	possible
Short-eared Owl	yellow	S1S2B	SC	unlikely
Purple Martin	yellow	S1S2B	-	highly unlikely
Eastern Bluebird	yellow	S2S3B	NAR	unlikely
Bicknell's Thrush	yellow	S1S2B	SC	highly unlikely
Vesper Sparrow	yellow	S2S3B	-	possible
"Ipswich" Savannah Sparrow	yellow	S1S2B	SC	highly unlikely
Nelson's Sharp-tailed Sparrow	yellow	S2S3B	NAR	highly unlikely
Bobolink	yellow	S3B	-	unlikely
Eastern Meadowlark	yellow	S1S2B	-	highly unlkely
Least Bittern	green	S1B	T	highly unlikely
Northern Pintail	green	S2B	-	highly unlikely
Northern Shoveler	green	S2B	-	highly unlikely
Gadwall	green	S2B	-	highly unlikely
Common Goldeneye	green	S2B	-	highly unlikely
Red-breasted Merganser	green	S2S3B	-	highly unlikely
Cooper's Hawk	green	S1?B	NAR	highly unlikely
Merlin	green	S3S4B	-	unlikely

continued on next page

Breeding Bird Species (*cont.*)	Status: Prov. of N.S. Colour Ranking	Status: ACCDC N.S. S Ranking	Status: COSEWIC Canadian Ranking	Possible Occurrence At or Adjacent to Site
Virginia Rail	green	S2B	-	highly unlikely
Common Moorhen	green	S1B	-	highly unlikely
American Coot	green	S2B	-	highly unlikely
Semipalmated Plover	green	S2B	-	highly unlikely
Greater Yellowlegs	green	S2B	-	highly unlikely
Solitary Sandpiper	green	S1B	-	highly unlikely
Upland Sandpiper	green	S1B	-	highly unlikely
Least Sandpiper	green	S1B	-	highly unlikely
Wilson's Phalarope	green	S1B	-	highly unlikely
Black-legged Kittiwake	green	S2B	-	n/a
Black Tern	green	S1B	NAR	highly unlikely
Black-billed Cuckoo	green	S3B	-	unlikely
Boreal Owl	green	S1?B	-	highly unlikely
Whip-poor-will	green	S2B	-	highly unlikely
Willow Flycatcher	green	S1B	-	highly unlikely
Eastern Phoebe	green	S2S3B	-	unlikely
Great Crested Flycatcher	green	S2S3B	-	unlikely
Horned Lark	green	S2B	-	possible
Boreal Chickadee	green	S3S4B	-	unlikely
Marsh Wren	green	S2B	-	highly unlikely
Wood Thrush	green	S2B	-	highly unlikely
Northern Mockingbird	green	S3B	-	unlikely
Brown Thrasher	green	S1S2B	-	highly unlikely
Loggerhead Shrike	accidental	SHB	E	highly unlikely
Warbling Vireo	green	S2B	-	highly unlikely
Philadelphia Vireo	green	S2B	-	highly unlikely
Scarlet Tanager	green	S3B	-	unlikely
Northern Cardinal	green	S3B	-	unlikely
Indigo Bunting	green	S2S3B	-	highly unlikely
Rusty Blackbird	green	S3S4B	-	unlikely
Baltimore Oriole	green	S3B	-	unlikely

Mammal Species	Status: Prov. of N.S. Colour Ranking	Status: ACCDC N.S. S Ranking	Status: COSEWIC Canadian Ranking	Possible Occurrence At or Adjacent to Site
Eastern Cougar	undetermined	SU	DD	highly unlikely
American Marten	red	S1	-	highly unlikely
Lynx	red	S1	NAR	highly unlikely
Moose	red	S1	-	unlikely
Eastern Pipistrelle	yellow	S1?	-	possible
Fisher	yellow	S2	-	unlikely
Gaspé Shrew	yellow	S2	SC	highly unlikely
Hoary Bat	yellow	S2?	-	possible
Little Brown Bat	yellow	S4	-	possible
Long-tailed Shrew	yellow	S1	-	highly unlikely
Northern Long-eared Bat	yellow	S2	-	possible
Red Bat	yellow	S2?	-	possible
Silver-haired Bat	yellow	S1?	-	possible
Southern Flying Squirrel	yellow	S1	SC	possible
Southern Bog Lemming	green	S3S4	-	highly unlikely
Rock Vole	green	S2	-	highly unlikely

IMPACT OF AGGREGATE PIT OPERATIONS

Nature of Potential Impacts

See my previous report for this discussion. The only new information to be added is that, in the spring of 2003, the owner of the property (Lawson Bennett Trucking Ltd. does not own, but leases, the aggregate pit site) logged most of the proposed pit expansion site thereby degrading the habitat available on the site for many wildlife species. The habitat removed by the aggregate pit operation will therefore be of lesser quality than it would have been had the forest been cleared only as areas were required for pit expansion.

Amphibians and Reptiles

See the previous report for a general discussion of the reptile and amphibian species at risk and their potential occurrence in this area. This report deals with only one reptile species at risk: the Wood Turtle.

The ACCDC database identifies the Wood Turtle as a species at risk (yellow, S3) that might possibly occur in this area. This is based on a single dead specimen found in this general area in 1950. In the late summer of 2002, a live Wood Turtle was found in Coldbrook near the Cornwallis River (Tom Herman, *pers. comm.*). Although it is not absolutely certain that this turtle had not been released from captivity, Dr. Herman's opinion is that it was indeed a wild specimen.

As already indicated, no basking Wood Turtles were found in our 23 May 2003 search of the pond shoreline and the two streams adjacent to the proposed pit expansion (Figure 2). Dr. Tom Herman (*pers. comm.*) advised that surveys conducted in northeastern Nova Scotia during this time period were quite successful in locating basking Wood Turtles.

Neither of the streams present optimal habitat for Wood Turtles. Both streams are narrow, generally about one to three metres across, shallow and relatively fast flowing. They do, however, have the sandy or gravelly bottoms preferred by Wood Turtles.

Of the two streams, Tupper Lake Brook, the one feeding the pond, would appear to provide the better habitat. The other stream appears to be seasonal and subject to fast, turbulent flows in early spring followed, in late spring and summer, by extensive stretches where there is no surface flow at all. Tupper Lake Brook, while small, appears to flow year-round and there is little evidence of the extremes of flow that are apparent in the other stream. The pond on Tupper Lake Brook could also provide habitat for hibernating Wood Turtles. If Wood Turtles were to occur adjacent to the site, it is much more likely that they would be associated with Tupper Lake Brook than the other seasonal stream that is closer to the site. It is more likely, however, that if Wood Turtles were found in this drainage, they would be further downstream where the flow is slower. I therefore consider it most unlikely that any Wood Turtles would be impacted by the proposed pit expansion.

Breeding Birds

The three bird species at risk observed in areas adjacent to the proposed pit expansion all have some similar characteristics. They are all species whose main populations are found in non-forested areas of North America: the Vesper Sparrow and Bobolink in the plains and prairies and the Horned Lark in prairies, tundra and alpine barrens. With the European settlement of the Maritimes, the cutting of the forests and their conversion into agricultural lands, nesting habitat for these species increased and so did their populations. In the latter half of the 20th century, much of the marginal farmland was released from agriculture and allowed to return to forest thereby reducing available habitat for these species. More intensive modern agricultural practices have, in many cases, led to decreased reproductive success of the birds using these remaining agricultural lands. These are believed to be the major factors contributing to the decline in populations of these three species over most of the Maritimes in recent decades.

Although the populations of these three species are in decline in Nova Scotia, and indeed in much of eastern North America, all are considered by the ACCDC to be "demonstrably secure" at the national (N5B) and global (G5) levels. In the past, none of these species has been considered for review by COSEWIC and none are candidate species on COSEWIC's current Prioritized Candidate List.

The Vesper Sparrow (yellow, S2S3B) is "scattered thinly across the more open areas of the Maritimes" and "is characteristic of areas with short grass or low shrubs such as pastures, blueberry fields and clearings…" (Erskine, 1992). In the plains and prairies of North America, where few species of birds have been able to coexist with the extensive monocultures of modern agriculture, Vesper Sparrows are one of the most common breeding birds (Rodenhouse and Best, 1983, 1994). In Iowa, these investigators found breeding Vesper Sparrows using hedgerows between fields planted in soybeans and corn. They suggested that the Vesper Sparrow was "unique among birds using fencerows because, although it sings from the fencerows and forages along their edges, nests are placed on the ground in the crop field" (Rodenhouse and Best, 1983). These investigators found that Vesper Sparrows nesting in agricultural lands produced relatively few fledged young. The leading causes of low production of young were nest failures due to destruction by agricultural field operations (27%) and predation (29%).

Although in our very brief investigation, no Vesper Sparrow nests were found, the almost complete lack of "normal" nesting habitat within the area where territorial males were found suggests that this group of birds might also be using cultivated fields for nesting.

Erskine (1992), using a limited database, estimated the Nova Scotia population of breeding Vesper Sparrows at about 200 nesting pairs. If the six territorial males we observed represent six nesting pairs, then this group could represent a small, but significant, portion of the Nova Scotia population.

The proposed pit expansion will not result in the removal of any Vesper Sparrow breeding habitat. The relocation of extraction operations to the pit expansion area will move these operations further from Vesper Sparrow habitat thereby reducing the potential for any impacts from noise generated by the pit operation, particularly crushing.

The road leading from the pit to Highway 1 passes through or immediately adjacent to four of the six Vesper Sparrow territories identified in 2003 (see Figure 3). If, as expected, extraction levels remain at similar levels to that experienced in 2002, noise from truck traffic should not increase substantially from current levels.

I have not found any studies that directly assess the Vesper Sparrow's tolerance of disturbance. Rodenhouse and Best (1983) attributed all nest losses due to agricultural activities to "nest destruction by agricultural field operations". No references were made to desertion of nests due to disturbance from these or other human activities. This study also refers to the use of roadside habitat by breeding Vesper Sparrows although no data are provided. The extensive use of croplands, and the use of roadside habitat, would suggest that this species is relatively tolerant of noise associated with human activities.

On this property, agriculture has provided habitat in which Vesper Sparrows can breed. The agricultural portions of this property have been under intensive agriculture regimes (cash crop production) for many years. It would appear that a small Vesper Sparrow population has been able to maintain itself under this agricultural regime. Agricultural activities also have the greatest potential for impacting this population through nest destruction associated with tillage and cultivation. Herbicide and pesticide use could also be factors. Disturbance from trucking is likely to have considerably less impact than agricultural activities. The nature of these two activities is quite different. Trucking is confined in space (the roadway), does not directly impact potential nesting habitat, and is more or less continuous throughout the breeding season. Agricultural activities, on the other hand, are extensive, covering the entire cultivated area and directly impacting potential nesting habitat. Given the more or less continuous nature of trucking activities, a response to this activity by Vesper Sparrows setting up their territories might be expressed by these birds avoiding the trucking route. There was no evidence of this in the preliminary information we gathered in 2003 (see Figure 3).

It is recognized, however, that even a small incremental impact on productivity of a small local population that is having difficulty maintaining itself could have serious consequences. The same small impact on a healthy population might have few or no consequences. At this time, we are unaware of the size and health of this population.

Only a single territorial Bobolink (yellow, S3B) was heard during our site visits; this bird was singing in a hayfield on an adjacent property to the east, far from the proposed pit expansion site or the roadway leading to it (Figure 3). The lush hayfields or pasturelands used by this species for nesting are not part of the current agricultural regime on this property and hayfields in adjacent properties are too distant to be affected by pit operations or trucking. A change in agricultural regime from cash crops to hayfield or pastureland could attract Bobolinks to these areas. However, if this were to happen, it would be agricultural activity (harvesting of hay before young are fledged) that would pose by far the greatest threat to nesting birds.

Only a single pair of Horned Larks (green, S2B) was observed on the property. Erskine (1992) estimates the Nova Scotia population of Horned Larks at about 100 breeding pairs. If this estimate is accurate, even a single breeding pair of this species is of some significance to the Nova Scotia population.

Erskine (1992) reports that the main habitats used by this species in Nova Scotia are large open areas and particularly airfields. It would appear that the large open area of croplands has proven attractive to at least one pair of Horned Larks. Selection of airfields as a favoured habitat would also suggest that this species is tolerant of noise and human disturbance.

The location where the Horned Lark pair is suspected to have nested in 2003 is far from the proposed pit expansion site and about 280m from the road that accesses the pit. I expect that any future nesting by Horned larks in this area would also be associated with

the agricultural lands and not the pit site. As with the Vesper Sparrow, the greatest threat to Horned Larks nesting on this property would be the agricultural activities.

In our previous report we indicated that two raptorial species at risk, the Northern Goshawk (yellow, S3B) and the Long-eared Owl (yellow, S1S2B), might possibly nest on or adjacent to the site. Habitat on the proposed pit expansion site was considered marginal for both species. Some habitats immediately adjacent to the proposed pit expansion site were considered good to very good for Northern Goshawk but marginal for Long-eared Owls.

The proposed pit expansion site was searched for nest structures of both bird species (Long-eared Owls generally use nests built by other birds) during the autumn of 2002 and for nest structures and nesting birds in the spring of 2003, before logging operations commenced. No indication was found of these species either using, or having used, the site. With the logging of the site in 2003, any potential nesting habitat for these species has been removed.

Moderate to very good nesting habitats for Northern Goshawks do remain in areas adjacent to the proposed pit expansion site. Our lack of observation of Northern Goshawks during the 2003 breeding season tends to support our more intensive work in the autumn of 2002 where searches for nest structures in potential nesting habitat within 0.5km of the proposed pit expansion site (see previous report) revealed none. I consider it most unlikely that there is a Northern Goshawk nest within 0.5km of the proposed pit expansion site even though favourable nesting habitat exists and this species is known to have nested within the general area (ACCDC database).

Our autumn 2002 and spring 2003 searches of habitats adjacent to the proposed pit expansion site that might be used by nesting Long-eared Owls, our examination in the spring of 2003 of the nest structure found during the autumn of 2002 and our spring 2003 nocturnal survey all failed to provide any indication that this secretive species nested in the vicinity of the proposed pit expansion site. Indeed our finding of two Barred Owl territories in this area would further decrease the likelihood that long-eared Owls nest here given that Barred Owls often behave aggressively toward the smaller Long-eared Owls. I therefore continue to believe that there is little likelihood that Long-eared Owls nest in the vicinity of the proposed pit expansion site (see also previous report).

A search of the ACCDC database indicated that, in addition to some of the bird species already discussed, five bird species at risk had been previously recorded within relatively close proximity to our study site. These species are: Eastern Phoebe (green, S2S3B), Eastern Bluebird (yellow, S2S3B), Scarlet Tanager (green, S3B), Baltimore Oriole (green, S3B) and Rusty Blackbird (green, S3S4B). None of these species were observed during our work. The bogs, swamps, swales and sluggish streams preferred by the Rusty Blackbird do not exist on or adjacent to the proposed pit expansion site. The American Elm trees so favoured by nesting Baltimore Orioles were not present in the areas studied. While a mature forest exists adjacent to the proposed pit expansion site, it is not the mature hardwood forest preferred by the Scarlet Tanager. While some marginal habitat

was available for both the Eastern Phoebe and Eastern Bluebird, these comparatively rare species were not found using the areas surveyed in 2003.

Three bird species of high conservation priority, as designated by Partners in Flight - Maritimes current, but tentative and unapproved, list (see Appendix 1), were found on or adjacent to the site. Two, the Eastern Wood-Pewee and the Northern Parula, were recorded on the proposed pit expansion site. These same two species and the Purple Finch were recorded in areas adjacent to the proposed pit expansion site (see Figure 3 and Table 2).

It should be pointed out that the Partners in Flight - Maritimes list is not simply a list of species that are currently approaching some stage of endangerment within the region (Bird Conservation Region 14). It is Partners in Flight's mission to "keep common birds common" (Dan Busby, *pers. comm.*.). The Northern Parula is on the list not because its populations are declining (populations are, in fact, either stable or increasing), but because it has been identified as a high priority species for this Region since a disproportionately high proportion of the entire population breeds within this Region. A disproportionately high proportion of the entire Purple Finch population is also found within the Region; however, this species is also experiencing a long-term steady decline over most of its range. The causes of this decline are unknown. The Eastern Wood-Pewee, which occurs in the Region in only average densities, is experiencing significant declines throughout its range, the reasons for which are not known. So, while two of these three species are currently experiencing problems which require further scientific study, they are still common species within the Region. Any impact upon these three species by the proposed pit expansion would be negligible.

Mammals

No additional information was collected on any mammal species at risk during our 2003 investigation. Although two new mammal species were added to our "at risk" list, the very specific habitats required by these species does not exist either on or adjacent to the proposed pit expansion site. (The Southern Bog Lemming (green, S3S4) inhabits low, damp bogs or meadows and the Rock Vole (green, S2) inhabits rocky outcrops, talus slopes or other rocky areas.) See my previous report for a discussion of the mammal species at risk that might occur on or adjacent to this site and the potential impacts of the pit operations upon these species.

Summary

1. Because of the lack of appropriate breeding habitat, the one amphibian species at risk in Nova Scotia, the Four-toed Salamander, is not believed to occur on the proposed pit expansion site.
2. None of the three reptile species at risk in Nova Scotia are believed to occur on this site.
3. Although good potential nesting habitat for the Northern Goshawk exists adjacent to the proposed pit expansion site, searches of this habitat within 0.5 km of the proposed site revealed no Northern Goshawk nest structures. Although marginal nesting habitat for Long-eared Owls exists adjacent to the proposed site, it is unlikely that this species would nest here. While three breeding bird species at risk (Vesper Sparrow, Horned Lark and Bobolink) were found in agricultural lands adjacent to the proposed site, the greatest threat to these birds is from agricultural activities.
4. The only mammal species at risk that are likely to use the proposed pit expansion site are bats during their nocturnal foraging. It is unlikely that maternity colonies of the Little Brown Bat or the Northern Long-eared Bat would be found on or immediately adjacent to this property.
5. Given the apparent lack of use of the proposed pit expansion site by any amphibian, reptile, breeding bird or mammal species considered at risk in Nova Scotia, the proposed aggregate extraction operation should have no direct impact on any of these species. The transport of aggregate is through agricultural lands that currently support two bird species at risk: the Vesper Sparrow and the Horned Lark. Although trucking activities might, through disturbance, have a minor impact upon these birds, both species appear to be rather tolerant of noise. The direct impacts of agricultural operations would appear to pose the greatest potential threat to these birds.

IMPACT MITIGATION

Lawson Bennett Trucking Ltd. will take the following steps to mitigate impacts of its operations on wildlife and meet its obligations under the Migratory Birds Convention Act by:

1. in recognition of the fact that a species at risk, the Vesper Sparrow, may nest in the area immediately north of the existing pit site, not extending extraction activities north of the existing pit site;
2. removing overburden, and the wildlife and bird nesting habitat it supports, only during a time when birds are not nesting (August through November);
3. not removing aggregate from pit embankments used for nesting by such species as the Belted Kingfisher and Bank Swallow during the period when nests are active (May through July);

4. avoiding, where possible, the nests of ground-nesting species that are sometimes attracted to aggregate pits (e.g. Killdeer, Spotted Sandpiper, Common Nighthawk);
5. assuring that all toxic materials that might be used in the operation of the aggregate pit (gasoline, engine oil, hydraulic fluid, antifreeze) are not accessible to birds and other wildlife. Any accidental spills of toxic materials will be dealt with expeditiously using protocols described elsewhere in this submission.

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Busby, Dan, Senior Wildlife Biologist, Canadian Wildlife Service, Sackville, New Brunswick.

Elderkin, Mark, Species at Risk Biologist, Nova Scotia Department of Natural Resources, Kentville, Nova Scotia.

Herman, Thomas B., Professor, Biology Department, and Co-director, Centre for Wildlife Conservation Biology, Acadia University, Wolfville, Nova Scotia.

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Environment Canada - http://www.on.ec.gc.ca/wildlife/wildspace/

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Nova Scotia Department of Natural Resources - http://www.gov.ns.ca/natr/wildlife/

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APPENDIX 1

PARTNERS IN FLIGHT – MARITIMES HIGH PRIORITY SPECIES *

Bicknell's Thrush
"Ipswich" Savannah Sparrow
Nelson's Sharp-tailed Sparrow
Bay-breasted Warbler
Canada Warbler
Wood Thrush
Northern Parula
Chimney Swift
Boreal Chickadee
Rose-breasted Grosbeak
Purple Finch
Short-eared Owl
Eastern Wood-Pewee
Olive-sided Flycatcher
Rusty Blackbird

* This list is tentative and has not been approved by the Partners in Flight Working Group,

APPENDIX 2

COMMON AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS CITED IN THIS ANALYSIS

Trees

Common Name	Scientific Name
American Beech	*Fagus grandifolia*
American Elm	*Ulnus americana*
Balsam Fir	*Abies balsamea*
Eastern Hemlock	*Tsuga canadensis*
Paper Birch	*Betula papyrifera*
Poplar species	*Populus spp.*
Red Maple	*Acer rubrum*
Red Oak	*Quercus rubra*
Red Pine	*Pinus resinosa*
Red Spruce	*Picea rubens*
Sugar Maple	*Acer saccharum*
White Ash	*Fraxinus americana*
White Birch	*Betula papyifera*
White Pine	*Pinus strobus*
White Spruce	*Picea glauca*
Yellow Birch	*Betula alleghaniensis*

Amphibians

Common Name	Scientific Name
American Toad	*Bufo americanus*
Four-toed Salamander	*Hemidactylium scutatum*
Green Frog	*Rana clamitans*
Pickerel Frog	*Rana palustris*
Spring Peeper	*Pseudacris crucifer*

Reptiles

Common Name	Scientific Name
Blanding's Turtle	*Emydoidea blandingi*
Eastern Painted Turtle	*Chrysemys picta picta*
Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*
Wood Turtle	*Clemmys insculpta*

Birds

Common Name	Scientific Name
Alder Flycatcher	*Empidonax alnorum*
American Black Duck	*Anas rubripes*
American Coot	*Fulica americana*
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis tristis*
American Redstart	*Setophaga ruticilla*
American Robin	*Turdus migratorius*
Arctic Tern	*Sterna paradisaea*
Atlantic Puffin	*Fratercula arctica*
Baltimore Oriole	*Icterus galbula*
Bank Swallow	*Riparia riparia*
Barred Owl	*Strix varia*
Bay-breasted Warbler	*Dendroica castanea*
Belted Kingfisher	*Ceryle alcyon*
Bicknell's Thrush	*Catharus bicknelli*
Black Tern	*Chlidonias niger*
Blackburnian Warbler	*Dendroica fusca*
Black-and-white Warbler	*Mniotilta varia*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Black-capped Chickadee	*Poecile atricapilla*
Black-crowned Night Heron	*Nycticorax nycticorax*
Black-legged Kittiwake	*Rissa tridactyla*
Black-throated Green Warbler	*Dendroica virens*
Blue Jay	*Cyanocitta cristata*
Blue-headed Vireo	*Vireo solitarius*
Bobolink	*Dolichonyx oryzivorus*
Boreal Chickadee	*Poecile hudsonica*
Boreal Owl	*Aegolius funereus*
Brown Thrasher	*Toxostoma rufum*
Brown-headed Cowbird	*Molothrus ater*
Canada Warbler	*Wilsonia canadensis*
Cedar Waxwing	*Bombycilla cedrorum*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Chimney Swift	*Chaetura pelagica*
Common Goldeneye	*Bucephala islandica*
Common Grackle	*Quiscalus quiscula*
Common Loon	*Gavia immer*
Common Moorhen	*Gallinula chloropus*
Common Nighthawk	*Chordeiles minor*

Birds (continued)

Common Name	Scientific Name

Common Raven	*Corvus corax*
Common Yellowthroat	*Geothlypis trichas*
Common Tern	*Sterna hirundo*
Cooper's Hawk	*Accipiter cooperii*
Dark-eyed Junco	*Junco hyemalis*
Downy Woodpecker	*Picoides pubescens*
Eastern Bluebird	*Sialia sialis*
Eastern Phoebe	*Sayornis phoebe*
Eastern Meadowlark	*Sturnella magna*
Eastern Wood-Pewee	*Contopus virens*
Gadwall	*Anas strepera*
Great Crested Flycatcher	*Myiarchus crinitus*
Greater Yellowlegs	*Tringa melanoleuca*
Hairy Woodpecker	*Picoides villosus*
Hermit Thrush	*Catharus guttatus*
Horned Lark	*Eremophila alpestris*
Indigo Bunting	*Passerina cyanea*
"Ipswich" Savannah Sparrow	*Passerculus sandwichensis princeps*
Killdeer	*Charadrius vociferus*
Least Bittern	*Ixobrychus exilis*
Least Flycatcher	*Empidonax minimus*
Loggerhead Shrike	*Lanius ludovicianus*
Long-eared Owl	*Asio otus*
Marsh Wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*
Northern Cardinal	*Cardinalis cardinalis*
Northern Flicker	*Colaptes auratus*
Northern Goshawk	*Accipiter gentilis*
Northern Mockingbird	*Mimus polyglottos*
Northern Parula	*Parula americana*
Northern Pintail	*Anas acuta*
Northern Saw-whet Owl	*Aegolius acadicus*
Northern Shoveler	*Anas clypeata*
Northern Waterthrush	*Seiurus noveboracensis*
Olive-sided Flycatcher	*Contopus cooperi*
Ovenbird	*Seiurus aurocapillus*
Peregrine Falcon	*Falco peregrinus*
Philadelphia Vireo	*Vireo philadelphicus*

Birds (continued)

Common Name	Scientific Name
Pileated Woodpecker	*Dryocopus pileatus*
Pine Siskin	*Carduelis pinus*

Piping Plover	*Charadrius melodus*
Purple Finch	*Carpodacus purpureus*
Purple Martin	*Progne subis*
Razorbill	*Alca torda*
Red Crossbill	*Loxia curvirostra*
Red-breasted Merganser	*Mergus serrator*
Red-breasted Nuthatch	*Sitta canadensis*
Red-eyed Vireo	*Vireo olivaceus*
Red-tailed Hawk	*Buteo jamaicensis*
Ring-necked Pheasant	*Phasianus colchicus*
Roseate Tern	*Sterna dougallii*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Rusty Blackbird	*Euphagus carolinus*
Scarlet Tanager	*Piranga olivacea*
Semipalmated Plover	*Charadrius semipalmatus*
Short-eared Owl	*Asio flammeus*
Solitary Sandpiper	*Tringa solitaria*
Song Sparrow	*Melospiza melodia*
Spotted Sandpiper	*Actitis macularia*
Upland Sandpiper	*Bartramia longicauda*
Veery	*Catharus fuscescens*
Vesper Sparrow	*Pooecetes gramineus*
Virginia Rail	*Rallus limicola*
Warbling Vireo	*Vireo gilvus*
Willow Flycatcher	*Empidonax trailii*
Wilson's Phalarope	*Phalaropus tricolor*
Whip-poor-will	*Caprimulgus vociferus*
White-throated Sparrow	*Zonotrichia albicollis*
White-winged Crossbill	*Loxia leucoptera*
Wood Thrush	*Hylocichla mustelina*
Yellow Warbler	*Dendroica petechia*
Yellow-rumped Warbler	*Dendroica coronata*

Mammals

Common Name	Scientific Name
American Beaver	*Castor canadensis*
American Marten	*Martes americana*
American Porcupine	*Erethizon dorsatum*
American Red Squirrel	*Tamiasciurus hudsonicus*
Coyote	*Canis latrans*
Eastern Cougar	*Felis concolor*
Eastern Chipmunk	*Tamias striatus*
Eastern Pipistrelle	*Pipistrellus subflavus*
Fisher	*Martes pennanti*
Gaspe Shrew	*Sorex gaspensis*
Hoary Bat	*Lasiurus cinereus*
Little Brown Bat	*Myotis lucifugus*
Long-tailed Shrew	*Sorex dispar*
Lynx	*Lynx canadensis*
Moose	*Alces alces*
Muskrat	*Ondatra zibethicus*
Northern Long-eared Bat	*Myotis septentrionalis*
Raccoon	*Procyon lotor*
Red Bat	*Lasiurus borealis*
Rock Vole	*Microtus chrotorrhinus*
Silver-haired Bat	*Lasionycteris noctivagans*
Striped Skunk	*Mephitis mephitis*
Southern Bog Lemming	*Synaptomys cooperi*
Southern Flying Squirrel	*Glaucomys volans*
Varying Hare	*Lepus americanus*
White-tailed Deer	*Odocoileus virgianus*

APPENDIX 3

VESPER SPARROW OBSERVATIONS – 2003

Figure 3 of this report indicates the locations where observations of Vesper Sparrows were made and identifies these birds by number (e.g. VS1). The following notes were recorded regarding these birds:

VS1

4 June	heard and observed male singing from perch near the top of a poplar tree alongside road to pit (N45°02.621′ W064°36.837′). Later observed and heard male singing from stubble field to west of singing perch.
9 June	saw Vesper Sparrow in scrubby growth at base of singing perch where recorded on 4 June. Not vocalizing. Windy and much trucking and agricultural activity.
21 June	heard Vesper Sparrow singing from shrubby growth along southern boundary of recently planted field just west of existing pit site. No bird at former singing perch so assume this to be VS1.

VS2

4 June	heard and saw singing male high up in a poplar tree adjacent to stubble field (N45°02.765′ W064°36.903′). Later saw this bird foraging on ground alongside roadway just east of singing perch.
21 June	heard and saw singing male on same singing perch as 4 June.

VS3

21 June	heard and saw male singing from the top of a small willow along roadway to pond (N45°02.826′ W064°36.795′).

VS4

21 June	heard singing male in newly planted field.

VS5

4 June first heard singing male in unplanted crop field. Later saw bird fly from field west across road to pit and land in grain field.

21 June heard singing male in recently planted crop field east of pit road.

VS6

4 June heard and saw male singing from a perch near the north end of a long pile of overburden marking the eastern boundary of a sand pit (N45°03.347′ W064°36.756′).

21 June heard and saw singing male at a perch at the southern extremity of the overburden pile at the eastern boundary of the sand pit (N45°03.272′ W064°36.731′).

saw another silent Vesper Sparrow, presumed to be a female, foraging at the base of the overburden pile, perhaps 30m north of the singing male.

27 July at the southern extremity of the overburden pile, encountered a very agitated Vesper Sparrow flitting about very close to me and giving alarm calls.

5.3.3 Potential Effects and Proposed Mitigation

The expected potential impacts of the aggregate pit expansion on wildlife are: (1) the direct removal of habitat; and (2) the disruption of wildlife in adjacent habitats resulting from increased noise levels. Lawson Bennett Trucking Ltd. will mitigate, lessen or eliminate all potential impacts of the proposed pit expansion on streams and wetlands and their inhabitants by employing setbacks 30 meters or more between watercourses and high water marks and the active area of a pit as has been stated elsewhere in this document. While a search of the "edge" habitat on, and in the vicinity of, the proposed pit site did not reveal any evidence of nesting Northern Goshawk or Long-eared Owls, nonetheless, if the Northern Goshawk or Long-eared Owls are found to be nesting on or adjacent to the site, crushing operations may be rescheduled and/or relocated to mitigate potential impact of pit activities, particularly crushing operations during their early nesting period (i.e., April and May). The proponent will invite Mr. Bernard Forsythe

and Dr. Alliston to carry out a survey for Northern Goshawk and Long -eared Owls nesting.

In appreciation of the fact that the Vesper Sparrow may nest in the area immediately north of the existing pit site, the proposed gravel pit expansion will not extend extraction activites north of the existing pit site. To protect the wildlife and the bird nesting habitat it supports, Site preparation and the spreading of overburden at the proposed gravel pit will only take place during a time when birds are not nesting, namely August through November. Moreover, the proponent will not remove aggregate from pit embankments at either pit (i.e., sand or gravel pit), which are being used for nesting. To avoid destroying nests of ground-nesting species that are sometimes attracted to aggregate pits, the proponent will carry out a visual survey of the Site by walking over the area before it is prepared for excavation. To assure that all toxic materials (petroleum-based fuels and fluids, antifreeze, etc.) used in the activities of the Undertaking are not accessible to birds and other wildlife, they and any containers in which they are stored will be removed from the property immediately after use. Any accidental spills of toxic materials will be dealt with expeditiously using protocols described earlier in this document.

5.4 Groundwater Resources

5.4.1 Description of Existing Environment

Geology, Geomorphology, Hydrogeology of a Proposed Pit Expansion
Cambridge, Kings County, Nova Scotia
Submitted by:
Ian Spooner, Ph.D. – 01 August 2003
Associate Professor
Department of Geology
Acadia University, Wolfville, N.S.

Summary

Cambridge Aggregate Site

The physiographic region of the Cambridge Aggregate Site has been called the Triassic-Jurassic Region by Roland (1982) and is characterised by gently rolling topography and with highly variable surface drainage. Peat lands account for less than 1% of the surface

area. Surficial sediment cover at the site is characterized by a thin soil (< 50 cm) that overlies outwash sands and gravels which in turn overlie Wisconsin (Lawrencetown) Till (Stea et al., 1992). At depth this stratigraphy may be repeated. The till is compact, clay-rich, and has low hydraulic conductivity . In some cases it may act as the lower confining layer of a locally perched aquifer. Bedrock (Wolfville Sandstone) outcrops locally at the south end of the property but can be at depths of > 30 m at the north end of the property. This bedrock is both porous and permeable and comprises an important aquifer in the region; the presence of calcite cement results in the buffering of commonly acidic surface waters.

Water quality at the site is poor, samples obtained in drainage ditches on the property exhibit high pH, conductivity and nitrate levels, most likely the result of agricultural practices on the property. It is anticipated that the removal of surface aggregate in the quantities indicated (2, 5-7 ha pits per year) will have very little effect on both the quality and quantity of surface drainage and groundwater in the region. Both local and regional well water levels should not be significantly affected by this extraction.

Geological Assessment

Overview: Wolfville Formation sandstones underlie most of the Cambridge Aggregate Site (CAS, PID 55156681). Regional mapping indicates that Halifax Formation slate may be present at the southern boundary of the property; the contact between these two units is not visible in the study area (Donohoe and Grantham, 1989). Both units are buried beneath relatively thick glacial outwash and till deposits and so this contact is implied mostly on the basis of well water drillhole data. No mineral deposits have been identified in either of these units within the study area. Glacial till deposits are moderate to thick and only apparent at the surface in the southern ¼ of the study site (Stea et al., 1992; see Figure 1).[4] The northern ¾ is dominated by outwash sands and gravels. The morphology of the landscape is variable with a youthful appearance in the southern 1/3 with moderate to high gradient, largely ephemeral streams. The northern

[4] Please find figures 1-11 at the end of this section.

2/3's has more subdued topography and has been largely modified by farming practices. The Wolfville Formation sandstone has been recognized as an excellent aquifer (Trescott, 1967) with well developed hydraulic conductivity and high storage capacity. The Halifax Formation slate has variable secondary porosity and can have high storage capacities but water quality is often compromised by the presence of iron and sulphur which are common constituents of this rock type.

Wolfville Formation Sandstone: The Wolfville Formation sandstone is a braided river deposit that consists of trough cross-bedded conglomerates and very coarse grained pebbly sandstones; fining upwards sequences within this sandstone are common. The Wolfville Fm. commonly exhibits high primary porosity (up to 20%) and where calcite cement is common porosity can be reduced. High secondary porosity (> 5%) can occur due to fracturing and local faulting. This unit is present at or near the surface in the forested southern ¼ of the property (Fig. 1); it is found at depths of > 30m at the northern end of the property.

Halifax Formation Slate: The Halifax Formation is a fine grained slate that may weather to a rusty brown because of the presence of iron pyrite (FeS_2) and occasionally pyrrhotite and arsenopyrite especially at the contact zone between the Halifax and the Goldenville Formations (which may occur about 1 km south of the southern edge of the property). The latter minerals, when disturbed, are responsible for acid drainage which may be locally significant to biota and water quality.

Contact Relationships and Alteration: A major structural and compositional contact between the metasediments of the Halifax Formation and the Wolfville Formation sandstone occurs near the southern end of the CAS (Figure 1). No significant mineralization is known to occur along this contact though it has been noted by Donohoe and Grantham (1989) that this unconformity can often be a vector for groundwater and surface water due to highly developed primary and secondary porosity (the latter associated with alteration and shearing at the boundary).

Mineral Occurrences: No mineral occurrences are known within or near to the CAS (Fowler, 1985). The site has been noted as having sand and gravel deposits but as noted by (Hopper and Gillis,1989) these deposits have not been deemed as particularly extensive or of high quality.

Geomorphology

The CAS forms the southern half of the east-west trending Annapolis Valley. The site proper is characterized by gently-rolling, low relief hills, moderate to low gradient to the south and very low gradient to the north (Figures 2, 3). Surface drainage on the property consists of ungraded, ephemeral creeks to the south and very low gradient creeks that remain ephemeral in the northern portions; these creeks for the most part have been heavily altered and channelized by agricultural practices. Discharge within these creeks is highly variable and can vary from less than 0.1 m^3/s to up to 2 m^3/s during high flow events. No natural lakes or ponds are evident on the property though Tupper Lake Creek has been dammed to form an irrigation (?) reservoir (see Figures 1, 4, 5). It is unclear how the outflow of this reservoir pond is regulated, the apparent creek bed at the base of the reservoir dam did not have any substantial flow during the time that this study was done.

Glacial Geology: Three distinct glacial deposit types are found in the CAS (Graves and Finck, 1990). Much of the area is underlain by generally thin glaciofluvial deposits, most commonly outwash (see Figures 6, 7). These deposits are moderately to well-sorted, have less than 10 % silt/clay and are, in the study area, rarely greater than 10 m thick. Individual sand and gravel lenses within these deposits are highly variable both laterally and vertically. Compact, clay-rich lodgement till often underlies these deposits. In the northern 2/3 of the property these deposits may be underlain by ablation till. The glacio-fluvial deposits are generally flat-topped and can often be located by the well-developed surface drainage. In the southern 1/3 of the property some thin, cryptic kames and kame terraces are present (Stea et al., 1992; see Figures 8, 9). Kame sediment is generally coarse grained and poorly sorted, silt and clay are common constituents (Trenhaile, 1998). As the sediment was deposited in close proximity with glacial ice

debris flow lenses and large erratics are common. This sediment is generally angular and its coarse fraction is composed primarily of locally derived rock (Trenhaile, 1998). The deposits themselves vary widely in size and thickness, in the CAS they are restricted to the southern 1/3 of the property and are generally thin (< 4m) and laterally discontinuous. The permeability of this sediment is low (in till or debris lenses) to very high (in gravel lenses) but hydraulic conductivity within the deposit is low due to the lateral and vertical anisotropy of these deposits. The kame deposits are generally underlain by compact lodgement till and as such surface drainage of pit floors can be poor (see Figure10).

Lawrencetown Till is found primarily in the southern 1/3 of the study area particularly in the vicinity of the reservoir (Stea et al., 1992; see Figure 1). Lawrencetown Till is a reddish-brown, moderately-compact massive till in which cobbles and larger sized clasts make up less than 5% of the till (Graves and Fink, 1990). This sediment exhibits very low permeability and hydraulic conductivity. It is worthy of note that Hopper and Gillis (1989) did not note any substantial sand or gravel deposits at the CAS.

The three surficial units noted above often overlie substantial thicknesses (> 30 m) of undifferentiated non-consolidated deposits both of glacial and interglacial origin (unpublished maps, H. Cameron, Acadia University). These deposits may comprise till, gravel, sand, and possibly soils and though probably highly anisotropic may form locally, in some cases regionally significant aquifers due to the extremely high porosity and hydraulic conductivity of the gravel units (Trescott, 1967). Unfortunately the distribution and thickness of these sediments is speculative, their presence is only inferred through the interpretation of drill logs and by inference. It is likely that these deposits, if in fact present are thicker towards the north and are thin to non-existent in the higher gradient southern ¼ of the study area.

Soils and Peat: The CAS contains three distinct soils (Cann et al., 1954; Cann and MacDougall, 1965). The northern portion of the study area is covered by Cornwallis soils which are water deposited loose, weakly stratified yellowish red sands and gravels. The southern portion is covered by the Berwick soils which are derived primarily from the

Lawrencetown Tills (in turn derived from Triassic bedrock) which are found over much of the region (Stea et al., 1992). The Cornwallis soil is excessively drained and the Berwick soil is well to rapidly drained. Though the Cornwallis soil has been classified as poor cropland susceptible to drought it is used extensively in the region for both potato and carrot farming; irrigation is often required. The are no significant peat deposits in the study region (Anderson and Broughm, 1986)

Hydrogeology

Surface Water

Where clay rich till is present at surface (in the forested southern ¼ of the site) both infiltration and conductivity are low. Overland flow is relatively high and stream discharge fluctuates with input (storm) events. The coarse grained nature of both the outwash and kame sediments results in both high infiltration capacity and high hydraulic conductivity. During input events throughflow would dominate and where sorted sediments are present, input into watercourses would occur over a more extended time period. Conductivities of both kame and outwash sediment are high enough that storage would not persist. This was evident in the pits being worked at present. Though the site had been subjected to appreciable rain events (>20mm) during this investigation 2 days after the event both pits walls and floors were mostly dry (Fig. 6, 7, 8, 9). The standing water that did exist pooled at sites underlain by compact, clay-rich till (Fig. 10). The removal of limited quantities (5 -7 ha) of this sediment will not appreciably affect water storage in the area. As well, it appears unlikely that any of the surface watercourses have year around flow. Input infiltrates easily into outwash and kame sediments and is transmitted as throughflow either down gradient or, if local conditions exist may form a locally perched water table (Fetter, 1994) These surface sediments do not provide a consistent source of water to surface water courses.

During heavy rains some overland flow may exist, particularly in the vicinity of the reservoir, in the southern ¼ of the site, and where roads and excavations have resulted in compacted, low permeability surfaces. This overland flow has resulted in some minor

erosion. The proposed excavations will probably result in a local increase in infiltration and throughflow (due to removal of moderate to low permeability soilcover) and a local decrease in overland flow, and a local decrease in storage capacity. This may have a minor negative effect on vegetation immediately down - hydraulic gradient of the excavation and may periodically reduce flow in some creeks. It must be stressed that these effects will be minor. I do not anticipate that this will have a significant effect on well water levels or recharge in the region.

Groundwater

Little is know about groundwater in this region. There are four hydrostratigraphic units in the study region; the Halifax Formation slate, Wolfville Formation sandstone, undifferentiated stratified till and gravel, and locally outwash deposits (Stea et al., 1992; Donohoe and Grantham, 1989; Trescott, 1967). The Halifax Formation slate may be found at depth in the southern end of the property though its exact contact with both the South Mountain Granite (to the south) and the Wolfville Formation sandstone (to the north) is unknown. Primary porosity within the slate is very low and most groundwater travel would be through secondary porosity in fractures and joints. Secondary porosity in the slate is highly variable and would be enhanced near major shear zones, contacts with other units, and fracture systems. Groundwater flow directions are generally slope parallel and therefore to the north but are locally governed by the orientation of fracture systems. The water in this slate can have low pH and high iron values as pyrite is a common mineral within this unit. The Wolfville Formation sandstone is moderately isotropic with fair to good connection between different facies. As a result hydraulic potential does not appear to change substantially between wells of different lengths that are cased in bedrock (Trescott, 1967). The sandstone can have porosities of up to 25% and calcite cementation is common resulting in excellent aquifer and water buffering potential. The stratified till and gravel deposits can be thick (30 + m in the northern end of the site), anisotropic, and can be very porous and permeable. They constitute a significant groundwater resource and are capped locally by till which in turn is overlain but either outwash or kame deposits (discussed previously). This till often forms both an upper seal for water stored in the stratified till and gravel deposits and an effective barrier

to the downward migration of surface water. As such, limited extraction of the outwash and kame gravels should not significantly affect the potential for contamination or degradation of the underlying aquifers.

Groundwater moves regionally from the South Mountain north towards the Annapolis-Cornwallis Valley, water table and artesian water potentials follow the regional topography (Trescott, 1967). Surface water drainage also moves towards the north, though this tendency is only strongly developed in the southern 1/3 of the study area where surface gradient is moderate (Trescott, 1967). Transfer of surface water to the groundwater table is only likely to be substantial where the undifferentiated glacial deposits are thin and where access to bedrock (preferably the Wolfville Fm. sandstone) is possibly. Under these conditions (likely possible only in the southern 1/3 of the study area) surface water may recharge the regional aquifer.

Water Quality Assessment

A limited assessment of water quality and water chemistry was performed at four sites on the property (see Figure 1, Table 1). The assessment of water chemistry consisted of analyses of pH, Conductivity, nitrate as NO_3-N, and phosphate as PO_4. These analyses were performed using a YSI water quality meter as well as a Chemetrics VVR Water Analysis System. A summary of the water chemistry is displayed in Table 1. Limited aquatic invertebrate counts were also performed at Tupper Lake Creek south of the reservoir (WS-1, Figure 1,) and at one of the drainage ditches in the northern portion of the site (WS-3, Figure 1, 11). The water chemistry data indicates poor quality at sites WS-2, 3 and 4; water at these sites was unfit for human consumption (Canadian Drinking Water Standards, 1998). High nitrate and elevated pH values can be attributed to the heavy application of fertilizers. Water at WS-1 exhibited fair water chemistry with somewhat elevated pH but little nitrate and phosphate (Table 1).

Site	pH	Cond. (Mmohs)	Nitrate NO_3-N	Phosphate PO_4
WS-1	6.8*	.105	0.15 ppm	0.0 ppm
WS-2	8.9*	.347	0.19 ppm	0.0 ppm
WS-3	9.4*	.459	> 4 ppm*	1.3 ppm*

WS-4	9.8*	.501	> 4 ppm*	1.6 ppm*

Table1. Water chemistry results for sites indicated on Figure 1. * indicates that the concentrations very likely or do exceed Canadian Drinking Water Standards.

Macroinvertebrate populations can provide a reasonable indication of long term water quality. It was found that indicators of fair to good water quality were present at WS-1. No macroinvertebrate sample was obtained for the reservoir site WS-2 (Figure 1). The two samples obtained from drainage ditches in the agricultural portion of the study region indicated poor water quality. Overall both water quality and water chemistry of surface water appears to be heavily influenced by present agricultural practices and extraction of aggregate may actually reduce contamination by reducing the amount of land exposed to fertilization.

Assessment of Impact of Aggregate Extraction on Surface and Groundwater

It is my opinion that extraction of aggregate in the quantity indicated (5-7 ha per year at two sites) and from proglacial/glaciofluvial surface deposits within the study area will have little effect on the quality and quantity of groundwater and well water levels with the region. There is a possibility that local perched aquifers (< 3 ha in size) may be negatively affected though, in my opinion, these aquifers are ephemeral and do not constitute a significant water resource for water users in the region. Surface drainage systems may experience reduced flow during low input (summer) months as a result of excavation. These systems appear to be ephemeral and thus represent limited habitat. The limited (spatially and temporally) water quality assessment that was done indicated that surface water quality is poor and that this water appears to be negatively impacted by agricultural practices in the region. It must be stressed that water stored in surface aquifers is extremely vulnerable to contamination. It is my opinion that, given present and past land use, water from these surface deposits should not be used as a potable water resource. Erosion associated with excavation will be relatively minor and, in my opinion will have no affect on local water resources. I see no evidence that appreciable mass wasting has occurred in the past or will occur as a result of the proposed development.