throughout the area. The productive potential of these soils is restricted both in the range of crops grown and crop growth because of their low water holding capacity. The sandy soil profile allows for rapid movement of water and nutrients. The agricultural land at the site does have productive potential, but only with the addition of high volumes of water and supplemental nutrients throughout the growing season.

The Cornwallis and Hebert soil types provide the best opportunity for excavation sites and least potential impact on future agriculture production. With the topsoil layer removed, the subsoil layer has sufficient depth to allow for the removal of the desired sand material.

Soil Type and Characteristics

The Cambridge area has several soil types found throughout this map unit. The information on the main soil types found in the proposed gravel pit site are taken from the Agriculture Canada publication, Soils of the Cambridge Station Map Sheet (21H/02-T3), Nova Scotia Soil Survey Report #25, they include:

CNW85 = HBT86 PGW52 DRT22

C C C

Two views of the map sheet for Cambridge Station are located in Appendix 1-A. A legend and scale for this map sheet and soil descriptions are available in Appendix 1-B.

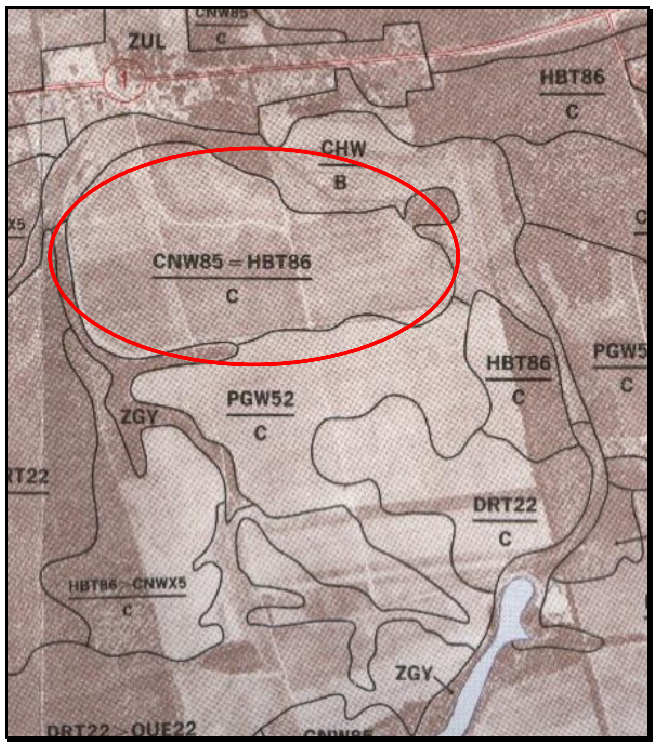
Symbol	Name	Drainage	Lower Soil Material	Surface Material Depth (cm)	Particle Size	CLI Rating
CNW	Cornwallis	Well	Loose sandy glaciofluvial sediments	> 100	Medium to coarse sand	3M
DRT	Debert	Imperfect	Friable to firm coarse loamy till	20-50	Coarse loamy	3D

HBT	Hebert	Rapid	Loose sandy-gravelly glaciofluvial sediments	20-50	Coarse loamy - gravelly	4M
PGW	Pugwash	Well	Friable to firm coarse loamy till	50-80	Coarse loamy	2C

Table 1: Summary of Soil Characteristics of Types Dominant in Proposed Site Source: Holstrom, D.A. (1988)

Cornwallis = Hebert CNW85 = HBT86

C



Map 2 – Soil Type Area (Source: Holstrom, D.A. (1988)

Appendix 3, 4 & 5 - Scale & Legend

The area with this designation is a complex map unit with Cornwallis and Hebert soil types co-dominant through the unit. The CNW85 indicates the Cornwallis soil type, the 8 represents the depth class of the surface material – greater than eighty (80 cm) centimeters and the 5 represents the family particle size of the surface material – in this classification the 5 represents sandy. The Hebert soil type is has the same depth class of surface material at 8 – greater than eighty (80 cm) centimeters, the particle size class is 6 that represents sandy-gravelly.   The C is for the slope class of this area – C indicates a slope of two (2%) to five (5%) percent. The CLI capability classifications for agriculture rating for this area would be 3M for the Cornwallis soil type and 4M for the Hebert soil type. The class 3 rating represents soils that have moderately severe limitations that restrict the range of crops grown; the M is the subclass for lack of water adversely affecting crop growth.

The major limitation of Cornwallis = Hebert soil type for agricultural production is the low water holding capacity and the rapid movement of water and nutrients through the sandy soil profile. Agricultural production on this soil type has potential, but only with the addition of high volumes of water brought about by way of irrigation and supplemental nutrients to meet the crop requirements throughout the growing season.

The Cornwallis soil type provides the best opportunity for excavation sites and least potential impact on agriculture production for the reclaimed sites.   With the topsoil layer removed, the subsoil layer has a sufficient depth to allow for the removal of the desired sand material while leaving approximately one (1 m) of the subsoil layer to provide adequate depth for a root zone for most crops after the topsoil is returned to this area. The growing conditions should be similar with respects to water consumption and nutrient requirements.

A Horizon	Range	Mean
Thickness (cm)	12 –57	26
Particle Size – Sand %	75 – 95	84
Particle Size – Silt %	1 – 21	11
Particle Size – Clay %	1 – 9	5
B Horizon		
Thickness (cm)	6 –75	33
Particle Size – Sand %	72 – 97	90
Particle Size – Silt %	0 –20	7

Particle Size – Clay %	0 –10	3
C Horizon		
Particle Size – Sand %	67 – 99	91
Particle Size – Silt %	0 – 23	6
Particle Size – Clay %	0 – 10	3

Table 2 – Cornwallis Profile Characteristics (Holstrom and Thompson, 1989)

A Horizon	Range	Mean
Thickness (cm)	10 –40	24
Particle Size – Sand %	76 – 93	81
Particle Size – Silt %	4 – 20	16
Particle Size – Clay %	1 – 6	3
B Horizon		
Thickness (cm)	11 – 50	37
Particle Size – Sand %	78 – 98	87
Particle Size – Silt %	0 – 20	10
Particle Size – Clay %	0 – 6	3
C Horizon		
Particle Size – Sand %	78 – 99	91
Particle Size – Silt %	0 – 22	7
Particle Size – Clay %	0 – 5	2

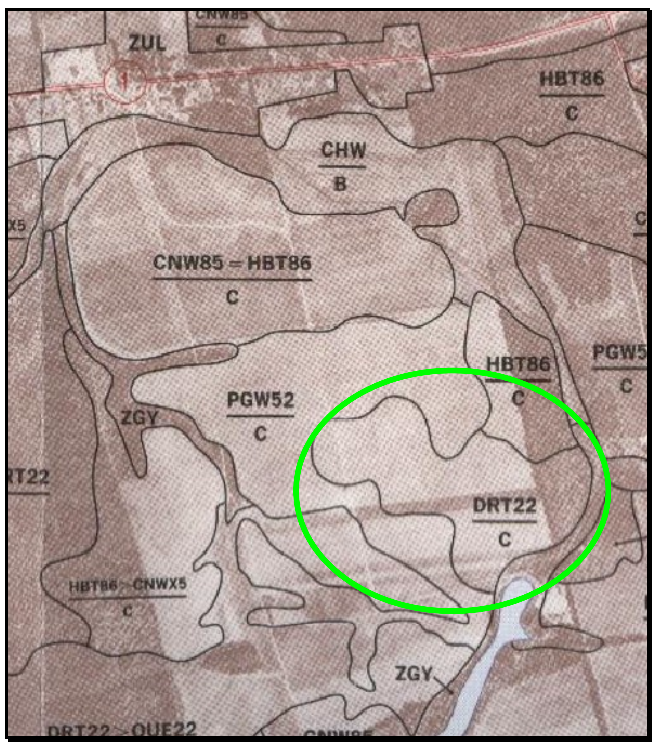
Table 3 – Herbert Profile Characteristics (Holstrom and Thompson, 1989)

The CNW85 = HBT86 complex map unit are characterized with the Herbert located in the lower slopes with the Cornwallis being located in the upper slopes and crests. An existing excavation site was viewed on this soil type. The present pit area on the site has a subsoil layer that can be removed from the site. Again it will be beneficial to leave approximately one (1 m) of the subsoil materials over the clay layer present and observed in the current pit. This will result in similar water and nutrient movement through this sandy topsoil and subsoil layers. To produce crops on this land area, large volumes of water via irrigation and high fertility levels will be required, similar to present circumstances.

A potential benefit for production agricultural would be the reduced depth of the subsoil layer; hence less water would be required to saturate the soil profile to provide water to the root zone of the crops being grown. There would be less depth for the plant roots to penetrate to access water.

Debert   DRT22

C



Map 3 – Soil Type Area (Source: Holstrom, D.A. (1988)

Appendix 3, 4 & 5 - Scale & Legend

The area with this designation is a simple map unit with the Debert soil type. This soil type has a more shallow surface material class of 2 that represents twenty (20 cm) centimeters to fifty (50 cm) centimeters.   The family particle size of the surface material in this classification is 2 that represents coarse loamy. The C is for the slope class of this area – C indicates a slope of two (2%) to five (5%) percent.

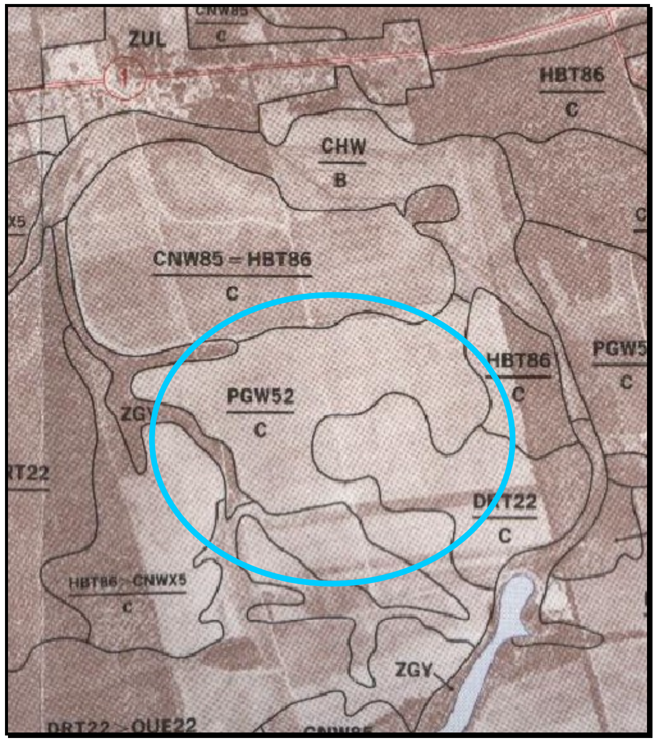
The CLI capability classifications for agriculture rating for the Debert soil type would be 3D. The class 3 rating represents soils with moderately severe limitations that restrict the range of crops grown; the D is the subclass for soils with a potential restriction in the root zone from conditions other than a high water table or consolidated bedrock. The description in the soil survey indicates the depth of the constricting layer to be in the range of twenty-five (25 cm) to fifty (50 cm) centimeters with a mean of forty-five (45 cm) centimeters.

A Horizon	Range	Mean
Thickness (cm)	10 – 29	21
Particle Size – Sand %	22 - 71	54
Particle Size – Silt %	20 – 63	36
Particle Size – Clay %	4 – 18	10
B Horizon		
Thickness (cm)	13 – 58	24
Particle Size – Sand %	43 – 81	60
Particle Size – Silt %	11 – 47	29
Particle Size – Clay %	6 – 18	11
C Horizon		
Particle Size – Sand %	22 – 69	53
Particle Size – Silt %	21 – 64	34
Particle Size – Clay %	9 – 17.9	13

Table 4 – Debert 22 Profile Characteristics (Holstrom and Thompson, 1989)

Pugwash PGW52

C



Map 4 – Soil Type Area (Source: Holstrom, D.A. (1988)

Appendix 3, 4 & 5 - Scale & Legend

The area with this designation is a simple map unit with the Pugwash soil type. This soil type has a surface material class of 5 that represents fifty (50 cm) centimeters to eighty (80 cm) centimeters in depth. The family particle size of the surface material in this classification is 2 that represents coarse loamy. The C is for the slope class of this area – C indicates a slope of two (2%) to five (5%) percent.

A Horizon	Range	Mean
Thickness (cm)	7 - 55	26
Particle Size – Sand %	35 - 77	58
Particle Size – Silt %	17 - 49	32
Particle Size – Clay %	1 – 17	9
B Horizon		
Thickness (cm)	10 – 62	31
Particle Size – Sand %	24 – 77	60
Particle Size – Silt %	18 – 67	31
Particle Size – Clay %	4 - 17	9
C Horizon		
Particle Size – Sand %	28 – 76	58
Particle Size – Silt %	14 - 59	31
Particle Size – Clay %	4 -17	11

Table 5 – Puwash Profile Characteristics (Holstrom and Thompson, 1989)

The CLI capability classifications for agriculture rating for the Pugwash soil type would be 2C. The class 2 rating represents soils with moderate limitations that restrict the range of crops grown; the C is the subclass for soils with inadequate heat units for optimal growth of a wide range of crops. The description in the soil survey indicates the depth of the constricting layer to be in the range of fifty-one (51 cm) to ninety-five (95 cm) centimeters with a mean of fifty-seven (57 cm) centimeters.

The reclamation process of removing the topsoil, stock piling, removing the subsoil layer, and reclaiming the area using the original topsoil is commonly used in agricultural production during land levelling. Laurie Cochrane, Soil and Water Engineer, with the Nova Scotia Department of Agriculture and Fisheries confirmed that levelling and sloping of agricultural production areas where the slope could have detrimental impact on the environment through erosion has been successful in optimizing the productivity of the field area.

Recommended Procedure:

- Remove any existing crop or weeds from the proposed site; use Round Up at the label rates to remove plant material. Round Up is recommended to assist in the breakdown any plant material before topsoil removal. This will be beneficial during reclamation to reduce any sod or plant clumps in the reclaimed seedbed,
- Remove the topsoil from the proposed site area,
- Reuse the topsoil to reclaim an existing excavated site or stockpile the topsoil for later use in reclamation,
- Add recommended additions to the soil as indicated by the soil test and reseed the reclaimed area. If the topsoil is to be stockpiled a cover crop can be seeded to prevent potential movement of the material.

<u>Topsoil</u>

Remove at least thirty (30 cm) centimeters of the surface material layer - topsoil; remove all the topsoil to the actual depth where deeper levels are present. The required depth can be determined by observation of the surface material class while removing the surface material during stockpiling. The more topsoil available at reclamation, the greater the impact on the potential crop production of the reclaim area. The topsoil can be handled in two ways. One method is to strip the topsoil from the site and move it directly to a site being reclaimed. Such will minimize the amount of topsoil stockpiled at any one time. The alternative is to stockpile the topsoil close to the reclamation site, in small piles, to minimize the potential for erosion. The stockpiles can be temporarily seeded with grass seed to prevent movement of this material. Soil test should be taken before the excavation and stripping process to document the present soil characteristics of a given area.

Soil Testing - Soil tests should be taken after the reclamation process to determine the appropriate inputs for the crop to grown. The organic matter should be above three (3%) percent for plant growth. If the organic matter is low, amendments can be added before the crop is planted, these would include compost, solid livestock or other sources of organic matter. The pH should be in the range of 6.0 to 6.5 for most crops, limestone could be incorporated at reclamation, if the pH needs to be increased. Nutrient requirements for a particular crop, organic matter percentage and rates for limestone application are provided on a standard soil test from the Department of Agriculture and Fisheries.

Compaction – There is potential risk of compaction during the excavation process. Testing before reclamation with a soil probe can be used to determine the extent of the compaction. If compaction has occurred, an excavator, conventional ripper or subsoil implement can be used to break up the compacted layer.

Slope – During the reclamation process, consideration should be given to the slope of the fields being reclaimed. The excavation and reclamation of the site provides an opportunity to deal with existing and potential surface drainage and run-off. Laurie Cochrane[3], Engineer, recommended that the reclaimed fields should have a slight slope so that, any excess surface water will be will not remain in the field. The reclaimed area should have a gentle slope (15 cm every 30 meters) to allow excess surface water to leave the field area.

General Recommendations

1) Ideally, the topsoil should be used immediately, stripping a new pit area to reclaim an existing excavated site. If stockpiling occurs, the topsoil should be stockpiled close to the reclamation site, in small piles to minimize the potential for erosion. The stockpiles can be temporarily seeded with grass seed to prevent erosion,

2) It will be beneficial to leave approximately one (1 m) of the subsoil materials over the clay layer present and observed in the current pit. This will provide an adequate root zone for future cropping considerations on the reclaimed land area,

3) The reclaimed area should have a slope (15 cm every 30 meters) to allow for excess surface water to leave the field area,

4) Testing before reclamation with a soil probe can used to determine the extent of the compaction and if action should taken, and

5) Soil tests should be taken before the sites are excavated and after reclamation process to determine the appropriate inputs for optimal plant growth.

---

[3] Conversation with Laurie Cochrane, Engineer, Nova Scotia Department of Agriculture and Fisheries

Conclusions

There are several soil types present in the proposed site area. The best potential sites for excavation of sand and gravel and reclamation for agriculture are on the Cornwallis and Hebert soil types. There are potential problems with the areas of the Debert and Pugwash soil types returning them to their present production capabilities after reclamation. These would also be areas that would not contain significant subsoil layers of sand material for removal. In my professional opinion, the proposed reclamation process will have minimal impact on the agricultural potential of the Cornwallis and Hebert soil types documented in this report.

The areas of Cornwallis soil type will provide the best opportunity for both the extraction of the subsoil material and minimal impact on agriculture after reclamation.

References

Title	**Source**
Soils of Cambridge Station Map Sheet (21H/02-T3) Nova Scotia, Report #25	Holstrom, D.A. (1988) Research Branch, Agriculture Canada
Soils of the Annapolis Valley Area of Nova Scotia, Report #22	Holstrom, D.A. and Thompson, B.L. (1989) Agriculture Development Branch, Agriculture Canada