Re: Project 4/350-801/74 Contract No. 279-74
Stone Masonry at the Rideau Canal System

In accordance with the terms of the above noted contract, a survey was made of the stones at a number of locks along the Rideau Canal System and a comparison was made of these stones with stones found in canal structures at Cardinal and Cornwall. This report is divided into three parts: 1) an overview of the problem and the methodology which was followed, 2) details of the findings and 3) conclusions and recommendations. A number of 35 mm colour slides accompany this report and are meant to be referred to in part 2).

Overview of the Problem

As stated in the terms of reference, Appendix A, the Department of Indian and Northern Affairs intends to replace some deteriorated masonry on the Rideau Canal with materials from other abandoned canals. In order to determine the feasibility of the project, it was necessary to compare the stones at selected locks on the Rideau with stones available at Cardinal and Cornwall.

During the course of this project the locks at Hartwells and Hog's Back in Ottawa were inspected as were all locks from Smiths Falls to Kingston Mills inclusive of the locks at these two centres. In all, some 24 locks were involved in the survey of the Rideau Canal. At Cardinal, Ontario, the two remaining open stretches of the old
canal which once divided the town from the 'mainland' were visited. The work involved mainly inspecting the large number of stones which lie on the sloping earth sides of the canal which is in cut. An old lock and two masonry control structures were examined at Cornwall.

The character of the stones on the Rideau Canal was defined in terms of generic classification, colour, texture, dimensions, shapes, tooling, surface finish and weathering*. It seems worthwhile to discuss each of these in turn before going on to the detailed findings.

(i) Generic classification: The field work consisted of a visual examination of the stones and a preliminary classification based on colour, hardness and mineralogy. Small rock chips were broken off the back surfaces of some stones at each site (the back surfaces were always rough and in the 'as quarried' condition of the stones). The rock chips were used subsequently to determine the reaction of hydrochloric acid on the stones to help differentiate between rock types (namely between limestone and dolomite since the reaction is much more subdued with dolomite) and to determine the cementing agent in the sandstones (calcium carbonate reacts vigorously to the acid while silica shows no reaction). It so happened that the mineral content of the stones can be deduced readily from the generic classification. Each of the different kinds of stone contain essentially only one mineral, for example the limestone is essentially calcium carbonate and the sandstone is quartz. Therefore, detailed mineralogy of the stones was found to be unnecessary.

(ii) Colour: An apology is due the Department on the issue of colour. In the original suggested terms of reference, colour photographs were required of the stones. Since charts are available by which rock colours can be coded, it was suggested that the 'chart method' be used instead. It soon became obvious that the colour variations from stone to stone at any site made a mockery of the chart method. Both print and slide film was exposed at the various sites but it was found that the reproduction of colour was much better in the slides and these are attached to the report in spite of the inconvenience of this form of presentation.

(iii) Texture: The texture of the stones was examined with a hand lens on the fresh surface of the rock chips taken in the field. In general, notes were made on the size of the mineral grains making up the rock and the roughness of the surface. It was obvious, however, that the basic texture of the rock was of little importance to the stones of the Rideau Canal. Their appearance depended more upon the surface finish and tooling.

(iv) Dimensions: After measuring a number of stones at the first locks which were visited it soon became apparent that the important dimension was the height of the stone. Even their dimension varied only within a small range for all of the stones which were inspected. The length (that

*weathering is defined in the geological sense (effect of the climate, atmosphere, etc., not in the masonry sense).
is their breadth looking at a wall of masonry) varied considerably depending upon such things as location in the lock and the local supply. The depth (thickness of a wall) was generally impossible to measure, although the depth of the capping stones could always be measured of course. The depth dimension turned out to be really not much of an issue anyway since with very few exceptions it is the blocks which only show their faces that have to be renewed on the Rideau. In this case oversize replacement blocks (in depth) could be either dug back into the soil backfill or the excess split off. Undersize replacement blocks could be backed with concrete as necessary.

(v) Shapes: In essence the blocks requiring replacement are all rectangular in shape as are the proposed replacements. Shape was, therefore, not much of a factor.

(vi) Tooling and Surface Finish: Careful note was made of the tooling and surface finish of the various stones. The nomenclature used in the Encyclopedia Brittanica for masonry finishes was adopted (Appendix B).

(vii) Weathering: Since the rock types varied so little in their basic colour as displayed on freshly exposed surfaces (after chipping off a rock sample), the more varied colours that are seen on the masonry walls are the result of weathering or contamination. Weathering includes the oxidation of mineral impurities in the rock which can lead, for example, to rust coloured streaks or patches on the surface (oxidation of pyrite). More often though it is the result of bacterial action or chemical pollutants in the water or atmosphere. Contamination is, for example, the leachate from the mortar which is found on the rock surface. It can also be algae or an oily scum which adheres to the stone.

In summary, it is evident that the masonry work along the Rideau Canal was all carried out to a well defined, common specification. In masonry terms, 'block in course' was used for walling. That is: roughly squared blocks of stone which may vary in length, having worked beds (horizontal surfaces) and hammer-dressed faces and joints and set in courses which may vary in height. Admittedly there are local variations in the texture and colour of the stone and slight differences in the surface finish and tooling. However, the most striking feature of the masonry at all 24 locks that were visited is the uniformity. The size and shape of the stone as well as the overall appearance of the finished walls, abutments, etc. are such that one would have a hard time telling just where he was if he were brought blindfolded to a particular lock. There are exceptions of course - mainly due to modernization or attempts to repair since Colonel By's day which lead to instant recognition of the location.

The Cardinal and Cornwall canals are another story. It is obvious that they were built at different times, with strikingly different stone and to different specifications. On the Rideau the impression always
is one of care leading to a fine, tooled finish whereas at Cornwall and Cardinal the overall impression is one of greater variability and coarseness.

Detailed Findings

There were essentially three types of rock used for the stones in all the canal structures covered by this report. These are (a) sandstone, which predominates on the Rideau, (b) limestone, which is found in abundance only at Hartwells and Hog's Back on the Rideau but predominates at the St. Lawrence Canals and (c) dolomite. The blocks of stone were everywhere of the same general shape (rectangular) and size (18 to 22 inches high and widths varying from 24 to 70 inches). Their colour on freshly broken surfaces was grey for the limestone and buff for the sandstone and dolomite. However, the weathered surfaces varied from black to grey to buff to white at any lock. It would seem that as long as replacement stones fell generally into this pattern of colour, they could be used almost anywhere on the Rideau system.

The only real concern would seem to be matching the surface finish and tooling to a particular lock. Even then, as has been stated earlier, the surface finishes and tooling along the Rideau were tightly controlled so that it would be possible to mix stones among the Rideau locks without worrying about adverse comment. There are subtle differences, however, along the Rideau, and the St. Lawrence locks are certainly different. The following notes should assist with an understanding of the tooling and surface finishes. Appendix B contains the Encyclopedia Britannica definitions of the various terms.

Tooled margin: fine grooves extending 2" from edge - can be observed on most stones in the Rideau system of canals and locks.

Bush-hammered surface: on limestone only. Observed at Hartwell, Hog's Back, Smiths Falls, Poonahmalie, rejected stones at Kingston Mills (also groove for locks' doors). Best examples: Cornwall canal on two types of limestone, also on the edge of pier at Cardinal.

Batted: on all sandstone rocks from Hartwell to Kingston Mills. Weathering has removed some of the relief.

Pitched surface: observed on canal lining at Cardinal. The backs of the stones in the Rideau system are also of this type.

Pointed: with a trace of a hammer point at large intervals up to 2" and the rock split between points. Typical of wall stones at Cornwall (no margin there).
Chief, Restoration Services Division  
March 6, 1975

Summary: rock face showing traces of drill holes where 'feathers' were introduced to break the stones from the bench in the quarry. Observed at Cardinal on both sloping walls in 2 limestone types. No margin on those stones.

Sawed surface: mechanical sawing of stone (recent) same stones at Cardinal; restoration work in Smiths Falls, Newboro, Poonahmalie.

"Embossed" (bossagée): pitch with a margin and the large broken surface forms a convex surface inside the margin - Cardinal (stones lining the canal) and Cornwall (some stones over weirs)(similar to rusticated).

Grooved: long-parallel grooves usually vertical in the stone are found around shaft of lock's doors. Good example seen at Smiths Falls and Brewers Mills.

With the above general picture in mind, it seems time to have a 'tour' of the various locks based on the following notes and accompanying slides.

Locks 9 and 10 - Hartwells

General - Striking feature is extent to which concrete has been used to replace both capping stones and lock walls, generally with poor results.
- original piers and capping stones are Nepean sandstone with the individual sand grains cemented together with silica and some carbonate.
- walls of lock 9 are of Ottawa limestone.

Slide 1 - Sandstone capping stones (15 inch height) and pier stones.
- note natural weathered colours above the waterline with contamination (white colouration) due to leachate from the mortar.
- note black discoloration (which would hide almost any natural stone colour) on surfaces below the waterline.

Slide 2 - Batted surface (a surface comprising a series of parallel groves irregularly spaced across the face of the stone; the number of grooves may vary from 5 to 10 per inch).
- picture is of horizontal surface of a sandstone capping stone.

Slide 3 - Sandstone capping stone is 15 inches high.
- other stones are 24 inches high.
- note variety of colour and surface staining.
Slide 4 - Interior of lock 9.
- note sandstone capping layer and blocks of limestone used for walls.
- black surface probably due to bacterial attack from polluted water.
- note limestone is deteriorating along horizontal partings in the rock.

Slide 5 - Interior of lock 10.
- note advanced deterioration of and spalling of the concrete which has exposed the reinforcing steel.
- the worst appearing lock in the survey.
- capping layer is of concrete rather than sandstone.

Locks 11 and 12 - Hog's Back

General - Piers and capping stones are of sandstone.
- lock walls and some capping stones are of local limestone thought to have been cut from a quarry 100 yds or so to the east of the locks themselves.

Slide 6 - Closeup of Ottawa limestone.
- looks blue grey in sunlight.
- note tooled, grooved margin (2 inches wide) and bush hammered surface.
- note poor condition of mortar.

Slide 7 - Interior of lock 11.
- note sandstone capping stone.
- dark grey discolouring of stones would hide the natural colour of almost any rock.

Slide 8 - Surface texture of sandstone capping stone, after 'pecked' tooling (looks like a bird pecked away at the stone with its beak).

Slide 9 - Interior of lock 12.
- note capping stones are limestone as are the walls.
- note deterioration of many stones along horizontal partings.
- the pier to the left is in sandstone and never submerged so stones have remained relatively clean.
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March 6, 1975

Slide 10 - Surface and colour of the sandstone.
- colour varies from grey to buff.
- note margin.

Locks 28, 29 and 30 - Smiths Falls Combined Locks
and Lock 31 - Smiths Falls Detached Lock

General - Lock structures are built of sandstone and limestone mainly.
- some stones contain both dolomite and sandstone and could be of the March formation.

Slide 11 - Gateway between locks 28 and 29.
- air weathered colours are above centre of photo.
- dark, black-coloured stone below centre of photo due to action of canal water.
- rock is a mixture of sandstone and dolomite.

Slide 12 - 2 and 3 courses up from the bottom of the inside of lock 29.
- stones are 22 inches high and from 30 to 50 inches wide.
- note algae staining and tooled margin.

Slide 13 - North wall of lock 29.
- note varieties of stone size, in particular the variation in height (an unusual feature in Colonel By's locks).
- upper rows of stones are 12 to 16 inches high by 30 to 50 inches long.
- staining of the surface of the stones is not uniform, colour varies from grey to black.

Slide 14 - Entrance to lock 29.
- note grooved margin and pecked surface (margins are 2 inches wide).

Slide 15 - At lock 29.
- note leachate from mortar and concrete patch over grout hole.

Slide 16 - Gateway to lock 29.
- note vertical and horizontal tooling.

Slide 17 - Middle of the north side of lock 30.
- note variations in block dimensions from about 24 inches high and 52 inches wide to 13 inches high and 36 inches wide.
- rock is sound but a number of small concrete patches are noted.
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Slide 18 - Lock 30.
- stone changes from sandstone on top (buff coloured) to dolomite on the bottom (grey).
- pecked surface and grooved border.

Lock 32 - Poonahmalie
General - Mainly grey coloured dolomite although the piers and capping are of sandstone for the most part.
- dolomite blocks in the piers blend in well with the sandstone.
- capping course is 14 inches high, rest of the stones generally 15 to 18 inches high, with some courses up to 26 inches.

Slide 19 - Interior of lock, north side - note dark colour below the water line.
- stone is dolomite.

Slide 20 - North-east pier, general view showing blending of various colours and sizes of stone.

Slide 21 - North-east pier as seen from across the canal.
- note central nine or ten stones are dolomite, remainder are sandstone.

Slide 22 - Note surface finish and staining of sandstone in the north-east pier.

Slide 23 - South-west pier showing loss of mortar between stones.

Locks 33 and 34 - on the Tay Canal to Perth - were not included in this survey

Lock 35 - The Narrows
General - The structures are of cream coloured sandstone.

Slide 24 - Sandstone.
- note dark, water induced staining starting about 2/3 of the way down the capping stone.
- stones are about 22 inches high.
- colour is grey.

Slides 25- Note patching and dark, stained band which could hide almost and 26 any kind of stone.
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Slide 27 - Closeup of surface of sandstone capping stone.
- grooved margin has generally been weathered away.
- note colour.

Slide 28 - Sandstone with orange coloured surface probably due to staining from oxidation of iron (pyrite) in the stone.

Slide 29 - Note leachate from mortar and dark staining at water line.

Slide 30 - Note margin is still visible in this sandstone capping stone.

Lock 36 - Newboro
General - Sandstone blocks were originally used for this lock structure.
- recent modernization has involved use of sandstone veneer which has deteriorated quite rapidly - probably a result of stresses set up in the rock during sawing and veneering process.

Slide 31 - Sandstone 18 inches high.
- note grooved margin and pecked finish.

Slide 32 - Second row of stones is 26 inches high and more typical of stone size.
- note variations in buff colour.

Slide 33 - Detail of pecked surface tooling.
- note sloppy mortar repair.

Lock 37 - Chaffeys
General - Lock is of sandstone.

Slide 34 - Details of typical rock surface, generally rougher than at other locks.
- note unsightly concrete patches.

Lock 38 - Davis
General - Lock is of sandstone.

Slide 35 - East entrance, north side.
- details of pecked surface and grooved margin.
- stone is 18 inches high.
- note sloppy masonry repair work.
- colour is grey to buff.

Slide 36 - Note black staining below the water line.
- height of rock varies from 15 inches to 22 inches.
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Lock 39 - Jones Falls Detached lock

General - Lock is of sandstone.

Slide 37 - Centre of lock, east side.
- note lower stones are only 12 inches high (approx.)
- note dark, stained surface of lower stones.

Slide 38 - South entrance.
- note variated colours.

Slide 39 - Details of surface tooling.
- Note algae growth.

Locks 40, 41 and 42 - Jones Falls in flight

General - Locks are of sandstone.

Slide 40 - East side of lock 40.
- note curious patchwork effect during repairs with stone and concrete.

Slide 41 - North entrance to lock 40.
- note multi-coloured surface with rust coloured pyrite staining.
- poor concrete work leading to unsightly appearance.

Locks 43 and 44 - Upper Brewer

General - Blocks of stone are mainly 12 to 18 inches high and 36 to 50 inches wide.

Slide 42 - Sandstone sill between locks 43 and 44.
- note mortar has disappeared from upper levels of stone.
- green colour is algae.

Slide 43 - Concrete surface in poor state of repair.

Slide 44 - Lock 44, North face.
- note stone size changes so there are 3 courses on the left and 2 on the right below the capping level.
- note leachate on the pier.

Slide 45 - Capping stone of lock 44, south side.
- note grooved margin and buff coloured stone.
- note surface finish.

Slide 46 - Details of tooled surface at west entrance to lock 44.
- general surface is batted.
- note margins.
Slide 47 - Additional details of west entrance to lock 44.

Lock 45 - Washburn (Lower Brewers)
General - Unusual red sandstone mixed in with the usual buff coloured stone.

Slide 48 - Note changing height of stone in upper courses.
- stones vary from about 16 inches high and 22 inches wide to 22 inches high by 48 inches long.
- note reddish coloured sandstone in the capping course.
- dark colour is surface staining by canal water.

Slide 49 - Closeup of dressing of north gateway.
- batted surface at lower levels with pecked surface above.
- note margin.

Slide 50 - West side of lock.
- note changing stone size.

Lock 46 - Kingston Mills detached lock
General - Lock is constructed mainly of sandstone blocks with some limestone.

Locks 47, 48 and 49 - Kingston Mills in flight
General - Locks are mainly sandstone with some limestone.
- a number of limestone blocks have been discarded in the approach basin at the Kingston end.

Slide 51 - Lock 47, east side.
- note colours of the sandstone above the levels reached by the canal water.
- rust colouring on top due to handrail and iron fittings.

Slide 52 - Lock 47.
- poor concrete and sloppy masonry repair work.

Slide 53 - Entrance to lock 48.
- note bedding planes in the capping course.
- tooling has been weathered away for the most part.

Slide 54 - East side of lock 49
From lock 49 - the most southerly of the Rideau Canal - the 'guided tour' proceeds to Cardinal, Ontario.
Cardinal, Ontario

A large 'ditch' runs parallel with the St. Lawrence River and separates the town of Cardinal from the 'mainland' and Highway 2. The centre portion of the ditch has been filled leaving two long stretches open at either end. Both sides of the ditch at the east end are lined with large stones laid in courses on the sloping ground, only the north side is lined in this fashion on the west end. The old canal is lined throughout on both sides by vertical walls but only the capping and one or two courses of stone are visible above the water.

Slide 55 - Typical of the Cardinal canal.
- general view of the north side of the east half of the canal showing the lining of canal waterway and a large number of stones lying on the sloping banks.

Slide 56 - General view of the vertical walls of the waterway.
- stones are 16 to 18 inches high.

The plan is to perhaps use the stone lying on the banks for repair work along the Rideau.

An unusual landmark of the area is what appears to be a large masonry bridge abutment left abandoned at the east end of the central filled-in section of the ditch. The abutment contains about 200 good sound stones of rectangular shape and 16 to 18 inches high. An excellent source of stones for the Rideau perhaps? The blocks are of limestone, with fine surface tooling and grey in colour.

Slide 57 - General view of the abandoned bridge pier.

Slide 58 - Detail of stones in the bridge pier.
- note margin at corner and pick pointed surface of the limestone.

Considering for a moment the west ditch and the stones lying on the sloping surface. A striking feature is the abrupt change in rock colour and type that occurs about one-third of the way along this section coming from the west. To the west the stones are fine grained dolomite, grey-brown to dark buff in colour. To the east, the stone is grey, fine grained limestone which seems darker than any of the stone above the waterline along the Rideau. The vertical walls of the canal are a lighter grey stone, also limestone.

Slide 59 - Line of separation between mainly dolomite stones to the left (west) and limestone to the right (east).
- note limestone blocks are generally bigger.

Slide 60 - West end of bank showing brownish dolomite and few blocks of blue grey limestone.
Slide 61 - Limestone blocks vary in height from 16 to 36 inches.

Slide 62 - Typical surface of sound limestone block.

Slide 63 - Close up showing rough surface of limestone blocks and deterioration along partings.

Slide 64 - Canal lining - note margin on top course of stones and occasional parting in the stone.

Slide 65 - Close up of rusticated or embossed finish of limestone lining the actual waterway.
- total relief is of the order of 2 to 3 inches.
- view is vertically downward with canal water on the right.

Only the light grey limestone (the canal walls) and the dark grey limestone are found in the east section of the ditch.

Slide 66 - Typical size and surface finish of sound limestone block on east half of canal.

Slide 67 - Limestone.
- notice partings leading to deterioration.

Everywhere the canal stones are large. They are generally 16 to 18 inches high or more. The stones are more often in poor condition, however, with marked surface deterioration and numerous partings. A rough estimate would be that good blocks of massive stone make up about 25% of the total; even so, this is enough to replace the poor stones seen on the Rideau many times over.

All the canal stones have a pitched or split surface with some evidence of dressing.

There is ready access to the length of the canal throughout Cardinal.

Cornwall, Ontario

Limestone is found in three forms at Cornwall - fine, medium and coarse grained. Colour ranges from medium to dark grey. Much of the stone is the same formation as is found in the Hog's Back and Hartwells locks at Ottawa.

The size of the stone is large, generally 18 inches or better in height.

The capping stones are bush-hammered with a tooled margin. On the walls of the old lock and the southerly diversion channel, the stones
are coarse-pointed. The general surface is planar but the marks from a pointed hammer are wide spaced (2 inches or more) with a pitch rock surface in between. There is no margin.

Slide 68 - General view of limestone lining the lock structure.

Slide 69 - Capping stones of lock showing dark, fine grained limestone on the right and lighter, medium grained stone on the left.

Slide 70 - Surface finish of lock capping stones.
- bush hammered.
- no discernible margin.

Slide 71 - Sound limestone blocks in the lock.
- minor deterioration along partings in evidence.

Slide 72 - Stones of the middle (control) channel.
- note grey colour in shade.

Slide 73 - Stones of the middle (control) channel.
- note colour of limestone blocks in sunshine.

The northern diversion channel has stones which are said to be embossed or rusticated, that is they have a margin but with a pitched surface inside the margin. The rough, pitched surface is convex to the marginal boundaries of the stone.

Slide 74 - General view of interior of northernmost (control) channel showing typical surface finish.
- capping stones are bush hammered, lower courses are coarse pointed.
- stones are sound.

Slide 75 - Surface finish of the stones of the northernmost (control) channel.
- note absence of margin.

The majority of the stones are sound.

There would be easy access for cranes and trucks to the canal facilities under consideration at Cornwall.

Discussion

1. Rock Type: In order of decreasing importance, the stones of the Rideau Canal consist of sandstone, limestone and dolomite. The sandstone
Chief, Restoration Services Division

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is much the harder stone and is much more resistant to weathering and deterioration. In fact, it has proven to outlast both the limestone and, more recently, concrete. The sandstone has a distinctive and variable colour in comparison with the dull greys of the limestone and dolomite.

The limestone found at Cornwall appears to be sound and durable. It matches in colour and texture the limestone found on the Rideau. The Cardinal blocks of limestone and dolomite are definitely inferior from a durability point of view, with the exception of the stones in the abandoned bridge pier. The dolomite is darker brown colour than the light buff of the Rideau Canal sandstone. The Cardinal limestone is a darker grey than the Rideau or Cornwall limestones.

2. Colour: If the stones of the Rideau locks were to be cleaned at any time, no doubt colour matching would play an important role in the choice of replacement stones. A principal conclusion of the study of the Rideau locks is, however, that if the stones are left the way they are, the variety of colours is so great that matching would be virtually impossible - even with new stones from the old quarries! With time, of course, it is likely that even initially mismatched colours would weather to resemble the present conditions along the Rideau canal. This is particularly so if one considers the bacterial attack and algae growth below the waterline and the leaching of salts from the mortar above the waterline. It could be argued that the final results would be more consistent if a match was made of the type of rock. This is debatable.

Presumably the quality of the water and atmosphere will not change in the foreseeable future so that the present weathering and contamination processes will continue.

3. Dimensions: All the stones along the Rideau and at Cornwall and Cardinal are large. Certainly the stones at Cardinal and Cornwall are large enough to be compatible with the Rideau Canal stones. If necessary, the height of the stones can be changed partway along a course and still be blended into a wall. This has been done for example at Brewers and Washburn without difficulty.

4. Surface: The stones of the Rideau are planar with fine working (tooling) of the surface. Similar stones are found only in the bridge pier at Cardinal. It is this feature which means that all other stones at Cardinal and the Cornwall stones would have to be dressed before they could be used in the Rideau Canal. Given the fact that modern pneumatic tools make the dressing of stone far less laborious than it used to be, the re-working of replacement stones should not be a large hurdle to overcome both technically and economically.

5. Access: Stones could be won quite readily from both Cardinal and Cornwall. Access to the Rideau Canal locks varies, of course, but workboats could be used to transfer the stone from road access points to the canal structures as required.
Conclusions

1. Purists would maintain that since the major rock type along the Rideau is sandstone, this type of rock should be used for replacement stones. The sandstone also happens to be the most durable of the stones along the Rideau. No sandstone is found at Cardinal or at Cornwall.

2. Limestone and dolomite were used on the Rideau, so the limestone and dolomite found at Cardinal and Cornwall should be acceptable generically.

3. The colour of the stones at Cardinal and Cornwall would blend in just as well (or as poorly?) as the natural stones would along the Rideau given the weathering conditions and contamination that prevails. They would certainly blend in better than the concrete which has become so widespread.

4. Stones from the old bridge pier at Cardinal could be used interchangeably with stones along the Rideau in their present condition.

5. Re-working of the surface of the canal stones at Cardinal or Cornwall would be required if they are to be used for the Rideau. This should prove no great handicap.

6. The use of stones from Cardinal and Cornwall is feasible from the point of view of logistics.

7. The poorer quality and finish of the Cardinal canal stones makes the sound Cornwall stones preferable for restoration work.

Acknowledgement

This work was carried out with the able assistance of Dr. Pierre Gélinas of the Geology Department, University of Ottawa.

Yours truly,

D. H. Shields, P.Eng.,
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TERMS OF REFERENCE

Investigation of Stone Masonry at Rideau Canal System

1. Objectives

The Department intends to replace some deteriorated masonry on the Rideau Canal with material from other abandoned Canals:

The Consultant shall identify the stones and determine the feasibility of the project.

2. Scope of Work

2.1 The Consultant shall visit selected parts of the Canals to carry out his on-site examinations:

A. Rideau Canal (5 typical locks from the following)
   - Hartwell Locks & Hog's Back Locks at Ottawa
   - Section between Smith Falls and Kingston Mills

B. Abandoned Canals
   - Cornwall Locks
   - Cardinal Canal
   - Soulange Canal

2.2 Both on the Rideau Canal and at the Abandoned Canals the Consultant shall examine and identify the stone masonry:

   - Mineralogical (Generic) Classification
   - Colour and Texture
   - Dimensions, shapes, tooling and surface finish
2.3 The Consultant shall submit a report on his findings:

- describe the stones found at the Rideau Canal and at
  the Abandoned Canals, according to Para. 2.2.
- provide a comparison between the stones, by
description and with references to Colour Charts.

2.4 The Consultant shall provide recommendations on the feasibility
of reusing the stones from the Abandoned Canal on certain
sections at the Rideau Canal. His recommendations shall be
based on the following:

- compatibility of stones, by colour, texture, size, mineral
  origin, tooling, etc.,
- feasibility of removing, transporting and re-cutting the
  stones, with special attention to technical difficulties.
Appendix B

SURFACE FINISHES FOR MASONRY

BATTED means having a surface comprising a series of parallel grooves formed with a wide batting regularly spaced across the face of the stone. The number of grooves may vary from five to ten per inch.

COMBED means having all irregularities on the exposed surfaces of soft stones worked off by the use of a drag or comb.

DABBED means fine and close sparrow-pecked with a sharp point.

DRESSED means having any kind of worked finish.

FLUTED means having a surface worked into a regular series of concave grooves.

PICKED or PECKED is a dressing obtained by means of a point tool or pick.

PITCHED is a surface produced by a pitching tool so as to resemble the natural rock face.

RUSTICATED refers to a stone which has a sunken, dressed margin.

TOOLED is a surface showing the mason's tool marks.

APPENDIX C

NOTES ON THE GEOLOGY OF OTTAWA-CORNWALL AREA

Ordovician Rocks

1. Beekmantown. Nepean Formation
   Lower limit: precambrian; upper limit: first dolomitic or calcareous bed.
   Quarry in Nepean Township.

   Description:
   - cream-coloured sandstone, weathering grey and mottled with irregular rust spots
   - towards the SW margin and to some extent in the eastern part it has a red tinge
   - coarse quartz sand (ave. 99.31%)
   - rounded grains, sometimes angular (shore facies; oceans and bars!)
   - some grains show secondary growth of quartz; much of cement is siliceous
   - top of formation, the cement in place is CaCO₃ or rust-staining iron oxide
   - varieties of bed height: few inches to 2-5 feet thick
   - origin: from precambrian rocks (gneisses of sedimentary origin rather than igneous)
   - relation to other rocks: over precambrian under other Paleozoic rock.

   References: A. E. Wilson, 1966

2. March Formation

   Definition and contacts
   Lie above Nepean and below Oxford
   Most of time conformable
   Lower contact at lowest dolomitic layer
   Very often interbedding with Nepean sandstone
   Upper limit set at last thickness of sand
   "Water bearing zone"
Description:
- alternating grey sandstone and sandy dolomite, or blue grey dolomite
- weathering dark rusty brown
- large sand grains, rounded, loosely cemented
- some thick dolomite beds have pockets 1-3" with large crystals of calcite
- transition between Nepean sandstone and Oxford dolomite
- beds at base (more sandy) are 2-2-1/2 ft, top (dolomite) 8-10"

Shallow-water deposit; thickness of formation varies.

References: A. E. Wilson, 1946.

3. Oxford Formation

Between March and Rockcliffe Formations
Lower limit: last layer of sand in March Formation
Upper limit: unconformable

Description:
- thick-bedded, rusty-weathering dolomite
- in places, changes laterally to limestone
- hard, spherical masses in dolomite, weathering concentric (0.5 - 2.0 ft)
- some shale in upper beds
- lower dolomite beds have some large crystals of calcite
- western edge of basin, dolomite is impure with mud, some sandstone

Thickness: very thick; no complete section.

Minor: Rockcliffe Formation

4. St. Martin Formation

Above Rockcliffe, below (unconformable) beneath Ottawa limestone

Description:
- mainly limestone
- in western margin and at base, shaly and dolomitic limestone with some shale and sandstone
- thick beds of impure limestone to the east
- dolomite weathers rusty, limestone remains gray.
5. **Ottawa Formation**

Above St. Martin, followed by black limestone and shale of Eastview

**Description:**

- dominant limestone; some shale and sandstone at base
- a little shale persists as shaly partings upward

**Three phases:**

**lower:** basal deposits, shale, some sandstone, impure limestone and dolomite

**middle:** pure, thick-bedded crystalline limestone (some beds weather rubbly)

**upper:** shale minor and thin limestone -- thick limestone of variable quality.
Slide 19  Lock 32
Poonamalie

Slide 20  Lock 32
Poonamalie  North-east
Slide 21  Lock 32
Poonamalie  North-east

Slide 22  Lock 32
Poonamalie
Close-up of north east pier
Slide 53   Lock 48
Kingston Mills

Slide 49   Lock 49
Kingston Mills   East side
Slide 55
Cardinal  east half
north side

Slide 56
Cardinal  Canal lining