



Public Works
Canada

Travaux publics
Canada

Western Region

Région de l'Ouest



D003069

MACKENZIE HIGHWAY, N.W.T., MILE 448.0 TO MILE 490.0
FINAL DESIGN SUBMISSION AMENDED OCTOBER, 1974

ERRATUM SHEET

For narrative portion of Final Design Submission - Mackenzie Highway
Mile 448.0 - 490.0 - Amended October 1974

Page 10 - Culvert Velocity Table

The culvert inlet velocities for fish migration design should read:

Creek Mile 469.0 9.0 f.p.s.

Creek Mile 486.3 8.0 f.p.s.



MEMORANDUM

NOTE DE SERVICE

TO
À

Mr. W. R. Binks
Program Manager (Civil)
Design & Construction
OTTAWA, Ontario

FROM
DE

F. E. Kimball
Project Manager NWT Roads
Western Region

SECURITY - CLASSIFICATION - DE SÉCURITÉ

000023

OUR FILE - N/RÉFÉRENCE

9305-52-300

YOUR FILE - V/RÉFÉRENCE

DATE

October 15, 1974

SUBJECT
OBJET

FINAL DESIGN SUBMISSION - MACKENZIE HIGHWAY
MILE 448.0 - 490.0 - AMENDED OCTOBER, 1974

In accordance with the DRCG meeting of December 14, 1973 and subsequently as requested by the Director of Engineering and Architecture Branch, two (2) sets of design plans with varying degrees of information were developed; one for review purposes and one for contract purposes.

Review Purposes - E.W.G.

Enclosed are twenty-four (24) copies of the narrative portion of the above-noted Design Submission. Two (2) sepia mylar copies of the plans have been forwarded under separate cover.

Six (6) copies of the narrative and one (1) set of sepia mylar copies of the plans have been forwarded to Mr. C. Amos of D.I.N.A. in Yellowknife. Single copies of the narrative and a single set of prints have been forwarded to D.O.E. in Edmonton and Winnipeg and E.M.R. in Calgary.

Contract Purposes - D.I.N.A.

One (1) set of sepia mylar copies of the design plans for the above-mentioned Submission have been forwarded to G. D. Reid of E and A for printing and distribution and one (1) set of prints has been forwarded to Mr. C. Amos of D.I.N.A. in Yellowknife.

Items included in the Review Set of the design plans, in addition to the information included in the Contract Set of the Design Plans are:

- (i) Location and nature of all off-take ditches plotted on the orthomapping.
- (ii) Cross sections of cuts and fills over fifteen feet plotted on the Plan-Profile Mile Sheets.
- (iii) Plan shape of every borrow area and planned location of access roads by a line marking the precise boundary of the natural ground surface proposed to be disturbed.


F. E. Kimball

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INTRODUCTION

The Final Design Submission, Mile 448 to Mile 490, amended October, 1974 has been prepared as a resubmission to include the Information Omissions as observed and noted by the Project Manager in the review of the Final Design Submissions, Mile 428 - 470 and Mile 470 - 490.

The reader should note that this report forms part of a total design resubmission, the major portion of which is contained in separate plan form.

CHAPTER 1

REFERENCE: Response to Information Omissions
Noted in Letter of Direction for
Final Design Submission, Mile 348 -
390, d.d. January 15, 1974.

INFORMATION OMISSIONS

The information omissions for the 'Final' Design Submission, Mile 348 to 390 noted in our letter to you dated January 15, 1974 have also been noted in this design submission. You are therefore requested to ensure this information is provided in subsequent submission for this section.

As noted in our letter of May 21, 1974 two sets of plans (one for review purposes and one for contract purposes) will be required in order to provide the requested information.

1. Orthophoto Mapping

As the orthophoto mapping requested was not available at the time the interim final design submission was submitted, you are requested to submit the final design with the orthophoto mapping as soon as it becomes available.

- Orthophoto mapping has been included on the Mile Sheets of the Final Design Submission, Mile 448 - 490 amended October, 1974.

2. Ditching

- (a) *The location and nature of all off-take ditches should be plotted on the orthophoto mapping to the detail and accuracy that can be determined from information available.*
- *All off-take ditches have been plotted as requested.*
- (b) *Typical Design Details of other methods of special treatments for ditches that will be employed in addition to the variable spacing of ditch checks are requested.*
- *Appendix A of this report describes the various methods proposed for special treatment for ditches. Typical details of ditch blocks, ditch checks and ditch linings are illustrated on the "Typical Drawings for Erosion Control" sheet contained in the Final Design Submission, Mile 448 - 490 amended October, 1974.*
- (c) *Please provide an explanation of how ditch checks will be protected against crest erosion whenever flow occurs during periods when culverts upstream from ditch checks are frozen solid together with more design information about ditch checks. In*

particular, details concerning size, shape, method of construction, composition, design lifetime and maintenance requirements are requested.

- It is obvious confusion of interpretation between ditch checks and ditch blocks still exists. Appendix A of this report should clarify the intended meaning of a ditch check and the "Typical Drawings for Erosion Control" Sheet of the amended Final Design Package contains a typical drawing of a ditch block.
- Assuming the above comment refers to ditch blocks, it is intended that maintenance will provide that culverts upstream from ditch blocks are opened prior to spring run-off.
- Construction of the ditch block is similar to embankment construction. Details concerning size, slope and rip-rap are contained in the typical drawing of ditch blocks.

3. Cross Sections of Cuts and Fills

Please ensure that cross sections for all cut and fill sections over 15 feet are provided on all future final design submissions. Please note that the letter of direction dated December 10, 1973 requested that the

sideslope angles for the design sections, wherever possible, take into account the material type to be used in the cut or fill.

- Cross sections for all cut and fill sections over 15 feet have been provided in the Final Design Submissions Mile 448 - 490 amended October, 1974.
- The slope angles for material type to be used in cut or fill sections as recommended by Acres, Volume 1, Geotechnical Investigations, Mile 346 - 450 have been considered as being over conservative. The more realistic slope angles for slope stability as determined by the design team, are indicated on the cross sections for cuts and fills over 15 feet.

4. Borrow Areas

It is noted that not all of the information requested by our Letter of Direction dated December 10, 1973 has been provided. All information available to D.P.W. should be submitted on the 1"=200' mapping. The information should continue to be shown on the 1"=1000' mosaics as well.

If at any time subsequent to the submission of a Final Design, requirements for borrow areas additional to those shown on the design plans are identified, this Department should receive for approval:

- (a) a plan showing areas where new pits are to be

developed accompanied by all the information required for borrow areas;

- (b) a plan indicating those borrow areas that are to be increased in volume by a factor greater than three or in areal extent by a factor greater than three over the anticipated sizes indicated by the Final Design Submission along with all relevant information.

- All information on borrow areas available to D.P.W. at the time of this Design Submission has been included on the 1"=200' orthomapping and on the 1"=1000' mosaics.

5. Effects of Construction on Fish and Wildlife

After consultation with the Canadian Wildlife Service and Fisheries Service you are requested to provide specific recommendations regarding limitations in construction operation, practice and scheduling to protect wildlife and fish.

Discussions with the above agencies are now in progress and specific recommendations will be forthcoming.

6. Waste Material Disposal Sites

Information as requested by the letter of direction dated December 10, 1973 on waste material disposal sites other than borrow pits was not provided with the design submission. It is understood that the only waste material disposal sites contemplated between Miles 348 - 390 are borrow pits. However, in such cases, written confirmation is requested.

- Completed borrow pits have been chosen as disposal sites for waste material, if required, for this section, Mile 448 - 490.

7. Submission of Final Design Plans

As noted in the letter of May 21, 1974 two sets of plans (one for review purposes and one for contract purposes) will be required in order to provide the requested information.

- Two sets of design plans have been prepared; one for review purposes and one for contract purposes.

Distribution of the two sets of design plans is outlined in the opening Memorandum of this Report.

CHAPTER 2

REFERENCE: Letter of Direction for Final Design
Submission Mile 428 - 470 d.d.
June 15, 1974

I. Information Omissions

The information omissions for the 'Final' Design Submission, Mile 348 to 390 noted in our letter to you dated January 15, 1974 have also been noted in this design submission. You are therefore requested to ensure this information is provided in the subsequent submission for this section.

- The information requested is provided in Chapter 1 of this report.

II. Alignment

1. Horizontal

The horizontal alignment from Miles 445 to 470 has been previously approved.

- No comment required from Department of Public Works.

2. Vertical

The vertical alignment within the approved section appears to be well integrated with the landscape and continuous with the horizontal alignment.

- No comment required from the Department of Public Works.

3. Typical Cross Sections

Typical cross sections have not been provided for the approach cuts and fills at a number of stream crossings which require bridges. It is recognized that this is due to the fact that bridge design elevations had not been firmly established when the roadway design was submitted for review. It is requested that these typical cross sections be provided with the amended final design submission or as part of the bridge design submission.

- Typical cross sections for the approach cuts and fills at stream crossings for which bridges are being designed have been included in this Design Submission.

III. Drainage

1. Culverts

- (a) It is requested that culvert inlet velocities for design discharge be provided for all large culverts and that inlet velocities and exit velocities be provided at fish migration discharge for those culverts subject to fish migration design criteria. Please note that this is a change from an earlier request that culvert inlet velocities be provided at

fish migration discharge for all
large culverts.

- The above request has been included in the hydrologist's culvert sheets contained in the amended design package, Mile 448 - Mile 490 and has been summarized as follows:

Culvert Velocities

Design Discharge				Fish Migration Discharge		
Creek Mile	Exit Velocity f.p.s.	Inlet Velocity f.p.s.	Max. Velocity Inside Culvert f.p.s.	Exit Velocity f.p.s.	Inlet Velocity f.p.s.	Max. Velocity Inside Culvert f.p.s.
454.2	7.6	9.8	9.8			
457.6	5.0	9.1	10.7			
461.0	5.1	8.4	15.4			
461.6	10.5	12.0	15.4	3.4	7.6	9.7
463.4	5.6	9.0	10.3			
463.8	6.2	10.4	14.8			
465.3	4.7	8.6	9.5			
466.0	4.9	9.5	11.7			
469.0	13.0	14.4	15.4	4.8	4.8	9.7
473.2	10.2	11.6	20.5			
479.1	10.5	14.5	22.2	3.7	9.1	14.5
481.0	8.4	11.2	15.9			
482.1		NOT REQUIRED				
483.6	6.8	8.5	8.5			
485.5	5.2	6.0	6.0			
486.3	10.5	12.8	17.8	4.6	4.6	11.3

- (b) *It is agreed with your environmental consultants that only the culverts located at Mile 461.6 and Mile 469.0 require fish migration design. However, the proposed use of baffles may not prove to be satisfactory. As of this date, the final results of the MHEWG sponsored Baffle Study are not available.*

D.P.W. has become aware of the Burlington Baffle Study and is currently arranging a prototype baffle installation on the Hire North training section.

- (c) *Fisheries Service have suggested that a wide-span elliptical culvert would be preferred at Mile 461.6. We would appreciate receiving your comments regarding the feasibility of using such a culvert at this location.*

The unfortunate experience with installations of wide-span elliptical culverts during the 1974 spring and summer seasons has influenced the decision to discontinue the use of such culverts.

- (d) *When streams are identified as having moderate to high fishery potential, scheduling constraints should be indicated. If scheduling constraints are not considered important at a particular culvert, it should be so indicated. For the design submission Mile 428 to 470, scheduling constraints have not been indicated for the culverts located at the following mileages: 430.0, 436.5, 454.6, 459.7, 461.6, 469.0.*

Scheduling constraints requested above are covered in Division 1, Section 2 of the draft specifications which states:

"No construction activity or alteration or diversion of a stream channel will be permitted in the construction of bridges and culverts in excess of 60 inch diameter in the period from May 15 to July 15 each year."

2. Special Treatment of Ditches

(a) Appropriate silt trapping devices should be installed to ensure that silt does not enter the stream at Mile 469.0.

- By using through grade culverts and ditch blocks at the top of both hills minimum run-off water is permitted to enter the cut. The cobble lining of the ditch bottoms in these cuts will prevent ditch bottom erosion and should provide sufficient trapping capacity of the anticipated silt from the backslopes until revegetation of the backslopes has been established.

(b) There are a number of locations where large cuts are proposed which will concentrate run-off water into ditches. Concern has been expressed that sufficient protection should be provided at the ditch outlet to achieve dispersion of this flow without undue erosion. Please indicate how this protection will be achieved.

One particular area of concern is Mile 486 - 487 where there is a 50-foot drop from the end of the ditch to the nearest creek or culvert and the grade is relatively steep.

- The use of through grade culverts, ditch blocks and off-take ditches at the upper end of large cuts will minimize run-off water from entering these cut sections. During the preconstruction surveys the field construction engineer will also determine the need for upslope interceptor ditches along the right of way parallel to the cut section, to divert larger quantities of run-off water away from these areas. Minimizing the quantity of run-off and contour blading and blending of the ditch cut onto the vegetated topography at the cut transition, should provide reasonable dispersion of the flow without undue erosion.
- (c) *Concern is expressed that at Mile 440 - 441, Station 325 to 347 an additional culvert may be required as the culvert spacing may be extreme for the gradients encountered.*
- This area is not included in this Design Submission.

- (d) *A significant difference exists between the drainage area determined by your consultant and that determined by the Hydraulic Assessment Sub-Group for the culvert at Mile 448.2. Please request your consultant to verify their information on this culvert.*

Bolter, Parish and Trimble Ltd., the hydrologist consultant, has checked this area in the field and they are satisfied that the drainage area is about 0.5 square miles.

(e) At Mile 469, Station 1174+25 the plan-profile sheets indicate a spring on the east side of the grade. Please indicate how the flow from this spring will be handled.

- The flow from this spring will be handled by the thirty-six inch culvert designed for this location.

IV. Soils

(a) Additional geotechnical data is required for the revised alignment from Miles 445 - 447 (Revision 319) including deep hole information for the cut at Station 120 - 136 and Miles 460 - 462 (Revision 322). This information should be collected when the additional geotechnical information required for the Wrigley area is collected.

- Miles 445 - 447 are outside this Design Submission. In Revision B22, Miles 460 - 462, additional geotechnical data was obtained in the cut at Station 994+00 in the October, 1973 helicopter supported test drilling. It was considered unnecessary to test drill the rest of this section at that time for the design called for an overlay construction.

(b) Additional geotechnical information is also required for the deep cuts proposed north of Hodgson Creek at Station 2220, and north of Ochre River at Station 627. Each of these cuts should have at least one borehole extending fifteen feet below the gradeline.

- Hodgson Creek is not in this Design Submission.

The centreline and borrow area geotechnical information obtained around the Ochre River in 1972 by Underwood and McLellan and Associates Limited, geotechnical consultants, indicates the cut area and the borrow areas are in the same formation, unfrozen granular material. Since the borrow area is downslope from the centreline it is expected the granular material at the centreline extends well below the gradeline.

(c) It is requested that information on the nature of vegetation mat be provided for locations where cuts having vertical backslopes are proposed.

(d) You are referred to the discussion in the attached report, on the use of vertical backslopes at Mile 453 and Mile 469. In the light of existing geo-

technical information, it is felt that the locations selected for the use of vertical backslopes may not achieve the desired results. The use of vertical backslopes should be reconsidered and further drilling undertaken prior to or during construction to confirm the suitability of the design by gathering more information of ground ice at these locations.

- (e) At locations where vertical cuts are proposed, adequate silt traps should be provided to prevent silt from entering adjacent streams.
- A reassessment of the areas in which vertical backslopes were proposed indicated 2:1 backslopes with slope protection would be more applicable for these areas.
- (f) DPW has previously indicated that additional geotechnical data was planned for collection at Mile 459, Stations 884 - 890. If collected, this information has not been made available to date. If the information is still outstanding, it should be collected with the additional work required in the Wrigley Area.

- The additional geotechnical information at Mile 459 mentioned above is still outstanding and can be collected during the additional work required in the Wrigley area.
- (g) *Please indicate if a quarry site is now proposed within the section Miles 443 to 446. If a site is proposed, please provide what information is available to DPW concerning the site.*
- This area is outside the limits of this Design Submission.
- (h) *The borehole information indicates locally high ice content soils at Mile 463, Stations 1084+00 to 1092+00. The cut at this section should be replaced by overlay construction to minimize thermal erosion.*
- The cut in this section has been replaced by overlay construction in the amended Final Design Submission.
- (i) *Concern has been expressed that locally high ice content soils may exist in the cut area proposed at Mile 461, Stations 984+00 to 997+00. The advisability of a cut at this section will have to be confirmed by the geotech information to be collected on the revision from Miles 460 to 462.*

- In reviewing the geotechnical data contained in the Geotechnical Consultant's report on borrow areas it was found the revised alignment passed through a tested area.

Test holes 461-B-103B and 461-B-102B which are on the revised centreline indicate no excess ice making this cut feasible. Therefore, no change in gradeline was instituted in this area.

- (f) *Concern has also been expressed that locally high ice content soils may exist in the cut and fill area proposed at Mile 448, Stations 264+00 to 311+00. As it is impractical to completely avoid excavation in this area, please indicate what action could be taken to minimize thermal erosion should ice-rich soils be encountered in the cut areas during construction.*

- If high-ice soils are encountered during construction the gradeline will be raised to minimize cutting. For areas where excavations can not be avoided thermal erosion will be minimized by employing methods as described in Chapter 7 of the Mackenzie Highway General Design Data - Mile 297 - 543.

V. Borrow Areas

1. Location

- (a) For all borrow areas located near streams or water bodies adequate sediment trapping devices should be installed and maintained. Adequate supervision should also be maintained during borrow pit operation so as to minimize potential erosion and siltation problems.
 - Steps will be taken to ensure that drainage from borrow areas during excavation will not enter streams or water bodies.
- (b) The borrow area located at Mile 454.2 should be located so as not to encroach upon the stream bank and to avoid any disturbance to, or siltation of, the stream.
 - The borrow area in the amended Final Design has been located so as not to encroach upon the stream bank.
- (c) The borrow area at Mile 469.0 should be relocated to ensure a greater distance from the stream entering the Mackenzie River at this location.
 - The borrow area has been moved at least two hundred feet farther away from the stream.

2. Location of Borrow Area Access Roads

- (a) The access road for the borrow area proposed at Mile 454.2 should be relocated so as not to closely parallel the stream.
- (b) The more northerly access road to the borrow area at Mile 463.8 which necessitates crossing a stream, should be eliminated.
- (a) The access road to the proposed borrow area at Mile 454.2 has been relocated sufficiently back from the stream.
- (b) The more northerly access road to the borrow area at Mile 463.8 has been eliminated. The more southerly access road to this borrow area is now the only access proposed in the amended Final Design Submission.

VII Wildlife Resources

The report Basic Environmental Data, Folio 1, November 1972 by F. F. Slaney indicated a potential impact area at Miles 445 - 446 due to raptor (nesting) throughout the area. The Environmental Data Sheets accompanying the Final Design Miles 428 - 470 make no mention of raptor nesting at this location. Please explain this difference between the preliminary and final designs.

This area is outside the limits of this Design Submission.

VIII Aesthetics

- (a) When clearing areas where vertical backslopes are to be used, please ensure that sufficient treed vegetation is hand cut, with stumps as described in Specification for Hand Clearing, March 1973, to prevent trees from slumping into the ditches.
- (b) Where possible borrow pit access roads should follow existing man-made openings such as geotech access roads or seismic lines.
- (c) Appropriate selective clearing and revegetation procedures will be carried out after road bed construction.
- The above recommendations will receive due consideration during construction.

CHAPTER 3

REFERENCE: Letter of Direction for Final Design
Submission - Mile 470 to 490 d.d.
June 15, 1974.

I INFORMATION OMISSIONS

The information omissions for the 'Final' Design Submission, Mile 348 to 390 noted in our letter to you dated January 15, 1974 have also been noted in this design submission. You are therefore requested to ensure this information is provided in subsequent submission for this section.

The information requested is provided in Chapter 1 of this report.

As noted in our letter of May 21, 1974 two sets of plans (one for review purposes and one for contract purposes) will be required in order to provide the requested information.

Two sets of design plans have been prepared; one for review purposes and one for contract purposes.

II ALIGNMENT

1. Horizontal

The horizontal alignment for Mile 470 to Mile 490 has been previously approved.

No comment required from the Department of Public Works.

2. Vertical

The vertical alignment appears to be well integrated with the landscape and continuous with the horizontal alignment.

No comment required from the Department of Public Works.

3. Typical Cross-Sections

Typical cross-sections for the fills at the Rainbow Creek Bridge should be provided, either with the amended design submission or as part of the bridge design submission.

Typical cross-sections for the fills at the Rainbow Creek Bridge have been included in this design submission.

III DRAINAGE

1. Culverts

(a) Please examine and report on the possibility of reducing the slope of the culvert at Mile 479.1.

- The Hydrologist Consultant indicated the fixed alignment prevented the reducing of the culvert slope.

(b) The culvert located at Mile 485.5 may be designed for normal discharge only.

- This was done, no further comment required.

(c) Fisheries Service assessors feel that the length of the circular culvert at Mile 486.3 could produce an increased hazard to fish migration. Therefore, consideration should be given to the use of a horizontal elliptical culvert which should produce lower velocity flows at the lower water levels.

- The pipe at Mile 486.3 has been left as a circular pipe, for the use of horizontal ellipses is not being considered at this time because of structural failures experienced elsewhere in N.W.T.

2. Ditching

(a) Appropriate sediment trapping devices should be installed along the southern approach to the culvert at Mile 479.1 to ensure that silt carried by the runoff does not enter the stream.

A through grade culvert with ditch blocks at Station 646+00 will provide a diversion of right of way drainage in this area allowing for dispersion prior to re-entering the stream.

- (b) Please indicate how the water from the channel bed being cut off at Mile 473, Station 946+00 will be routed.

The culvert and ditch blocks at Station 946+00 will provide through grade drainage of the channel bed indicated above.

IV SOILS

- (a) At two locations deep cuts with steep gradients are proposed:

- (i) Mile 473 - Stations 934 to 948 and
- (ii) Mile 478 - Stations 661 to 671.

Appropriate measures should be taken as soon as the slopes are exposed to ensure the stability of the backslopes.

The moisture contents of these areas as indicated in the geotechnical report do not appear to be detrimental in causing instability to a 2:1 back-slope. However, if during construction, higher moisture contents are encountered flatter back-slopes will be used.

- (b) Concern has been expressed that slope instability and stream siltation may occur in the cut proposed at Mile 470, Stations 1110-1114 as nearby boreholes indicate a mixture of materials and ice content. Information on the nature and distribution of ground ice at this location should be obtained and forwarded to this Department for evaluation prior to construction.

This concern has been noted and information on the nature and distribution of ground ice at this location will be obtained and forwarded prior to construction.

- (c) Please indicate how stability of the cuts at the following locations is to be realized:

- (i) Mile 481 - Station 521+00
- (ii) Mile 486 - Station 248+00

- (i) Mile 481 - Station 521+00
Stability of the cut at this location will be provided if necessary by over excavating the backslope and backfilling with granular material.

(ii) Mile 486 - Station 248+00

Slope instability is not likely to occur in this cut, for a study of the aerial photographs indicates the formation in which this cut is located is represented by test hole 486-C-274B which records clay with a few cobbles and a moisture content of less than ten percent.

- (d) *It is understood that although D.P.W. intended to obtain additional geotechnical information for the cut proposed at Mile 478, Stations 660-670, it proved impossible to gain access to the site via helicopter. Please indicate if D.P.W. feels that additional geotechnical information is still required at this site and how it could best be obtained. If it is felt that additional information is not required, please indicate why.*

It is considered the helicopter test hole 478-C-36 drilled at Station 684+00 was in the same geological formation as the cut at Station 660-670 and, therefore, additional geotechnical information in this cut area is not required at this time.

V BORROW AREAS

The access roads to the borrow areas at Miles 478.5 and 479.8 should be reassessed to ensure that these areas are not visible from the highway. If these areas are visible from the roadway, the access roads should be dog-legged.

Borrow area access roads for the above pits have been re-aligned to provide a minimum visual impact.

APPENDIX "A"

SPECIAL DITCH TREATMENT

Amended June, 1974

SPECIAL TREATMENT FOR DITCHES

Roadway and offtake ditches are often necessary elements in highway design and construction. These ditches require the removal of the vegetative cover from their respective areas, thus increasing the potential for scour erosion.

This scour erosion in highway ditches is dependent upon numerous factors including discharge, channel gradient, sediment in water, soil characteristics such as grain size, density, organic binder, cementation and ice content.

Some methods used in highway construction to control or prevent scour erosion are: blanketing the ditch floors with stable, free-draining granular materials, reducing the effective ditch gradient by constructing a series properly spaced ditch checks on the ditch floor and by diverting run-off water out of the ditch onto natural vegetation by using ditch blocks.

Design equations exist for open channel flow, which relate flow velocity to the gradient and cross-sectional configuration of the channel. The Manning formula, is such an equation and is commonly employed for open channel flow calculations. The formula is as follows:

$$V = (1.486/n) R^{2/3} S^{1/2} \quad (1)$$

where V=velocity of water, in feet per second
 R=hydraulic radius (water area divided by
 wetted perimeter)
 S=slope of channel gradient, in feet per foot.
 n=Coefficient of Roughness (Manning's "n")

One of the principles followed in designing the Mackenzie Highway was to avoid excavation in permafrost wherever and whenever possible. Therefore, the use of standard engineering texts for use in non-permafrost areas was considered applicable for deriving ditch lining and ditch check spacing charts for the Mackenzie Highway.

When cuts through ice-rich permafrost areas are unavoidable it is intended to sub cut and back fill with a sufficient depth of ice-free material, which would provide soil conditions similar to non permafrost areas.

The Handbook of Steel Drainage and Highway Construction Products, second Edition, 1971, lists limiting velocities for non erosion of channels. The following tabulated Manning's "n" and limiting velocities for the general soil types found on the Mackenzie Highway right-of-way are excerpts from this Handbook.

TABLE 1

<u>Material</u>	<u>Manning "n"</u>	<u>Velocity ft./sec. For Clear Water</u>
Fine sand	.020	1.50
Silty sand	.020	1.75
Fine gravel	.020	2.50
Stiff clay	.025	3.75
Coarse gravel		
Well graded gravel	.025	4.00
Cobbles	.035	5.00
Shale, hard pan	.025	6.00

Using the limiting velocities as tabulated above and Manning's formula, discharge versus gradient curves were calculated for a twelve foot wide "B" type road ditch. (See figure 2).

Ditch Lining

For a given soil type a curve in Figure 2 indicates the limiting discharge for a given gradient above which scour erosion may occur. Therefore, theoretically, by lining the ditch with an adequate depth of material selected higher in the graph scour erosion should be arrested or minimized.

Ditch Checks

As an alternate to ditch lining ditch checks, within their limits, would be adequate and possibly more economical in some areas for scour prevention.

See Figure 7 of this report for a schematic explanation of ditch check theory.

Figures 3 to 6 inclusive of this report are recommended ditch check spacing charts calculated for discharges up to 20 c.f.s. over various soil types. The derivation of these ditch check spacing charts was based on the effective gradient required for non-erosion of a soil type at a given discharge.

Due to the physical limitations of the highway ditch depth the ditch check crest is one foot above the ditch floor. A forty-foot minimum spacing of ditch checks was considered to be reasonable for construction, maintenance and effectiveness.

Discharge Determination

The Rational formula developed in 1889 by sewage engineers is probably the most widely used formula for estimating discharges. The formula is:

$$Q = CiA. \quad (2)$$

where

Q = discharge in c.f.s.

C = the run-off coefficient

i = the intensity of rainfall in
inches per hour.

A = the drainage area in acres.

This approach with the following modifications was considered to be an acceptable one for small drainage areas up to about one square mile.

Bolter, Parish, Trimble, consulting engineers, have in their publication, Hydrology Study and Design of Culverts, Mile 297 to Mile 345, Mackenzie Highway, November, 1972, developed a modified Rational formula for large drainage areas in the following form:

$$Q_i = 26.7 A R r (100 - L) M \quad (3)$$

where Q_i = maximum instantaneous discharge
- c.f.s.

A = drainage area - square mile

R = rainfall in 24 hours

r = rainfall reduction factor

L = percent water loss

M = conversion factor mean daily discharge
to maximum instantaneous.

Rationalizing the variables in the above formula as they are effected in the Mackenzie Valley small drainage areas the following empirical formula was developed for estimating small drainage area discharges:

$$Q = .584 C A \quad (4)$$

where Q = maximum instantaneous discharge in c.f.s.

C = run-off coefficient

A = drainage area in acres.

(a) - ".584" is the resultant of 26.7, R, r, M and the conversion of square miles to acres ($\frac{1}{640}$)

"R" - 4 inches per 24 hours was considered a conservative estimate.

"r" - 1.0 was used since no appreciable reduction can be expected in small drainage areas.

"M" - a value of 3.5 was considered conservative for small drainage areas.

(b) - "C" - run-off coefficient is similar to (100-L).

Bolter, Parish, Trimble arrived at an "L" value of 75% for large drainage areas (550 acres and greater). The accepted run-off coefficient for concrete and pavement is 0.8 suggesting a water loss of 20%. It was considered conservative to use this 20% water loss for drainage areas of 45 acres and less. Joining these limits with a parabolic curve, expected water losses for intermediate drainage areas were interpolated and converted to the following run-off coefficients:

TABLE 2

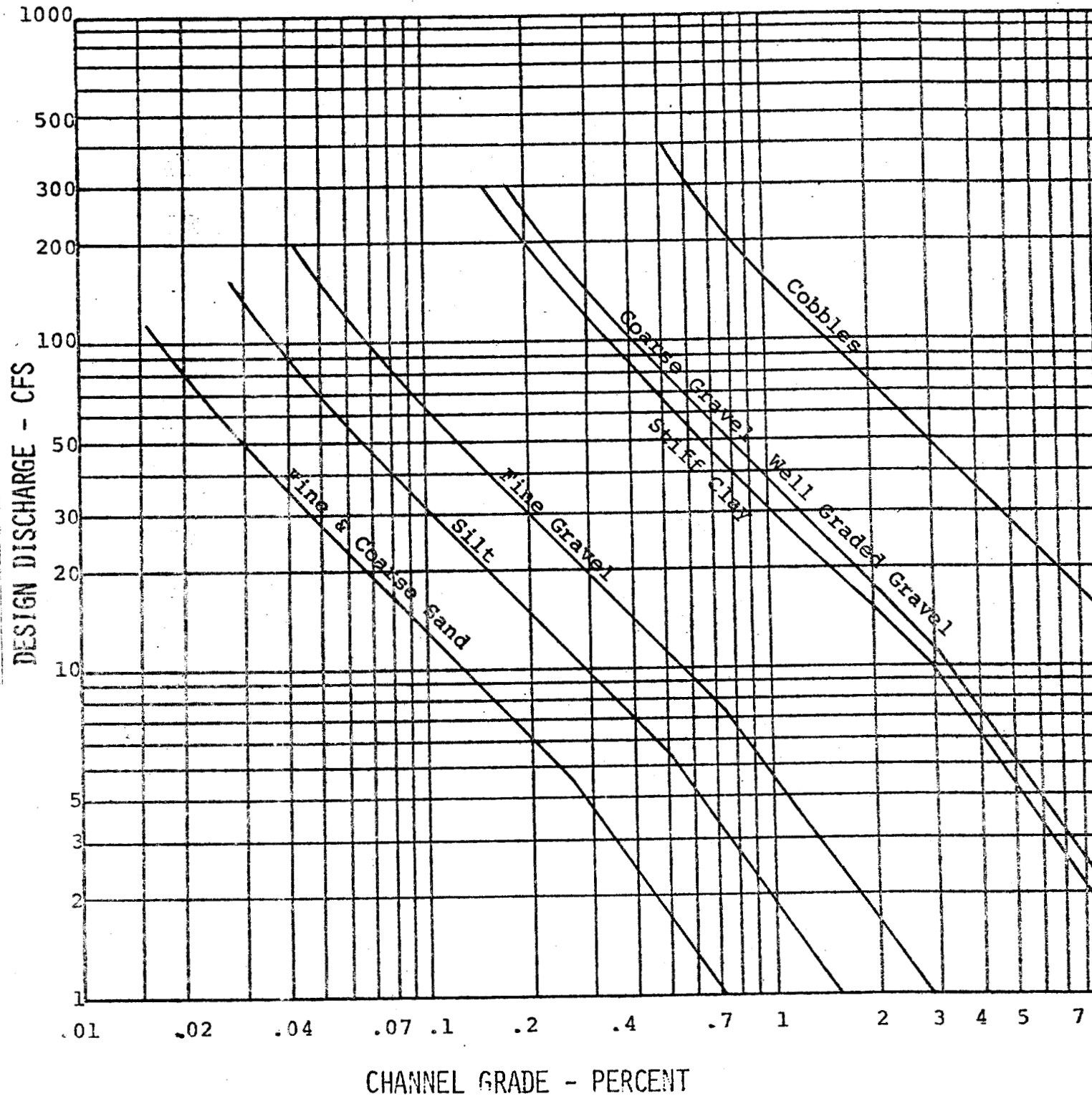
Expected run-off coefficients for small drainage
areas in the Mackenzie Highway

<u>Acres</u>		<u>"C"</u>
Up to 45	-	0.80
Up to 98	-	0.65
Up to 222	-	0.50
Up to 550	-	0.25

The selection of a particular type of ditch treatment or whether it is required will ultimately rest on the experience of the resident engineer.

Figure 2

LIMITING CHANNEL GRADES FOR THE DESIGN OF "B" TYPE DITCHES



DITCH CHECK SPACING
(DESIGN DISCHARGE - 3 CFS)

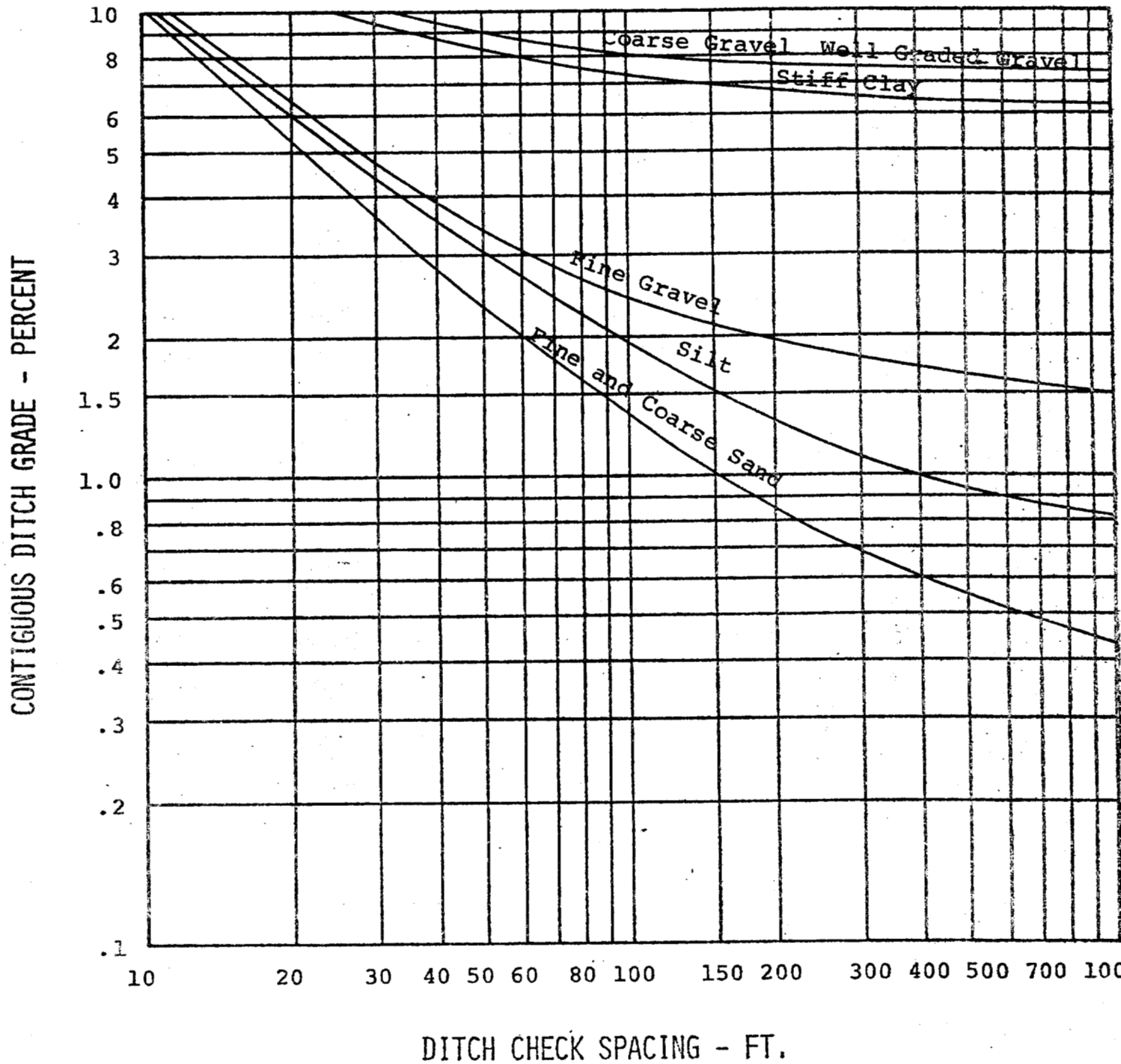
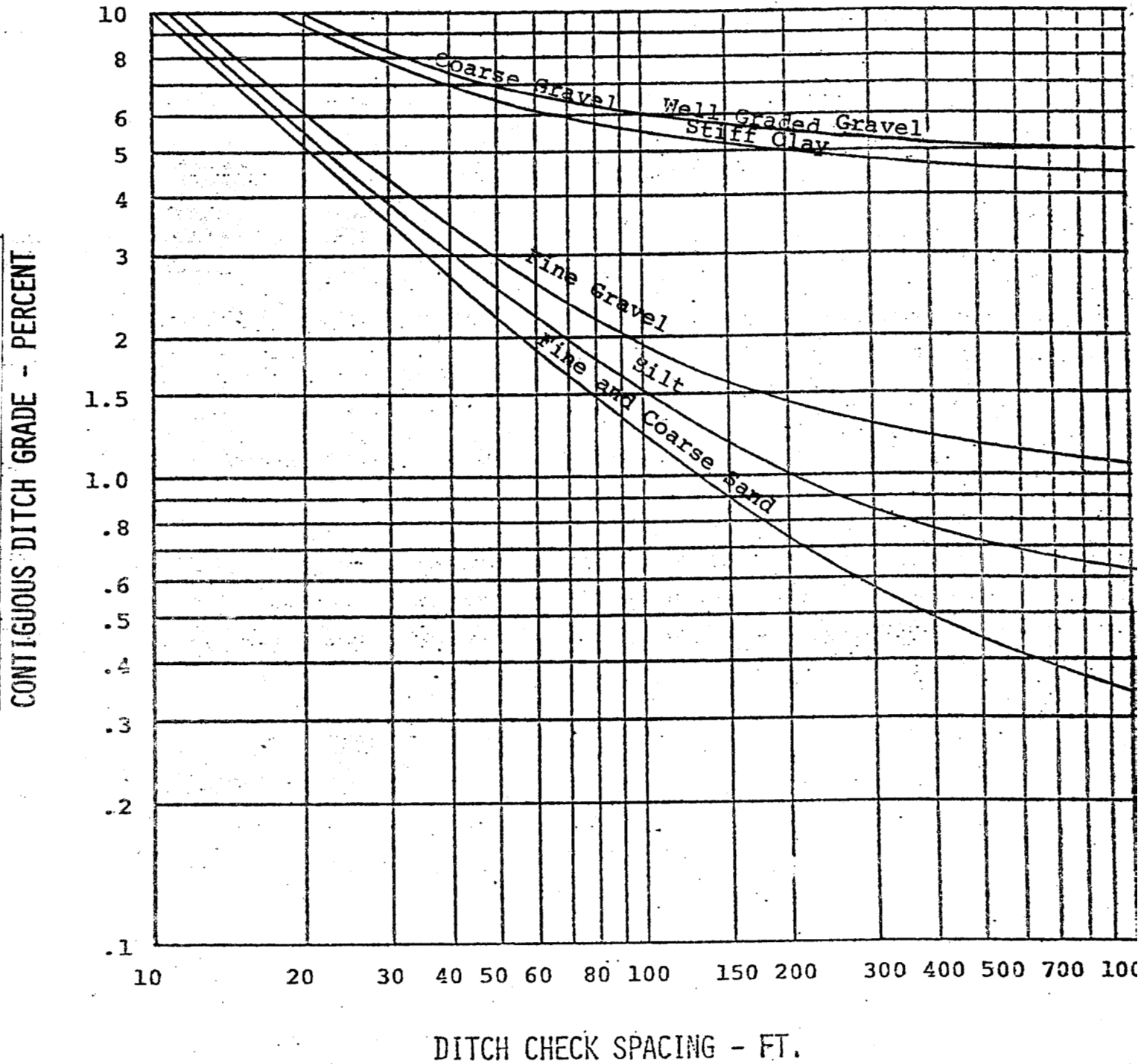


Figure 4

DITCH CHECK SPACING

(DESIGN DISCHARGE - 5 CFS)



DITCH CHECK SPACING
(DESIGN DISCHARGE - 10 CFS)

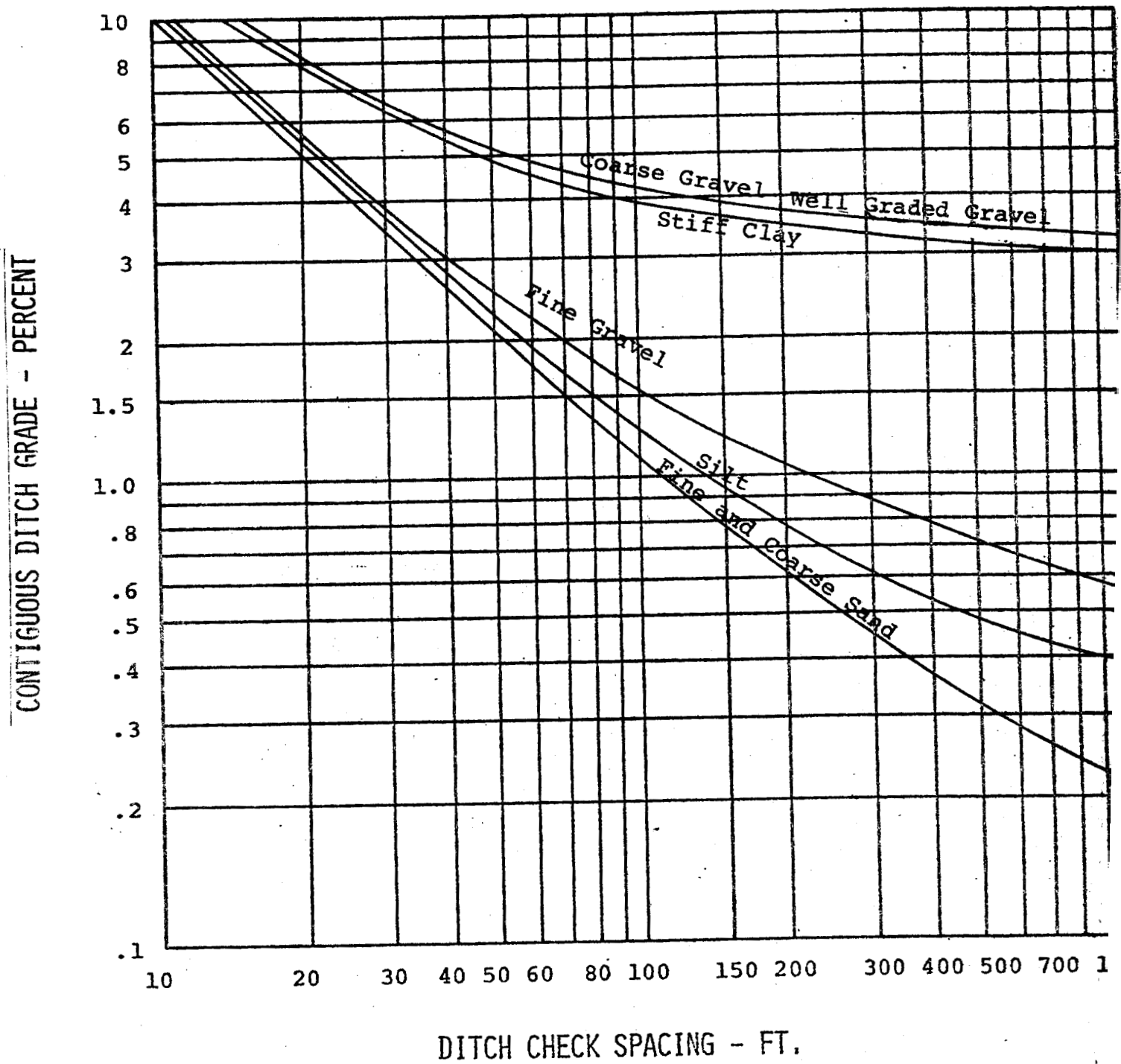
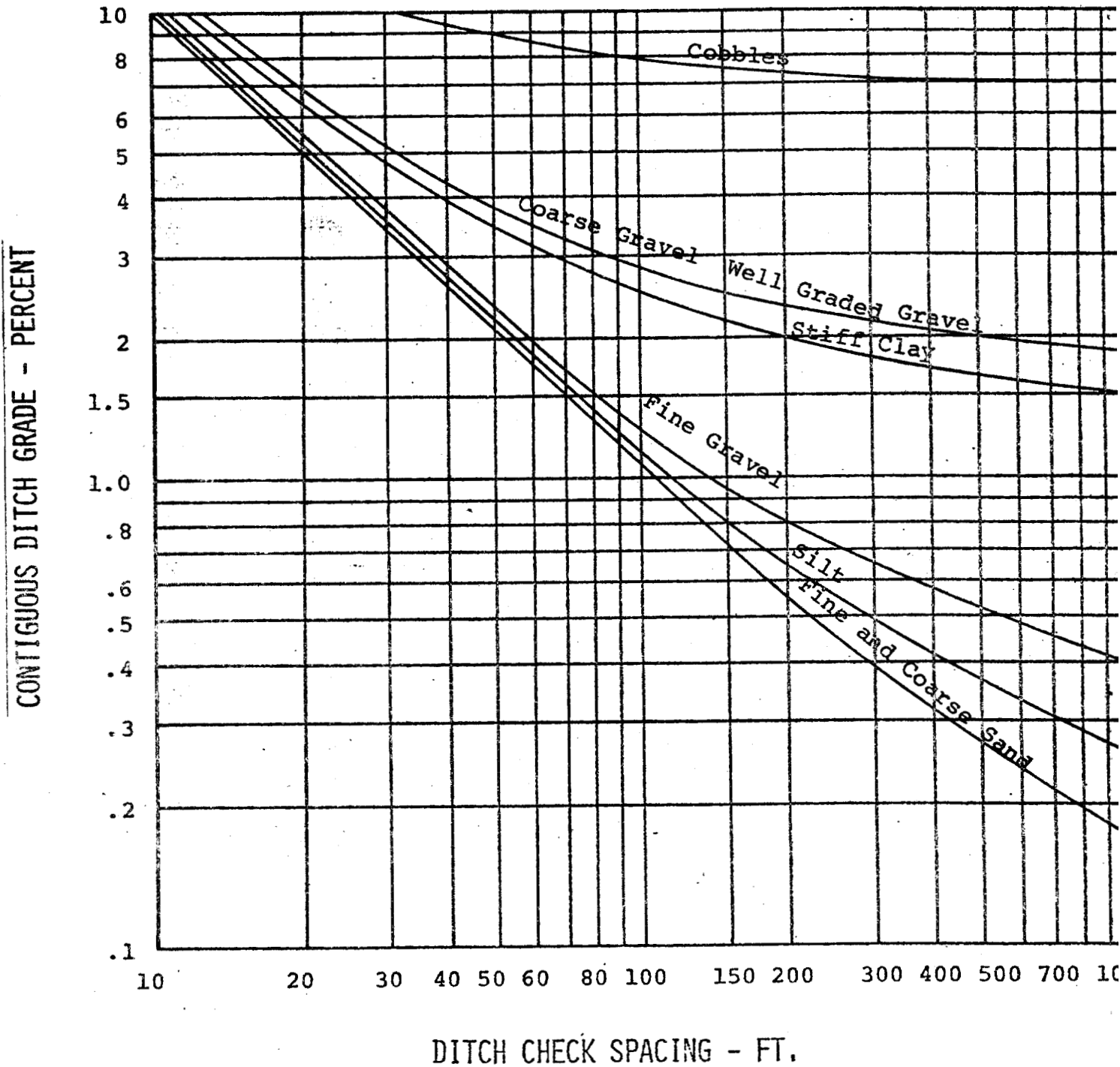


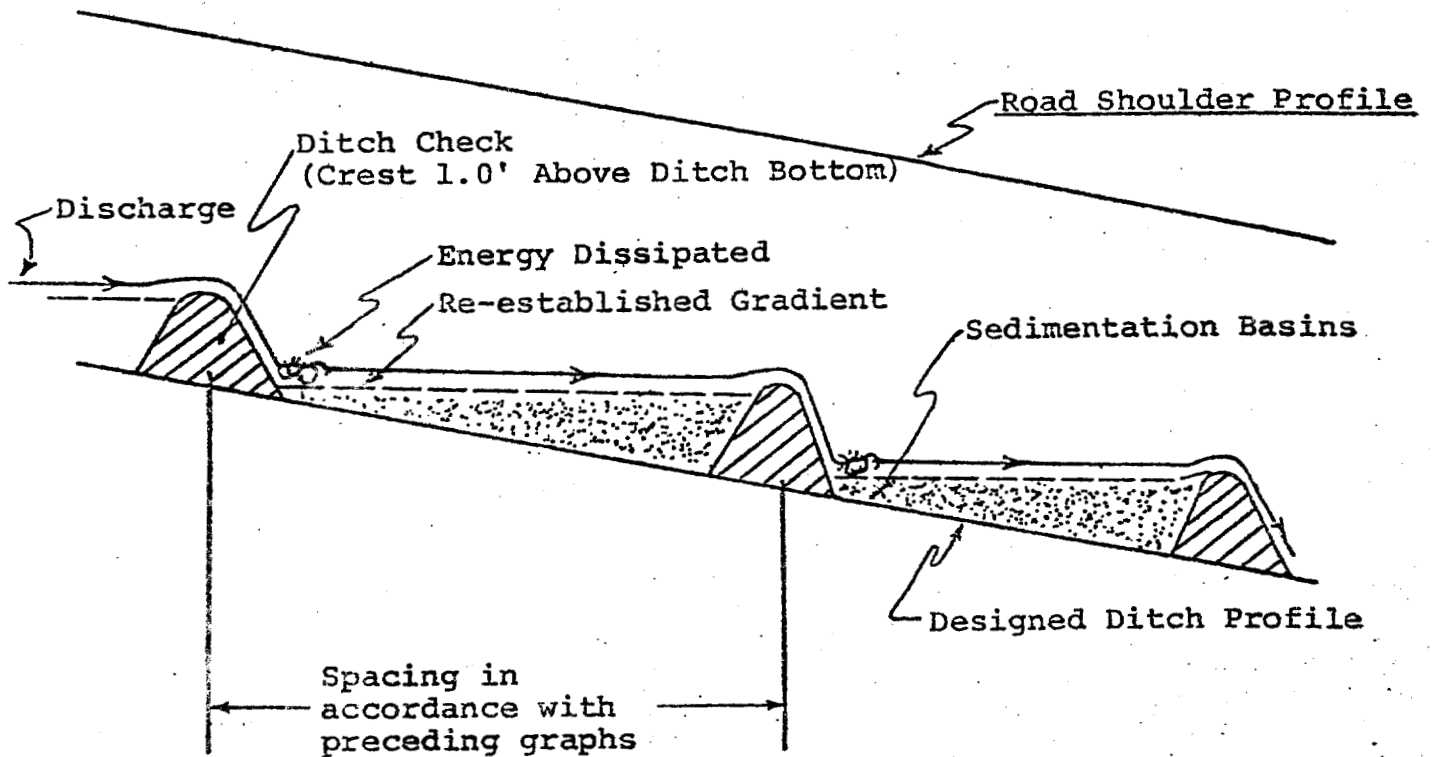
Figure 6

DITCH CHECK SPACING

(DESIGN DISCHARGE - 20 CFS)



DITCH CHECKS



- The ditch checks will be constructed with non-erodible materials.

APPENDIX "B"

HYDROLOGY SUMMARY

HYDROLOGY SUMMARY

MILE 448.0 - MILE 470.0

Part 1

MILE				448.2	454.2	457.6	461.0	461.6
Drainage Area (A) TOTAL (sq. miles)				.5	4.5	1.8	\triangle .8	\triangle 5.9
Qhwm (c.f.s.)				-	290	140	110	685
Drainage Area (Ae) EFFECTIVE (sq. miles)				.5	3.9	1.8	.6	5.9
Relief (feet)				75	350	250	250	500
(100 - L) Water Retained for Runoff				.19	.21	.20	.20	.21
Rainfall (inches in 24 hours)				3.5	3.5	3.5	3.5	3.5
M Ratio				4.50	3.97	4.14	4.50	3.82
Qe (c.f.s.)				40	304	139	50	442
Drainage Area (A1c) LAKE CONTROL (sq. miles)				-	.6	-	.2	-
Relief (feet)				-	50	-	50	-
(100 - L)				-	.19	-	.19	-
Rainfall (inches in 24 hours)				-	3.5	-	3.5	-
Q1c (c.f.s.)				-	11	-	4	-
Drainage Area (Am) MUSKEG (sq. miles)				-	-	-	-	-
Qm (c.f.s.)				-	-	-	-	-
Q rational (c.f.s.) (Qe + Q1c + Qm)				40	315	139	54	442
Q design				40	315	140	110	685

\triangle Drainage area determined at abandoned alignment. Increased area at new alignment downstream deemed not significant since Q design based on slope area method.

HYDROLOGY SUMMARY

MILE 448.0 - MILE 470.0

Part 2

MILE	463.4	463.8	465.3	466.0	466.6	469.0
Drainage Area (A) TOTAL (sq. miles)	1.2	1.5	2.7	2.3	.7	17.6
Q _{hwm} (c.f.s.)	112	100	310	130	50	570
Drainage Area (A _e) EFFECTIVE (sq. miles)	1.2	1.5	2.7	2.3	.7	17.6
Relief (feet)	350	400	600	450	300	2050
(100 - L) Water Retained for Runoff	.21	.21	.22	.21	.21	.28
Rainfall (inches in 24 hours)	3.5	3.5	3.5	3.5	3.5	3.5
M Ratio	4.18	4.16	4.07	4.10	4.40	3.40
Q _e (c.f.s.)	98	122	225	185	60	1565
Drainage Area (A _{lc}) LAKE CONTROL (sq. mi.)	-	-	-	-	-	-
Relief (feet)	-	-	-	-	-	-
(100 - L)	-	-	-	-	-	-
Rainfall (inches in 24 hours)	-	-	-	-	-	-
Q _{lc} (c.f.s.)	-	-	-	-	-	-
Drainage Area (A _m) MUSKEG (sq. miles)	-	-	-	-	-	-
Q _m (c.f.s.)	-	-	-	-	-	-
Q rational (c.f.s.) (Q _e + Q _{lc} + Q _m)	98	122	225	185	60	1565
Q design	110	120	310	185	60	1565

HYDROLOGY SUMMARY

MILE 470.0 - MILE 490.0

MILE	473.2	479.1	481.0	482.1	483.6	485.5	486.3
Drainage Area (A) TOTAL (sq. miles)	3.7	47.0	4.9	1.2	2.1	4.0	14.1
Qhwm (c.f.s.)	450	3250	370	125	150	175	1225
Drainage Area (Ae) EFFECTIVE (sq. miles)	2.7	37.5	4.9	1.2	2.1	4.0	14.1
Relief (feet)	300	2200	1150	350	850	850	600
(100 - L) Water Retained for Runoff	.21	.29	.24	.21	.23	.23	.22
Rainfall (inches in 24 hours)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
M Ratio	4.07	3.13	3.89	4.18	4.11	3.96	3.45
Qe (c.f.s.)	215	3180	427	98	188	340	1000
Drainage Area (A1c) LAKE CONTROL (sq. mi.)	1.0	9.5	-	-	-	-	-
Relief (feet)	50	1700	-	-	-	-	-
(100 - L)	.19	.27	-	-	-	-	-
Rainfall (inches in 24 hours)	3.5	3.5	-	-	-	-	-
Q1c (c.f.s.)	18	240	-	-	-	-	-
Drainage Area (Am) MUSKEG (sq. miles)	-	-	-	-	-	-	-
Qm (c.f.s.)	-	-	-	-	-	-	-
Q rational (c.f.s.) (Qe + Q1c + Qm)	233	3420	427	98	188	340	1000
Q design	450	3420	430	125	188	340	1225

PLANNING ONLY
NOT FOR CONSTRUCTION

APPENDIX "C"

DRAFT SPECIFICATIONS

1.1.1 Description

Description of the contract limits will be inserted.

1.1.2 Location

Location of the contract limits will be inserted.

1.1.3 Project Access
and Services

- .1 See Construction Schedule Specification, (Division 1, Section 2) for time restrictions on various methods of access.
- .2 Fort Simpson, Mile 300 on the Mackenzie Highway, has access by public road and by commercial aircraft. The road is open year round except for a period in the fall when the ice forms on the Liard River and in the spring when the Liard River ice breaks up.
- .3 Wrigley, Mile 436 of the proposed Mackenzie Highway, has access by an all-weather air strip and by barge landing.
- .4 There is no public road access to the site of the work.
- .5 The Contractor's attention is drawn to the following access restrictions to the project.
 - (a) Depending on the contract limits possible, barge access landing sites from the following list will be inserted.

1.1.3 Project Access
and Services
cont'd

- Mile 454 (Ochre River South) Barge access is at the confluence of the Ochre River and the Mackenzie; on the south side, a borrow pit exists adjacent to the landing. Access road would be direct to the right of way a distance of approximately a quarter mile.
- Mile 455 (Ochre River North) Barge access would be slightly downstream on the Mackenzie from the confluence with the Ochre. Access from the barge landing to the right of way is direct, a distance of approximately a half mile. This is a better access than the one at Mile 454. Any access in this area must consider the necessity to construct a temporary bridge over the Ochre River.
- Mile 459 (White Sands Creek) Barge landing is possible on either the north side or the south side of the White Sands Creek as it enters the Mackenzie. Access from the barge landing to the right of way is approximately 1,000 feet at either location and both are feasible. A minor temporary structure over the White Sands should be sufficient during the major portion of the year.
- Mile 469 (No Name Creek) Barge access is possible to the south and to the north of the confluence of this creek with the Mackenzie River. Ready access is available to the right of way a distance of less than 1,000 feet; a borrow pit is planned north of the creek and there is a substantial cut south of the creek - both materials are sandy gravel. A small temporary structure over the creek should be sufficient for the major portion of the year.
- Mile 471.5 (Rainbow Creek) Barge landing sites exist to the south and to the north of the confluence of Rainbow Creek in the Mackenzie. Access is available from either landing site to the right of way a distance of only a few hundred feet. A small temporary structure would be required across the Rainbow Creek through the major portion of the year.

1.1.3 Project Access
and Services
cont'd

- Mile 485 (Hire North Camp) There is an existing barge landing and access road constructed at this point by Hire North. The access road leads to the winter airstrip and is in relatively good condition although it has a fairly steep grade.

(b) Final loading date for equipment and material for shipment by barge is governed by the barge company and is generally in early September.

(c) Access may be possible via winter road to the project. However, there is no guarantee that this winter road will be open during the life of the contract.

.6 The above information on access is for guidance only and it will be the responsibility of the Contractor to familiarize himself with access to the site and with the availability of transportation and other services.

.7 The Contractor will be permitted to construct a maximum of two airstrips on sections of the roadway. For the airstrips the roadway surface will be widened to a maximum of 50 feet for a maximum length of 2,000 feet. The clearing will be widened to a maximum width of 200 feet for a total length of 4,000 feet, i.e. for the length of the runway plus 1,000 foot approaches to the runway. The locations of the airstrips will be subject to the approval of the Engineer in writing. Measurement for payment for the construction of the airstrips will be in accordance with the appropriate Unit Price Table items. Maintenance will be performed at no cost to the Department.

1.1.4 Schedule of
Work

See Construction Schedule Specification, (Division 1, Section 2) for details.

1.1.5 Land Use
Regulations

Land Use Permit No. issued to this Department, grants it the authority to carry out the work described in the Specifications and Plans subject to the Territorial Land Use Regulations of the Territorial Land Use Act and the operating Terms and Conditions of the Permit. A copy of the Permit is included in and forms part of, these specifications. The Contractor will be required to operate within the terms of the Permit.

1.1.6 Control of
Materials

The source of rock, gravel, sand and/or loam material will be located and designated by the Engineer, and will be made available to the Contractor. Royalties payable to the Crown under the Territorial Quarrying Regulation for rock gravel, sand and/or loam are hereby cancelled for the purpose of carrying out work under this contract.

1.1.7 Terms and
Definitions

Right of way: The area designated by the Engineer necessary for the construction of the roadway.

Roadway: The area of the right of way within the construction limits of the grading and drainage.

Culvert: A structure not classified as a bridge, which provides an opening under the roadway.

1.1.8 Plan Profile
Drawings .1

The profile elevations differ from the elevations shown on the 1" to 200 foot orthophoto mapping.

The profile elevations are elevations established in the field from departmental Bench Mark Elevations. The orthophoto mapping elevations are based on a separate map datum and indicate the difference in elevations of the general terrain, with the accuracy obtainable from aerial photogrammetry being approximately within one-half ($\frac{1}{2}$) the elevation difference between contours in open areas and within one quarter ($\frac{1}{4}$) the height of the trees in wooded areas. Where there is a discrepancy between the mapping and profile elevations, the profile elevations will govern.

.2 Where there is a discrepancy between plan and the profile relative to the horizontal location, the profile will govern subject to final layout for the culvert in the field by the Engineer.

1.1.9 Measurement of
Quantities .1

Linear: All linear measurements shall be based on horizontal distances, except as noted in Division 9, Section 6 (C.M.P. culverts).

1.1.9 Measurement of .2
Quantities
cont'd

Volume

- .1 In computing volumes of excavation, borrow and embankment, the average end area method will be used except as otherwise decided by the Engineer.
- .2 When materials are to be measured in the haulage vehicle, the vehicle shall be of a size and type acceptable to the Engineer. Unless approved vehicles are of uniform capacity, each must bear a plainly legible identification mark indicating its specific approved capacity. Loads shall be levelled and measured at the point of delivery and no allowance will be made for settlement of the material while in transit.
- .3 Material specified to be measured by the cubic yard may be weighed and such weights shall be converted to cubic yards for payment purposes. Factors of conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of measurement of pay quantities will be approved by the Engineer.

.3 Weight

- .1 The term ton shall mean 2,000 pounds avoirdupois.
- .2 All materials which are specified for measurement by weight shall be weighed on scales approved by and at locations designated by the Engineer. Trucks used to haul material being paid for by weight shall be weighed empty at such times as the Engineer directs, and each truck shall bear a plainly legible identification mark.
- .3 Weight measurements shall be made by a weightmaster provided by the Department using scales and a scale house provided by the Contractor. The scales shall be of suitable design and of sufficient capacity to accommodate any vehicles used on the work and shall be inspected and tested for accuracy as often as may be

1.1.9 Measurement of
Quantities cont

required by the Engineer. The scale house shall be weatherproof and constructed to afford protection for the recording device of the scales. It shall be of suitable size, having one sliding window facing the scale platform, one end window and a shelf desk at least 2 feet wide and 6 feet long. Doors shall not open onto the scale platform. The Contractor shall provide adequate lighting and heating.

- .4 If material is shipped by rail, the car weight will be accepted.

1.1.10 Construction
Interruptions
Resulting from
Environmental
Protection
Requirements

The Contractor will be required to temporarily cease operation on sections of the project for reasons of protecting the Environment. The Contractor shall cease work upon written instruction from the Engineer and will not recommence his operation before permission in writing is obtained from the Engineer.

The Contractor shall schedule his operations so that productive work can continue on sections of the road outside the areas listed for environmental protection during the periods of constraint as outlined in the Construction Schedule Specification, Division 1, Section 2.

When unscheduled shutdown of the Contractor's operation has been ordered for reasons of protecting the environment other than those specified in Division 1, Section 2 and when, in the opinion of the Engineer, productive work can not be performed on other sections of the project, the Department will make compensation for machinery and labour standby costs will be as follows:

- .1 Production Equipment Standby: Production Equipment is only those units listed in the following group: scrapers, dozers/rippers, front end loaders, trucks larger than 8 cubic yards, rock drills, compressors, back-hoes, shovels over 1/2 cubic yard. The formula to be applied in determining standby costs for a piece of equipment shall be 50% of the current "Alberta Roadbuilders

1.1.10 Construction
Interruptions
Resulting from
Environmental
Protection
Requirements
cont'd

Association Rental Rate," less the cost quoted in those rates of operator, which will apply only up to 10 hours per day, 5 days per week and to a maximum monthly of 200 hours.

The following example illustrates the method of determining such a standby rate based on the 1974 schedule of rates:

D-9 Cat complete with Dozer and Ripper (\$49.00+\$8.50)	= \$57.50
Less operator (Schedule A, Group 2)	= 6.15
Bare rental	= 51.35
Standby rate @ 50% bare rental	= 25.68

- .2 Labour Standby: Labour standby costs will be paid only for those operators assigned to production equipment. The costs of labour standby shall be according to General Conditions "C", Clause 45. The Contractor will be required to present copies of his payroll records to support any labour costs claimed under this section.

1.1.11 Barricades and
Warning Signs

The Contractor shall at no expense to the Department, provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals and other signs and take all necessary precautions for the protection of the work and the safety of the public.

1.1.12 Project Signs

The Contractor shall erect and maintain the standard Department of Public Works sign(s) supplied by the Department. Measurement for payment for the erection and maintenance of the sign(s) will be made on a Change Order in accordance with Clause 45 in the General Condition "C". The signs will be supplied by the Department.

1.1.13 Layout of
Work

.1

The Engineer will set stakes and establish bench marks to indicate the location, alignment and reference elevations for the work. This will include the setting out of one set of clearing flagging, grubbing stakes, offset baseline, bench marks, work or slope stakes, culvert plugs and two sets of second grade stakes.

.2

Any re-staking resulting from the careless operations of the Contractor will be at the Contractor's expense.

1.1.14 Maintenance of
Work During
Construction

.1

General

The Contractor shall maintain all work during construction. The maintenance shall constitute continuous and effective work, prosecuted day by day, with adequate equipment and forces to the end that the roadway or structures, are kept in a condition at all times satisfactory to the Engineer.

.2

Roadway

- (a) Ruts and ridges caused by machinery or vehicles shall be removed on the completed or partially completed roadway.
- (b) Any portion of the road opened to traffic, shall be kept free of snow.
- (c) Prior to spring thaw, snow shall be removed from the top of the road for the full length of completed or partially completed construction as directed by the Engineer.
- (d) On completion of the project and before the project is accepted by the Engineer, the Contractor will grade the surface of the entire route in one continuous operation.

1.1.14 Maintenance
of Work During
Construction
cont'd

(e) Maintenance except as provided in 1.1.15.3 will not be measured separately for payment, but will be considered incidental to and included in, the various Unit Price Table items.

.3 Icing of Culverts:

The Contractor will be required to thaw iced culverts so as to ensure that culverts are functioning during the period of spring breakup. The Department will provide a mobile steamer for this purpose and the Contractor will be responsible for operating and maintaining this unit and will return it to the Engineer in good condition upon completing this work. This work will be measured for payment as a Change Order in accordance with Clause 45 of the General Condition "C".

1.1.15 Use of Road-
way During
Construction

Vehicles of the Government of Canada and the Northwest Territories will be allowed access within the limits of the contract at all times; however, the Contractor may close the road to the general public during construction. Should others request permission to use any section of the constructed roadway prior to completion, authorization can be granted upon consultation with, and written approval from the Engineer.

1.1.16 Forest Protec-
tion and Fire
Fighting Equip
ment

The Contractor shall comply with the requirements for forest protection and fire fighting equipment regulations as outlined in the Land Use Permit and the Forest Protection Ordinance, Chapter 38 of the Revised Ordinances of the Northwest Territories.

The supply of fire fighting equipment shall be incidental to the contract and no separate measurement for payment will be made therefor.

1.1.17 Construction
Camp

The Contractor's camp and service area locations are subject to the approval of the Engineer and shall be set up and operated in accordance with the Government of the Northwest Territories Regulations governing operation of temporary field camps.

1.1.17 Construction
Camp cont'd

The Contractor shall make application to the Controller of Water Rights, D.I.N.A. Box 1500, YELLOWKNIFE, N.W.T., for authorization for the use of water and disposal of domestic sewage wastes at the camp in accordance with the Northern Inland Waters Act. The Contractor shall obtain this authorization prior to camp start-up.

Untreated sewage shall not be discharged directly or indirectly into any natural waters. Depending on camp population, soil condition, climatic conditions and time duration of camp at one site, the following generally are acceptable methods of waste disposal.

- .1 Total underground containment or lagooning by means of:
 - (a) Discharge directly to a suitably cribbed and covered cesspool.
 - (b) Discharge to suitably cribbed leach pit through a septic tank or through a leach cesspool compartment. The septic tank or leach cesspool compartment is for settlement and digestion and for sludge removal as necessary.
 - (c) Discharge to an underground holding pit (which could be a cesspool, leach pit or tank) of at least one week retention capacity and discharge weekly from there to a lagoon via a portable pump and flexhose or other suitable arrangement. The lagoon shall be suitably located and at least 300 feet away from the camp being served.

The lagoon shall have a minimum retention period of one year with a liquid depth of 6 feet to 8 feet with a free board minimum of 18 inches and impervious berms sloped at a minimum of 3:1 with a 10 foot top width. Suitable precaution shall be taken for erosion control.

1.1.17 Construction
Camp cont'd

- .2 Package treatment plants such as rotating Bio Disc, Physical Chemical Plant, etc.

The plants to be sized and operated to produce an effluent of secondary treatment quality.

The Contractor shall make every effort to use water-saving fixtures in the camps such as low water-use toilets and urinals, wash basin taps, shower heads, and washing machines.

- .3 Prior to the installation of the camp and services, a plan of the layout shall be submitted to the Engineer for approval.

The construction camp and service areas shall upon vacation, be left in a condition acceptable to the Engineer.

All costs relating to the Contractor's camp shall be incidental to construction and no separate payment will be made therefor.

1.1.18 Employment of
Native People

- .1 The Contractor's attention is drawn to the following guidelines on the Employment of Native People and Section 27 (2) of General Conditions "C". Notwithstanding all the terms of Section 27 (2), special arrangements are desired for this contract in line with these Guidelines. The Contractor, prior to recruiting his work force, shall meet with the:

Manager, Canada Manpower Centre,
FORT SIMPSON, N.W.T.

and acquaint him of all his labour force requirements.

1.1.18 Employment of
Native People
cont'd

- .1 The Canada Manpower Centre will identify for the Contractor, local residents in the area of the contract who are qualified to perform the duties as outlined by the Contractor and the Contractor must show just cause, in event these qualified local people are not offered employment.

During the progress of the work, the Employment Section, Department of Local Government, Government of the Northwest Territories, will make a Liaison Officer available on site to assist the Contractor with any employment arrangements with the local people.

.2 Project Employment Guidelines

- .1 The prime Contractor and sub-contractors will be required to notify the Canada Manpower Centre of all jobs prior to recruiting his work force and the Contractor agrees to recruit his workers outside the Northwest Territories only to the extent that qualified residents are not available. The Canada Manpower Centre will act as the employment referral agency.
- .2 The prime Contractor will maintain contact with Liaison Officers provided by the Territorial Government. The Liaison Officers will provide counselling services as required for employees and their families.
- .3 The prime Contractor will provide for training-on-the-job contracts to be arranged by the Territorial Government for those indigenous Territorial residents who require special assistance in order to fill available jobs.

1.1.19 Climatic
Conditions

The Contractor's attention is drawn to the severe climatic conditions on the location of the project. Information regarding the climatic conditions can be obtained from the Ministry of Transport.

1.1.20 Environmental Briefings

The successful bidder shall arrange to have all his field staff available for environmental briefings for a maximum of three (3) hours when he has commenced operation of all equipment necessary to perform the work identified as clearing, grubbing, common excavation, channel excavation and overhaul and thereafter approximately every six (6) months.

The Contractor shall provide the facilities for the briefings at his camp. The Department will arrange to have environmental experts available for the briefings and will bear the cost of bringing in these people.

The briefings will be scheduled to fit in with the Contractor's operation (double shift), so as to cause no shutdown of the construction work. The Contractor will choose the time convenient for him within a period of ten (10) days.

No payment will be made to the Contractor for the time that his staff attend the environmental briefing(s).

1.1.21 Winter Road

The winter road previously used from Fort Simpson is shown on the Plans. This road has been operated and maintained by a private company, which has been charging a toll for the usage of the road.

It is the Contractor's responsibility to make any arrangements concerning the usage of the road. The Contractor will be responsible for any toll charges at his own expense.

1.1.22 Additional Information Package

An additional information package consisting of:

- .1 Final Design Package.
- .2 Consultant reports (Environmental and Geotechnical).
- .3 Mass haul diagram.
- .4 Bar Chart of departmental scheduling opinion.

1.1.22 Additional
Information
Package contd

will be available for viewing in Edmonton office and Fort Simpson Area office. The additional information package is intended to provide the Contractor with background information used by the Department in preparing contract documents. This information package will not be part of nor will it be considered as part of the Contract Documents.

1.1.23 Engineer's
Camp & Board

.1 Description: This item will consist of the set up, operating, maintaining, dismantling and moving the Engineer's trailer camp, the supplying of meals, bedding and cleaning services for all equipment and staff as may be required therefor. The Engineer's camp may be located within the Contractor's camp facility subject to approval of the Engineer.

.2 Accommodation: The Department will supply and the Contractor will service in accordance with 1.1.25.1, the following equipment for the exclusive use of the Engineer and his staff for the duration of the work and for as long thereafter as required by the Engineer to complete final measurements.

- .1 One office trailer (10 feet by 50 feet), three (3) eight-man sleeper trailers (10 feet by 50 feet), one (1) ablution trailer (10 feet by 30 feet), one (1) recreation trailer (10 feet by 50 feet).

These trailers will be supplied to the Contractor at the barge landing site on the Mackenzie River at its confluence with the Willowlake River.

- .2 The trailers specified in 1.1.25.2.1 will be placed in a self-contained unit, joined by a minimum 8 foot wide walkway having the same floor elevation as the trailers. The walkway will be weather-proof, insulated and adequately heated and the layout will be subject to the Engineer's approval. If the Contractor has a camp with enclosed weatherproof walkways the Engineer's Camp is to be joined to it, and the Department's ablution trailer will be eliminated and the Engineer's staff will use the Contractor's ablution facilities.

All the trailers specified above will be adequately blocked and weather skirted.

1.1.23 Engineer's
Camp & Board
cont'd

- .3 One only cold storage shed a minimum of 8 foot by 12 foot, weatherproof and equipped with one locking door and one interior lite, will be supplied by the Contractor and placed near the Engineer's Camp.
- .4 There shall be provided near the office trailer five (5) parking places for vehicles complete with five (5) exterior electrical outlets for the exclusive use of the Engineer.
- .5 The trailers supplied by the Department to the Contractor are the Contractor's responsibility from the time he originally moves them from the barge landing site for the duration of the contract. At the completion of contract work, the Contractor will return these trailers to the Department at the barge landing site in the same shape as he received them, normal wear and tear excepted. The Contractor will be responsible for the operation of the trailers at his own expense. The supplying and installing of any replacement parts to these trailers will be carried out by the Contractor and the work will be measured for payment as a Change Order in accordance with Clause 45 of the General Conditions "C".
- .6 Services:
 - .1 The Contractor shall provide all equipment, supplies and labour required to prepare and serve each man on the Department's staff, registered and staying in the camp, or as otherwise designated by the Engineer, meals and services of the same quantity and quality provided for the Contractor. A man will be considered to have been in camp for a full day unless he is signed out twenty-four hours previous. There may be variations in the number of personnel from two to twenty-four over a season.
 - .2 The Contractor shall clean trailers daily and change the linen weekly or whenever a change in personnel occurs. "Linen" shall consist of three (3) blankets, two (2) sheets, one (1) pillow and one (1) pillow cover for each occupant.

1.1.23 Engineer's
Camp & Board
cont'd

.6 Services cont'd

- .3 If the Contractor shows movies, the Engineer's staff shall be allowed to attend these showings.
- .4 A water and sewage system shall be provided by the Contractor and installed, operated and maintained to service the camp. The Contractor shall connect the departmental ablution trailer to this system. The Contractor must include these units in his application under the Northern Inland Waters Act.
- .5 A steady and dependable source of electric power will be supplied by the Contractor. The Contractor shall connect all required trailers and buildings to this source.
- .6 The Contractor shall supply all the fuel requirements for the camp and shall see that each heating unit is kept supplied with fuel and is in good operating condition.
- .7 The Contractor shall dismantle, move and re-establish the camp when the Contractor moves his own camp.

.7 Measurement for Payment:

- .1 Measurement for payment for the camp shall be on a lump sum price for the delivery, set up, moving re-installation and return of the complete camp as specified.
- .2 The quantity of board which will be measured for payment will be the number of mandays that the Engineer's staff is registered in camp and shall include the supply, preparation and serving of meals, cleaning, bedding, fuel, electric power, garbage and sewage disposal and all other labour, materials and equipment required for the operation and maintenance of the camp.

1.1.24 Clearing and
Grubbing

Clearing and/or grubbing shall be in accordance with Division 9, Section 1 of these specifications and will include:

- a) Areas of right of way adjacent to stream crossings.
- b) Right of way widening as directed by the Engineer.
- c) Borrow pits and access roads as directed by the Engineer.

The Contractor is advised that a major portion of the right of way has been cleared by others.

Additional right of way clearing will provide a minimum of fifteen feet from toe of embankment or from top of excavation back-slope.

The Contractor shall advise the Engineer no later than October 1 of each year of the section of anticipated embankment construction between October 1 and April 15. This is to allow time for the Engineer to arrange for necessary flushcutting of stumps within the limits of the embankment, by others.

1.1.25 Excavation

All excavation shall be carried out in accordance with the requirements for Roadway and Borrow Excavation and Channel Excavation, Division 9, Sections 2 and 3.

Excavation Rock or Channel Excavation Rock is not expected to be encountered on this Project and these items are not shown on the Unit Price Table. If, however, during the construction, material is encountered that meets the definition of the above items, measurement for payment for the excavation of these materials will be made on a Change Order in accordance with Clause 45 of the General Conditions "C".

1.1.26 Embankments

The embankment construction shall be in accordance with the requirement for Embankment, Specification Division 9, Section 4.

1.1.26 Embankments
cont'd

- .1 As this project lies within the zone of permafrost, it will be permissible to construct embankment using soils in a frozen state, in a manner designated by the Engineer.
- .2 When constructing embankment with frozen material, the Engineer may direct that the embankment be constructed to a specified height above Grade to allow for settlement that will occur when frozen embankment thaws and consolidates.
- .3 The Contractor is to provide a minimum of:

Required compaction equipment will be inserted.

The Engineer may instruct that additional compaction units be placed on the work if necessary to meet the requirements of the Contractor's schedule.

The above units shall conform with the type of units described in Division 9, Section 4.

- .4 The Contractor is to provide a drying unit of the hinge type offset disk plowing harrow described in Division 9, Section 4.
- .5 Upon callup, a minimum of one (1) full shift of work will be specified by the Engineer for (the drying unit and required compaction equipment to be inserted). Upon callup, a minimum of one (1) hour of work will be specified by the Engineer for the self-powered hand operated tamping units and vibratory roller, type "B".

Notwithstanding minimum callup defined above No Payment will be made for interruptions or downtime of any kind, for any compactors specified in this contract.

1.1.27 Culverts

- .1 The locations of all culverts and the lengths of Corrugated Metal Pipe Culverts as shown on the plans are approximate only. The exact location of all culverts and the exact lengths of Corrugated Metal Pipe Culverts will be determined in the field by the Engineer.

1.1.27 Culverts
cont'd

- .2 The assembly and installation of all culverts shall be in accordance with Division 9, Sections 6 and 7 of the Specifications. All materials required for Corrugated Metal Pipe Culverts and Corrugated Structural Plate Culverts will be supplied to the Contractor by the Department as follows:

Approximate delivery dates and delivery points for contractor pickup will be inserted.

Upon delivery of culvert materials as outlined above, the Contractor shall supply the Engineer with a certificate acknowledging receipt and from then to completion of the project, the Contractor shall assume full responsibility for the materials and shall replace any lost or damaged items at no cost to the Department. The materials will be delivered in bundles, pallets or containers having maximum dimensions of 10 feet wide by 9 feet high by 22 feet long.

- .3 The Engineer may designate that certain of the Structural Plate Culverts be equipped with antibouyant devices and/or end treatments. For such cases, the payment for materials and work required will be negotiated in accordance with Article 45 of General Conditions "C".

1.1.28 Gravel

The source of gravel is not designated on the Plans. Possible sources of gravel are located at Mile 454.5 and at Mile 479.8. Sources discovered during the construction shall be used as directed by the Engineer.

The gravel shall comply with the specifications for Pit Run Gravel, Division 9, Section 8, and will be applied on the road in lifts varying from 2 inches to 4 inches in thickness.

1.1.29 Rip-Rap

The rip-rap placed on this project will consist of STONE RIP-RAP. The stone rip-rap will be hand-placed rip-rap or heavy rip-rap placed in the random manner as outlined in Division 9, Section 11. The type of stone rip-rap to be used at the various sites shall be as designated by the Engineer.

1.2.1 Tender
Schedule

The bidder will submit with his tender a schedule in bar chart form covering excavation, gravel and structural plate culverts and showing the calendar dates on which activities on each of those items will take place for each five-mile section of the contract. This schedule will have to clearly demonstrate that the bidder has examined all of the requirements of this specification, has examined the site conditions, has made himself aware of access problems to the site and is aware of schedule limitations which may be brought about by climatic conditions or Environmental Requirements.

1.2.2 Construction
Schedule

After notification of award of contract the Contractor must prepare a detailed Construction Schedule showing the calendar time planned for clearing, common excavation, traffic gravel, installation of corrugated metal pipe and installation of corrugated structural plate pipe and corrugated structural plate pipe arch on the basis of a mile by mile identification for the total length of the contract.

1.2.3 Scheduling
Details

.1

Milestone Dates

The Contractor's construction schedule must show milestone dates as follows:

Milestone Date 1

The Contractor must have completed all grading work with the exclusion of the placing of traffic gravel by a date to be inserted after contract limits have been decided.

Milestone Date 2

The Contractor must have completed all work including the placing of traffic gravel by a date to be inserted after contract limits have been decided.

.2

Commencement Restrictions

The Contractor's attention is drawn to the following restrictions to the project.

- a) The camp establishment shall be in a location approved by the Engineer.

1.2.3 Scheduling
Details cont'd

.2 Commencement Restrictions cont'd

- b) The commencement of construction will be controlled by the conditions outlined in the Land Use Permit which forms a portion of this contract.
- c) The access road from the barge landings to the right of way should be constructed during the late summer or fall.

.3 Environmental Protection Schedule Restrictions

The following constraints have been imposed for protection of the Environment during the construction period. During any shutdown listed in 1.2.3.3 (a), the Contractor will be responsible for any resulting costs as the Contractor shall so schedule his operations that alternative work can be carried out during the shutdown period on other sections of the Highway.

- a) No construction activity or alteration or diversion of a stream channel will be permitted in the construction of bridges and culverts in excess of 60" diameter in the period from May 15 to July 15 each year.

.4 Terrain & Material Restrictions

The responsibility for the detailed examination and planning of all activities in the construction schedule will rest with the Contractor. Other than the restrictions and milestone dates indicated above the Contractor will have full freedom to plan and schedule his operations. However, in determining the schedule of operations, the Contractor should consider the terrain and material conditions outlined below:

- a) The materials to be used for borrow and excavation from Mile 448.0 to 461.3 can be expected to be near the plastic limit. This material can be placed during the winter months. Planning and scheduling should be such that heavy equipment will not have to travel on this material during summer immediately following its placing.

1.2.3 Scheduling
Details cont'd

.4 Terrain & Material Restrictions cont'd

- b) The materials between approximately Mile 461.3 to Mile 465.9 can be expected to be granular material. The construction of this section can take place in the summer months.
- c) The materials to be used from Mile 465.9 to 473.0 can be expected to be near the plastic limit. This material can be placed during the winter months. Planning and scheduling should be such that heavy equipment will not have to travel on this material during summer immediately following its placing.
- d) The embankment on the section of road from approximately Mile 473.0 to 490 will be constructed mainly using granular materials. The construction can take place in summer months.

1.3.1 Description

This item consists of the provision to the Contractor of a fixed sum to cover costs of mobilization of plant, personnel and material, the establishment of temporary buildings, shops, offices and facilities and licenses, fees and premiums necessary to commence the work and which are not specifically measured under any other item contained in the Unit Price Table.

1.3.2 Measurement

Measurement for payment for mobilization will be on the basis of the LUMP SUM amount pre-established by the Department and shown on the Unit Price Table. This amount is to be included in the total amount of the tender and will be paid on the following schedule.

- .1 Fifty (50) percent of the lump sum amount when the Contractor has established his camp, has placed his fuel storage and has delivered to the camp site all the equipment necessary to perform work identified as clearing, grubbing and common and channel excavation.
- .2 Twenty-five (25) percent of the lump sum amount when the Contractor has commenced operation of all the equipment indicated in 1.3.2.1 above in the performance of that work identified on the project right of way as clearing, grubbing, common and channel excavation and overhaul.
- .3 Twenty-five (25) percent of the lump sum amount when the Contractor has completed construction of the equivalent of fifteen (15) percent of the mileage of the contract.

9.1.1 Description

This item consists of the removal and disposal of trees, stumps, brush, roots, surface logs, embedded logs, all other surface debris and other work as herein described. The areas to be cleared and/or grubbed shall be those areas indicated on the Plans or designated by the Engineer.

9.1.2 Materials

Not applicable

9.1.3 Construction

- .1 Clearing - Clearing shall consist of removal and disposal of all trees, brush, fallen trees and all other surface debris, except such trees and shrubs as may be designated for preservation. Trees and shrubs designated for preservation shall be protected from scarring, barking or other injury during the construction operations. Dangerous trees and snags overhanging the right-of-way and leaners along the edge of any cleared area are to be removed.
 - (a) Where clearing only is required, trees, brush, rubbish and stumps shall be hand cut to within eight (8) inches of the ground surface. This clearing operation must be carried out in such a manner that will prevent damage to the existing insulating value of the organic material.
 - (b) Where grubbing is designated by the Engineer, clearing and grubbing may be carried out in one operation if approved by the Engineer.
 - (c) Generally all right-of-way widenings, right-of-way adjacent to stream crossings and off-take ditches will be cleared by hand, and the use of machinery to pile and dispose of the clearing debris will only be allowed in the winter months. Borrow pit areas and haul roads will generally be machine cleared.
- .2 Grubbing - Grubbing shall consist of the removal and disposal of roots, stumps, imbedded logs and other objectionable debris on the surface and imbedded in the surface. Areas where grubbing is required will be designated by the Engineer. Grubbing will be required on all areas where excavation or subexcavation is to take place but generally will not be required on the right-of-way where height of embankment exceeds three (3) feet.

9.1.3 Construction
(Cont'd)

- .3 Brush Piles - Brush piles consisting of trees, rubbish and/or organic materials existing from previous operations shall be removed and disposed of by the contractor. Such work will not be measured separately for payment but will be considered incidental to those areas staked or designated for clearing and/or grubbing by the Engineer.
- .4 Disposal - All clearing and/or grubbing debris shall be disposed of as directed by the Engineer. Generally the disposal will consist of burning and placing of the burned debris in disposal pits or disposal areas. For the clearing and grubbing of borrow pits, the contractor will generally be permitted to push clearing and grubbing debris into a section of the pit where excavation is completed and to flatten and trim such debris to a condition acceptable to the Engineer. Any earth material pushed in with the clearing and grubbing debris will not be separately measured for payment, but will be considered incidental to the clearing and grubbing operation.
- In specific areas, the Engineer may permit trees from the hand-cut clearing operation to be laid into uniform mat transverse to the right-of-way centreline within the limits of future embankment. This work shall take place just in advance of the embankment construction.
- .5 Progress of Work - Except as may otherwise be provided or directed by the Engineer, borrow pit areas shall not be cleared and grubbed in advance of excavation by more than one (1) week. The clearing and/or grubbing within the right-of-way shall be completed at least one (1) mile in advance of the grading operation.

9.1.4 Measurement

The quantity of CLEARING to be measured for payment will be the number of acres acceptably cleared in accordance with these specifications.

The quantity of GRUBBING to be measured for payment will be the number of acres acceptably grubbed in accordance with these specifications.

9.2.1 Description

This item consists of the excavation, loading, hauling within the freehaul distance, placing or disposal and trimming of all materials classified as Excavation Rock or Excavation Common. The work is to be carried out in conformity with the lines, grades and dimensions shown on the plans or as staked by the Engineer.

9.2.2 Materials
Classification

.1 Excavation Rock - Excavation Rock is defined as:

- (a) Material excavated from solid masses of igneous, sedimentary or metamorphic rock which prior to removal was integral with its parent mass.
- (b) Boulder or rock fragments measuring in volume two (2) cubic yards or more.

.2 Excavation Common - Excavation Common shall consist of all other materials of whatever nature, including dense tills, hardpan and frozen materials that do not come under the classification of Excavation Rock or Channel Excavation.

9.2.3 Construction

.1 Roadway Excavation

- (a) Roadway Excavation will include the construction of roadway ditches, embankments, permanent access and connecting roads, berms, haul roads, excavation for culverts and the removal and disposal of unsuitable materials.
- (b) All suitable materials shall be placed in roadway embankments except as otherwise directed by the Engineer.
- (c) All unsuitable and/or excess material excavated from the roadway will be disposed of as directed by the Engineer.
- (d) All roadway excavation shall be carried out in a manner as not to damage the natural ground cover on adjacent areas.
- (e) Where the subgrade is in transition from excavation to embankment, sub-excavation will be carried out in that portion under the embankment to lines and grades established in the field by the Engineer.

9.2.3 Construction
(Cont'd)

- (f) All roadway excavation shall be to the lines and grades established on the Plans or set in the field by the Engineer to a tolerance maximum of two-tenths (2/10) of a foot.

In addition, variation in grade tolerances between any two successive 100 foot stations shall not exceed one-tenth (1/10) of a foot.

- (g) Where unsuitable material is encountered at the grade level of a cut, the sub-grade shall be sub-excavated to the depth staked by the Engineer.

- (h) Where suitable material is encountered at the grade level of a cut, scarifying to a minimum depth of one (1) foot below sub-grade will be performed prior to re-laying and shaping.

- (i) If during excavation, material appearing to conform to the classification of Excavation Rock is encountered, the Contractor shall notify the Engineer and shall provide ample opportunity for the Engineer to investigate and to make such measurements as are necessary to determine the volume of material in question.

- (j) Rock which can not be ripped, shall be drilled and blasted in such a manner as to allow usage of all material excavated.

- (k) Rock slopes shall be scaled down to remove boulders and rock fragments which may slide or roll down the slope.

.2 Borrow Excavation

- (a) The Engineer will designate and approve all borrow areas and access to borrow areas. Haul roads from borrow areas may consist of one two-way road having a maximum surface width of forty (40) feet or two one-way haul roads each having a maximum surface width of twenty-five (25) feet. The haul roads will generally be doglegged so that only a short section of the haul road is visible from the Highway.

9.2.3. Construction .2 cont'd
(Cont'd)

- (b) The location of potential borrow areas has been indicated generally on the photo mosaic plans. The indicated areas have been provided to give the Contractor an appreciation of the general type of material to be encountered in borrow areas and the general spacing of such borrow areas. The actual location, which need not be the same as indicated on the plans, dimensions and depths for excavation of all borrow areas will be designated in the field by the Engineer.
- (c) Slopes of the excavated borrow areas shall not be steeper than two to one (2:1) for excavation common and one quarter to one (1/4:1) for excavation rock, unless otherwise directed by the Engineer.
- (d) Unsuitable materials excavated from borrow areas will be disposed of by placing it immediately adjacent to the borrow areas as designated by the Engineer in such a location as not to interfere with the natural ground drainage or drainage from or into the proposed borrow area. The disposed of material will be trimmed as directed by the Engineer.

Where the unsuitable material from borrow areas is to be placed back into the excavated area after completion of the borrow excavation, this material will not be classified as roadway or borrow excavation but will be measured for payment as a Change Order in accordance with Clause 45 of the General Conditions "C".

- (e) If during excavation, material appearing to conform to the classification of Excavation Rock is encountered, the Contractor shall notify the Engineer and shall provide ample opportunity for the Engineer to investigate and to make such measurements as are necessary to determine the volume of material in question.

9.2.3 Construction
(Cont'd)

.2 cont'd

(f) Rock which can not be ripped, shall be drilled and blasted in such a manner as to allow usage of all material excavated.

9.2.4 Measurement

.1

Excavation Common - The volume of EXCAVATION COMMON which will be measured for payment, will be the number of cubic yards excavated in its original position, loaded, hauled within the free-haul distance, placed, trimmed and accepted in the work or disposed of in accordance with these specifications.

Original cross sections for measurements will be taken after the clearing and grubbing is completed.

Scarifying and relaying as specified in Article 9.2.3.1 (h) is incidental to construction and will not be measured separately for payment.

.2

Excavation Rock - The volume of EXCAVATION ROCK which will be measured for payment in cubic yards in its original position for those materials excavated, loaded, hauled within the free-haul distance, placed, trimmed and accepted in the work or disposed of in accordance with these specifications.

Original cross sections for measurements will be taken on top of the exposed rock surface.

Where, in the opinion of the Engineer, unavoidable overbreak occurs, measurement will be made for the actual quantity involved provided the overbreak does not exceed ten (10) percent of the actual quantity within the lines as staked by the Engineer between the established 100-foot station intervals where the overbreak occurs. All materials exceeding ten (10) percent by this definition, when placed in the embankment, will be measured for payment as Excavation Common.

9.3.1 Description

This item consists of the excavation required for deepening, widening and relocating water channels, the construction of ditches other than contiguous roadway ditches, loading, hauling material within the free haul distance, disposal and trimming of material in accordance with the Plans or as staked by the Engineer.

9.3.2 Materials

.1 Channel Excavation Rock

Channel excavation rock is defined as:

(a) Channel material excavated from solid masses of igneous, sedimentary or metamorphic rock which prior to removal was integral with its parent mass.

(b) boulder or rock fragments measuring in volume two (2) cubic yards or more.

.2 Channel Excavation Common

Channel Excavation Common shall consist of the excavation of all other materials of whatever nature, including dense tills, hardpan and frozen materials that do not come under the classification of Channel Excavation Rock.

9.3.3 Construction

All material excavated will be disposed of as shown on the Plans or as directed by the Engineer; suitable material will be used in the embankment. When excavated material is placed near the banks of a channel or a ditch, provision shall be made to ensure proper flow of water from adjacent land to this waterway. The excavation shall be neatly finished and the disposed of material shall be shaped and trimmed to a condition satisfactory to the Engineer. The Engineer must approve the use of excavation equipment other than draglines and/or backhoes.

9.3.4 Measurement

The quantity of CHANNEL EXCAVATION COMMON or CHANNEL EXCAVATION ROCK to be measured for payment, will be the number of cubic yards of material acceptably excavated and disposed of in accordance with the Plans or as directed by the Engineer, measured in its original position.

There will be no measurement for payment for material excavated beyond the lines shown on the Plans or as staked by the Engineer, except that for Channel Excavation Rock where in the

9.3.4 Measurement
(cont'd)

opinion of the Engineer, unavoidable overbreak occurs, measurement for payment will be made for the actual quantities involved, provided the overbreak quantity does not exceed ten (10) percent of the actual quantity of rock within the lines as staked by the Engineer between the established 100-foot station intervals where overbreak occurs.

Rock excavated beyond the lines staked by the Engineer in excess of the overbreak allowed, will not be measured for payment.

9.4.1 Description

This item consists of the construction of subgrade, approach road, ditch block embankments; and backfilling culvert and roadway sub-excavations with excavated material, all to the lines, grades, cross-sections and dimensions shown on the Plans or as staked or designated by the Engineer.

9.4.2 Materials

The materials shall consist of acceptable earth and rock material free from wood, brush, roots and organic matter. The Engineer will approve all materials prior to incorporation into embankments.

9.4.3 Construction

.1 Placing Roadway Embankment

- (a) The embankment shall be constructed to the lines, grades and cross-section as indicated on the Plans and/or staked by the Engineer. If an embankment is constructed beyond the staked grades and cross-section, without the written approval of the Engineer, the excess material will be removed by the Contractor at his own expense and placed on the grade where the embankment is not completed. If the excess material has not been removed at the time of the completion of the work, this material will not be measured for payment. The excavation quantity of excess material will be based on the excess embankment volumes times the embankment adjustment factor for the section where the embankment was constructed beyond the staked lines.
- (b) Sufficient crown and/or superelevation shall be maintained at all times during construction to ensure ready runoff of surface water. The top surface shall be free of ruts and ridges, and windrows will not be permitted to remain along the edges of the embankment.

9.4.3 Construction
(Cont'd)

- (c) The initial lift of embankment material on unstable foundations shall have a minimum compacted thickness of three (3) feet for support of the equipment. The Engineer may permit the initial lift to be placed in a narrow fill along the uphill side of the embankment area to provide access to various work along the right-of-way. After the initial lift has been constructed to the full design width, embankment material shall be placed in successive uniform layers across the entire width of the embankment. Where considered possible by the Engineer, this shall consist of placing successive layers of eight (8) inch maximum compacted thickness. In embankments composed principally of material obtained from rock cuts, the larger stones shall be carefully distributed and the interstices filled with smaller stones and other available material to form as compact a mass as practicable.
- (d) Preliminary shaping of side slopes shall be done as close behind embankment placement as possible.
- (e) Trimming of the top surface, side slopes and toe of the embankments shall be done in a neat and workmanlike manner. All embankments shall be constructed to the lines and grades shown in the Plans, or as staked by the Engineer, to tolerance maximum of two-tenths (2/10) of a foot. In addition, variation in grade tolerance between any two successive 100 feet stations shall not exceed one-tenth (1/10) of a foot.

.2 Compaction of Embankment

- (a) The embankment shall be placed as described in .1(c) above. Each layer of material shall be spread evenly and to the satisfaction of the Engineer. The hauling equipment shall be directed over the full width of each layer of material placed.
- (b) The Engineer will determine if and when additional compaction effort is required other than what is obtained by the hauling units and will decide the type and number of compaction units to be used.

9.4.3 Construction
(Cont'd)

- (c) Water may be added to the embankment material during the compaction operation. The Engineer will decide when this is required and the quantities to be applied. The water shall be distributed in accordance with the requirements for water (Specification Division 9, Section 10).
- (d) During embankment construction, if in the opinion of the Engineer, the material is too wet for placing and/or compacting, he will direct drying of the embankment material. The type and number of drying equipment and the drying procedure used will be as directed by the Engineer. If the weather is not suitable for drying, the Engineer will direct work to cease temporarily until such time as drying conditions have improved.

.3 Embankment Adjacent to Structures

- (a) Embankment on Bridge Approaches - The permission of the Engineer must be obtained before any fill is placed against concrete arches, abutments or wing walls.

Approach fills to structures within the lines shown on the Plans or as directed by the Engineer shall be constructed of approved material placed in layers of maximum compacted thickness of six (6) inches. The amount of compaction and the type of equipment to be used will be determined by the Engineer. For structures requiring embankments on both sides, the embankment shall be placed simultaneously at uniform elevations on both sides of the structure.

- (b) Embankment at Culverts - Embankment around culverts shall consist of approved material placed to the limits shown on the typical plans for installation of Corrugated Metal Pipe Culverts and Corrugated Structural plate Culverts or as directed by the Engineer. Material shall be placed and compacted in six (6) inch layers alternately on each side of the culvert so as not to displace it during installation. Special attention shall be given to compaction under the haunches.

9.4.3 Construction
(Continued)

- (c) Fill - Retaining Walls - The fill behind the walls shall be approved material placed in layers not exceeding six (6) inches in thickness and compacted as directed by the Engineer. In the case of cell type retaining walls, the fill behind the wall shall be tamped and kept near but not above the level of the compacted material within the cells. Where fill is to be placed on a sloping surface, the surface must be benched to reduce the load on the retaining structure.

.4 Compaction Equipment

All compactors specified herein for compaction of materials shall comply with the following minimum requirements:

- (a) Sheepsfoot compactors shall consist of one or more drum units, having a total minimum width of 8 feet. The length of the tamping feet shall not be less than 7 inches. Under working conditions, the compactor shall be of such weight that the minimum load upon each tamper foot will not be less than 400 pounds per square inch of cross-sectional area. The sheepsfoot compactor shall be of the self-cleaning type and the ends of the tamping feet shall at all times be kept in a flat condition acceptable to the Engineer.
- (b) Pneumatic-tired rollers shall have a width of not less than 6 feet. They shall be equipped with pneumatic tires of equal size and diameter. The space between the side walls of adjacent tires shall be not greater than the tire width, and the rear tires shall be staggered in relation to the front tires. The roller shall be equipped with mechanical means of distributing the contact pressure uniformly among all the tires and the tires shall be uniformly inflated so that the air pressure in several tires shall not vary more than 5 pounds per square inch. Pneumatic-tired rollers shall be so constructed that the total weight of the roller shall be not less than 17 tons and that the roller shall develop a minimum of 400 pounds pressure per

9.4.3 Construction
(Cont'd)

- (b) inch width of tire. During rolling, the operating weight of the roller and the tire pressure shall be varied to fit the soil conditions.
- (c) Grid Rollers shall not weigh less than 15 tons, and shall be of such weight that the load on each square inch of surface in contact with the road at any time shall not be less than 250 pounds.
- (d) Type (A) steel drum vibratory compactors shall have a drum width of not less than 6 feet. The weight on the drum end shall not be less than 5 tons with minimum total applied force of 500 lbs. (combined vertical components of dynamic and static forces) per linear inch of drum.
- (e) Type (B) steel drum vibratory compactors shall consist of a double drum (vibrations on both drums), self propelled compaction unit meeting the following minimum requirements:
 - Total weight: 1 ton
 - Width of drums: 30 inches
 - Drum diameter: 18 inches
 - Total applied force 150 lbs per
(combined vertical linear inch
components of dy- of drum
namic and static
forces)
- (f) A compaction unit shall consist of a self-propelled or a power-drawn compactor. Compaction units shall be capable of moving at a speed up to 5 m.p.h, with exception of the compaction units described in (e) above which shall be capable of moving at a speed up to 1.5 m.p.h.
- (g) Self-powered, hand-operated vibrating or tamping units for compaction of backfill and/or embankments immediately adjacent to structures and culverts shall be of the vibratory or ramming type of approved design and weighing not less than 100 pounds.

9.4.3 Construction
(Cont'd)

.5 Drying Equipment

- (a) Disc plowing harrows shall be of the heavy duty hinge offset type meeting the following minimum requirements:

Weight 8000 lbs. with provisions for additional weight as required

Width 8 feet

No. of discs 12

Disc diameter 36 inches

- (b) A drying unit shall consist of power-drawn drying equipment. Drying units shall be capable of moving at a speed up to 4 m.p.h.

- .6 (a) All drying units and compaction units with the exception of the self-powered hand operated tamper as described in 9.4.3.5(g) shall be equipped with an approved time recording device which accurately records the number of hours each machine is in operation.
- (b) It will be the contractor's responsibility to ensure that the time recording devices are properly mounted and maintained, that the cards are accurately identified, as to the machine, date, and shift, and to daily deliver said cards to the Engineer.
- (c) The Engineer will record the number of operating hours for each machine and both the Engineer and the Contractor will certify daily that such records are correct.

9.4.4 Measurement

Construction of an embankment in accordance with these specifications will not be measured for payment directly but will be considered as a subsidiary obligation of the Contractor under other Unit Price Table items.

9.4.4 Measurement
(Cont'd)

The quantity of COMPACTION AND DRYING to be measured for payment, will be the actual number of hours each compaction and drying unit is operated as directed by the Engineer.

Any other equipment used in the drying and compaction operation which is not shown in the Unit Price Table, will not be measured separately for payment but will be considered incidental to the drying and compaction operation.

9.5.1 Description

This item consists of authorized hauling of excavated material classified under the various excavation items for a distance beyond a free haul distance of one-half ($\frac{1}{2}$) mile (2,640 feet).

9.5.2 Materials

Not applicable.

9.5.3 Construction

Not applicable.

9.5.4 Measurement

The quantity of OVERHAUL to be measured for payment will be the number of cubic yard miles of authorized material hauled beyond the 2,640 feet free haul distance as calculated by the Mass Diagram Method.

(a) The overhaul distance shall be the distance between the centres of volume of the overhauled material in its original position and its position after placing, less the free haul distance. The haul distance shall be measured along the shortest route determined by the Engineer as feasible and satisfactory. If the Contractor chooses to haul the material over some other route, this route must be approved by the Engineer. The measurement shall be based on the haul distance of the route designated by the Engineer or if the alternate route is shorter, the haul distance will be measured along this route.

(b) When material is obtained by extra widening of a right-of-way cut, any area laying more than one hundred and fifty (150) feet from the centreline of the roadway will, for the purpose of centre of mass and overhaul calculations, be considered as a separate area off the right-of-way.

9.6.1 Description

This item consists of the transportation from barge landing and the installation of corrugated metal pipe and pipe arch culverts in accordance with these specifications, and to the lines and grades shown on the Plans or as directed by the Engineer.

This work shall include all types of corrugated metal pipe culverts except structural plate culverts and sub-surface drainage pipes.

9.6.2 Materials

Except as otherwise herein provided, corrugated metal pipes and couplers shall conform with the requirements of the latest A.A.S.H.O. Specification M36.

.1 Pipe

- (a) Culvert corrugations shall have a maximum pitch of 2 3/4 inches and a minimum depth of 1/2 inch. Annular corrugated culvert shall have a minimum width of longitudinal lap of 2 inches. Helically corrugated culvert shall have a minimum width of longitudinal lap of 3/8 inch (See Plan No. 1 for definition of longitudinal lap for helical culvert). Outside dimensions of the culverts shall meet the following requirements:

<u>Nominal Diameter</u>	<u>Minimum Outside Circumference Along the Crest</u>
30 inches	96.9 inches
36 inches	115.6 inches
42 inches	134.4 inches
48 inches	153.1 inches
54 inches	171.7 inches

- (b) For annular riveted culverts the longitudinal seam shall contain two rows of rivets. Rivets shall be not less than 3/8 inch in diameter.
- (c) For helically corrugated culverts, the metal sheets forming the pipe shall be joined with a continuous lockseam paralleling the corrugation. The lockseam shall be formed by folding over the edges of adjacent sheets so that they interlock with each other to form a tight joint. The joint shall not be an element of weakness in the pipe and shall be so fabricated as to not affect the shape or nominal diameter requirements specified. The two laps shall be of equal dimensions and not less than 3/8 of an inch. The lockseam shall be retained by an adjacent shoulder or retaining offset. The retaining offset shall be equal to at

9.6.2 Materials
(Cont'd)

- (c) least 1/2 of the sheet thickness in contact with the 180-degree fold, and in no case shall the total retaining offset for the two ends be less than 1 1/2 times the sheet thickness. The 180-degree fold of metal at the lockseam shall have a smooth curvature with no angularity of the interior of the fold. There shall be no roller indentations on the 180-degree fold.

Prior to shipment, the manufacturer shall be prepared to saw into the lockseam of any pipe section supplied. If the lockseam does not meet the specified requirements, the pipe section(s) with unacceptable lockseam, will be rejected, and shall be replaced with a satisfactory pipe section at no additional cost to the Department. The contractor may also be required to perform such saw cuts after delivery of materials to the site if such is considered necessary by the Engineer because of indicated weaknesses in the seam. All saw cuts shall be welded after inspection and the welded areas protected as specified in Paragraph .1(g) below.

- (d) The helical angle is here defined as the angle between the corrugations and the pipe axis and shall not be less than shown in the following table:

Minimum helical angle for Helical C.M.P.

Pipe Diameter 2 2/3" x 1/2" corrugation

24 inches	71 degrees
30 inches	75 degrees
36 inches	78 degrees
48 inches	80 degrees
60 inches	82 degrees
72 inches	83 degrees
84 inches	84 degrees
96 inches	85 degrees

- (e) The A.A.S.H.O. Specification for copper base metal, Designation M36, is hereby waived and the base metal shall conform to the current specifications of the American Iron and Steel Institute.

Butt welds joining coils of base metal in the manufacture of helically corrugated pipe shall be of the same strength as the base metal, watertight and protected as outlined in Paragraph 1(g) below.

- (f) The saw-cut ends of each continuously formed corrugated metal pipe section

9.6.2 Materials
(Cont'd)

- (f) shall be completely deburred and the allowable mismatch of the saw-cut end will not exceed 1/8 inch.
- (g) Damage to the spelter coating during the manufacturing process shall be protected by the application of two coats of weather-resistant, high zinc dust content outside paint. The areas damaged shall be thoroughly cleaned and rough edges ground smooth prior to the paint application.

.2 Couplers

- (a) Coupling bands shall be manufactured using the same base metal as used in the culvert. Coupling bands for 30-inch diameter culverts shall be no lighter than 16 gauge and for 36 inch to 48 inch diameter culverts inclusive, shall be no lighter than 14 gauge.
- (b) For annular corrugated culverts the coupling bands shall be corrugated type, at least 18 inches wide for 30 inch diameter culverts and at least 24 inches wide for 36 inch to 48 inch diameter culverts inclusive.
- (c) For helically corrugated culverts, 30 inches in diameter, coupling bands shall be either (a) the corrugated type not less than 18 inches wide, or (b) the universal dimpled type not less than 24 inches wide with a minimum of 6 rows of 8 dimples each, spaced equally circumferentially.
- (d) For helically corrugated culverts, 36 inch to 48 inch diameter inclusive, coupling bands shall be either (a) the corrugated type not less than 24 inches wide, or (b) the universal dimpled type not less than 27 inches wide with a minimum of 6 rows of 8 dimples each, spaced equally circumferentially.
- (e) The coupling bands shall be so manufactured as to lap on an equal portion of each of the culvert sections to be connected, and shall be connected at the ends by galvanized angles having section dimensions of not less than two (2) inches by two (2) inches by 3/16 inches.
- (f) The annular and helical corrugated coupling band shall be a two-piece coupler manufactured so that each half of the band will overlap the other. The

9.6.2 Materials
(Cont'd)

- (f) universal dimpled type shall be a one-piece band. All coupling bands shall be manufactured the full required width from a single sheet of metal.
- (g) The 18-inch wide couplers shall have at least four (4) 1/2 inch galvanized bolts for each set of angles and each angle shall be fastened to the coupling band by not less than seven (7) 3/8 inch rivets or spot welded to give equivalent strength.
- (h) The 24 inch and 27 inch wide couplers shall have at least five (5) 1/2 inch galvanized bolts for each set of angles and each angle shall be fastened to the coupling band by at least nine (9) 3/8 inch rivets or spot welded to give equivalent strength.
- (i) Wherever spot welds are used in manufacture of coupling bands, the damaged spelter coating shall be protected as outlined in Paragraph .1(g) above.

All galvanized coupling bolts shall be threaded the full length of the bolt. The contractor shall supply a 10% surplus of nuts and bolts to allow for loss during installation.
- (j) For helical corrugated couplers, the helical angle of the coupling band shall not differ from the helical angle of the pipe by more than two (2) degrees.

- .3 Culverts shall be shipped in pallets so as to minimize damage to the material during transit and handling. The contractor shall follow the Manufacturer's recommendation for pallet design.

Bolts and nuts shall be delivered in weather-proof containers.

Furnishing of pallets and containers will be incidental to the culvert supply and no separate measurement for payment will be made therefor.

- .4 The culvert material shall be handled so as not to bruise or damage the spelter coating. It shall not be dragged on the ground or manipulated with heavy equipment without proper precaution to protect the surface. Any damage to the spelter coating shall be protected as outlined in Paragraph .1(g) above.

9.6.2 Materials
(Cont'd)

- .5 Material used for the bed and fill around the culverts will be selected by the Engineer from one of the contract Unit Price Table items.

9.6.3 Construction

.1 Excavation

- (a) The location, elevation and excavation for culverts will be staked by the Engineer.
- (b) Excavation shall be carried out in accordance with the requirement for Excavation Common and/or Excavation Rock (Specification Division 9, Section 2).

During construction the contractor may be required to provide for the temporary flow of water outside of the limits of the culvert. The method used in diverting the water shall be approved by the Engineer.

.2 Bedding

The culvert bed shall provide a firm foundation of uniform density throughout its entire area. When a firm foundation is not encountered at the grade established the bottom of the bed shall be sub-excavated to the dimensions staked by the Engineer. The sub-excavated area shall be backfilled with material approved by the Engineer.

.3 Installation

- (a) Pipes shall be placed with the inside circumferential laps pointing downstream and with longitudinal laps at the side or quarter points.
- (b) The sections of the culvert shall be firmly jointed with coupling bands.
- (c) If a watertight joint is specified, the method used will be as directed by the Engineer.
- (d) If insulation is specified, installation of insulation material will be as shown on the plans or as directed by the Engineer.
- (e) The backfillfilling around the culvert will be in accordance with the Plans and shall conform with the requirements for Embankment Construction. (Specification Division 9, Section 4).

The Engineer will determine the amount of compactive effort required.

9.6.3 Construction
(Cont'd)

(f) No strutting of culverts will be allowed without written approval from the Engineer.

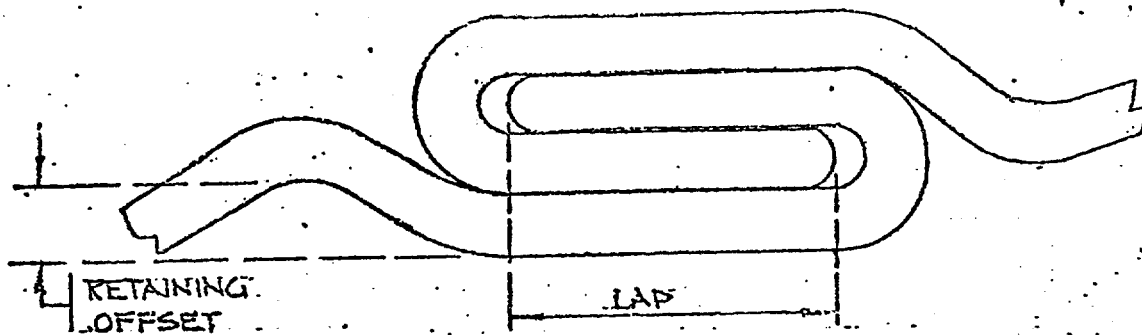
9.6.4 Measurement

.1 Delivery and Installation

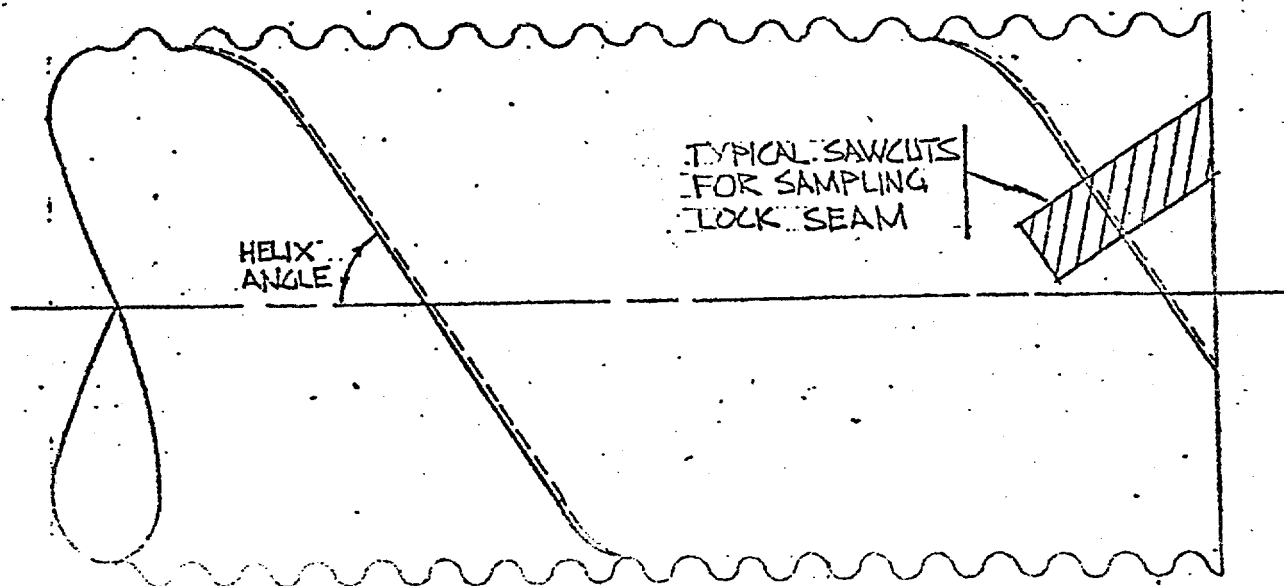
The quantity of CORRUGATED METAL PIPE to be measured for payment, will be the number of lineal feet of pipe complete in place and accepted by the Engineer. The measurement will be based on nominal length of pipe sections.

Loading of the pipes at designated stockpile sites, hauling and unloading the pipes at the culvert site, preparing the bed, assembling the culvert and placement of backfill material around the pipe, will be considered incidental to the culvert installation.

Quantities for culvert excavation, backfill material and compaction will be measured for payment in accordance with the appropriate Unit Price Table Items.



CROSS-SECTION OF LOCK SEAM



DEPARTMENT OF PUBLIC WORKS

MINISTÈRE DES TRAVAUX PUBLICS

Drawing title: LOCK SEAM ON
Titre du dessin: HELICALLY FABRICATED
CORRUGATED METAL PIPE

scale:
échelle:

date:

revisions:

designed by:
conçu par:

drawn by:
dessiné par: R SANDL

reviewed by:
examiné par: J TWACH

approved by:
approuvé par: F KINISALL

project no.:
no. du projet:

dwg. no.:
dessin no.

4 of 4

9.7.1 Description

This item consists of:

- .1 The transportation from barge landing and the installation of Corrugated Structural Plate Pipe (C.S.P.P.) and Pipe Arch (C.S.P.P.A.) Culverts in accordance with these specifications and to the lines and grades shown on the plans or as directed by the Engineer.
- .2 The design, supply, delivery and installation of Corrugated Structural Plate Horizontal Ellipse (C.S.P.H.E.) culverts in accordance with these specifications and to the lines and grades shown on the plans or as directed by the Engineer.

9.7.2 Materials

- .1 Corrugated Structural Plate Pipe Culverts (C.S.P.P.), Corrugated Structural Plate Pipe Arch Culverts (C.S.P.P.A) and Corrugated Structural Plate Horizontal Ellipse Culverts, (C.S.P.H.E.) shall conform to the requirements of the current Specification of AASHTO M167.
- .2 Fabrication of the culvert material shall conform to the requirements of Section 23, Division 11 of the Standard Specification for Highway Bridges of the AASHTO, 1969, or latest revision thereof with the following exceptions and additions.
- .3 All Corrugated Structural Plate Pipe (C.S.P.P.) shall be fabricated approximately five (5) per cent vertically elongated. The diameter dimension stipulated on the Plans and in the Specifications is nominal and is the clear inside diameter of a round pipe having equal circumference. The plates for the pipe shall be factory-formed so that the finished pipe is an ellipse in cross-section and is symmetrical about the vertical axis.
- .4 The Supplier shall submit five (5) sets of shop drawings, assembly plans and instructions for approval by the Engineer prior to shipment. These plans and instructions shall show all details of the ends, the shape, radii, circumference, inside clear horizontal and vertical dimensions of the assembled pipe, the position of bolts of different lengths, and the codes used to identify all plates and bolts.
- .5 All plates shall be marked with weather resistant paint so as to readily identify the mileage of the pipe they belong to and their position in the pipe. In addition, the mileage

9.7.2 Materials
(Cont'd)

for the structure, the radius of the plate, and the gauge shall be stamped into each plate on the inside of the structure.

- .6 The plates shall be shipped in bundles and strapped with metal bands to prevent the plates from separating.
- .7 The number of bolts and nuts for each pipe shall be 5% greater than actually required for assembly. The bolts and nuts shall be shipped in weather resistant containers which will be marked with the mileage of the pipe they belong to.
- .8 Furnishing of containers and strapping bands will be incidental to the culvert supply and no separate measurement for payment will be made therefor.
- .9 The metal culvert material shall be handled so as not to bruise or damage the spelter coating. It shall not be dragged on the ground or manipulated with heavy equipment without proper precautions to protect the surface. Any damage to the spelter coating shall be protected by the application of two (2) coats of weather-resistant, high zinc dust content paint. The areas damaged shall be thoroughly cleaned and rough edges ground smooth prior to the paint application.
- .10 Culverts shall be supplied to the size, length and gauge shown on the Plans. Materials for the standard bevelled end treatment, steel cut off walls and hold downs shall be fabricated and supplied, all in accordance with the details shown on the Plans.
- .11 The Structural Plate Horizontal Ellipses shall be the size shown on the drawings or approved equivalent to provide the same end areas.

The Contractor shall design the structures for a live load of HS20-44 and an embankment dead load of 125 lbs. per cu. ft. He shall submit with the tender, drawings and calculation sheets for consideration by the Engineer. This information shall include all steel thickness calculations and joint detail designs to allow a check to be made on the adequacy of the proposed design.

The Contractor shall submit to the Engineer:

- (a) Two (2) sets of shop and assembly draw-

9.7.2 Materials
(Cont'd)

ings for approval prior to fabrication.

(b) Five (5) sets of shop and assembly drawings as approved.

(c) Five (5) sets of assembly and installation drawings and instructions.

Steel end stiffeners, cut-off walls, retaining walls and wingwall bins shall be supplied and fabricated in accordance with the general details shown on the drawings and to the Contractor's approved drawings.

9.7.3 Construction

.1 Excavation

(a) The location, elevation and excavation for the culvert will be staked by the Engineer.

(b) Excavation shall be carried out in accordance with the requirement for Excavation Common and/or Excavation Rock, (Specification Division 9, Section 2).

(c) Where applicable, the Contractor shall provide a temporary diversion for the flow of water outside the limits of the culvert. The method used in diverting the water shall be approved by the Engineer.

.2 Foundation

The culvert bed shall provide a firm foundation throughout its entire area. The bed shall be sub-excavated to the dimensions staked by the Engineer and backfilled with approved material which will be compacted as directed by the Engineer.

.3 Assembly

(a) Placing and assembly of the pipe may only proceed after the excavation, foundation and bottom bedding layer for the pipe has been approved by the Engineer, except that for smaller diameter pipes the Engineer may give permission for assembly of the pipe prior to completion of culvert bed. The assembly shall be in accordance with the shop drawings. All holes shall be filled with bolts which will be tightened to a torque of not less than 150 foot pounds and not more than 200 foot pounds.

(b) The Contractor shall when specified in the General Requirements, arrange at his own cost to have in the field a fully qualified representative of the culvert

9.7.3 Construction
(Cont'd)

Supplier during the period of installation to ensure that the culvert assembly, erection and general construction are in accordance with the Supplier's recommendations.

.4 Backfilling

Assembly and tightening of all bolts shall be completed and approved by the Engineer before backfilling may commence. Backfill material will be located and approved by the Engineer.

During the course of backfilling around and above the pipe the deflections will be measured. Plumb bobs and line shall be installed within the pipe by the contractor at locations under each embankment shoulder, at the midpoint of the pipe and under each slope at locations designated by the Engineer. Plumb bobs shall be suspended and maintained by the contractor throughout the course of construction at the 10, 12 and 2 o'clock positions.

Backfill material shall be placed in successive layers and compacted in accordance with the Plans and Specifications or as directed by the Engineer. Equipment used for the backfilling operation up to three (3) feet above the top of the pipe shall run parallel and as close to the pipe as possible with simultaneous hand spreading and compaction by mechanical impact tampers along the face of the pipe. Special attention shall be given to compaction under the haunches.

Lateral movement shall be prevented by controlling the rate of filling on each side. The contractor will be responsible for the proper placing of the bedding and backfill as evidenced by the deformation of the pipe from its original shape. No strutting of the pipe will be allowed without written approval from the Engineer. Unless otherwise directed, the following criteria on deflection will be followed. Vertical deflections that tend to increase the original vertical dimension only will be allowed. Vertical deflections shall not be permitted to exceed three (3) percent of the original vertical diameter. Horizontal deflections shall not be permitted to exceed five (5) percent of the original horizontal diameter.

If during the placement of backfill or embankment around and above the pipe, the deformations should exceed the above limits, the work shall cease, and the Engineer shall

9.7.3 Construction
(Cont'd)

be notified. The Engineer may then order the removal and replacement of the backfill in its entirety or in part and may require, as a corrective measure, that the pipe be struttred, either horizontally or vertically, as directed by the Engineer. The contractor shall undertake the corrective work so ordered entirely at his own expense.

Vehicular traffic and construction equipment will not be allowed to cross over the structure until the backfill has been constructed and compacted to a minimum depth of three (3) feet over the highest point on the pipe, or to a height specified by the pipe supplier for the loadings anticipated.

9.7.4 Measurement

- .1 The quantity of Corrugated Structural Plate Pipe (C.S.P.P.) and Pipe Arch (C.S.P.P.A.) Culverts to be measured for payment will be as a lump sum for transportation and installation of each individual pipe acceptably completed in accordance with the Plans and Specifications.
- .2 The quantity of Corrugated Structural Plate Horizontal Ellipse (C.S.P.H.E.) to be measured for payment will be as a lump sum for the design, supply, delivery and installation of each individual pipe acceptably completed in accordance with the Plans and Specifications.

9.8.1 Description

This item consists of excavating; crushing and/or screening gravel or stone or removing oversize material, loading; and placing the material in stockpile(s) or on the road as shown on the Plans or as directed by the Engineer.

9.8.2 Materials

The material will be obtained from sources shown on the Plans, except the Engineer may designate other sources if during the construction other sources are located.

.1 Crushed Gravel - 3/4" Minus

The material shall consist of crushed stone or crushed gravel of clean, hard, angular particles, free from clay lumps, cementation and organic or other deleterious material, and shall meet the following gradation requirements:

<u>Sieve No.</u>	<u>Percent Passing (By Weight)</u>
3/4"	100%
No. 4	40 - 65
No. 10	25 - 55
No. 40	10 - 30
No. 200	3 - 8

A minimum of 50% of the material retained on No. 4 Sieve shall have at least one fractured face.

.2 Screened Gravel - 3" Minus

The material shall consist of screened gravel of clean, hard particles, free from clay lumps, cementation and organic or other deleterious material, and shall meet the following gradation requirement.

<u>Sieve No.</u>	<u>Percent Passing (By Weight)</u>
3"	100%
No. 4	30 - 70
No. 200	3 - 10

.3 Pit Run Gravel

The material shall consist of pit run gravel of clean hard particles free from cementation and organic or other deleterious material. All oversize material shall be removed at the pit or on the road. Stones of dimensions exceeding the thickness of the lift in which the gravel is spread by more than one (1)

9.8.2 Materials
(Cont'd)

inch is defined as oversize material; except that material passing the 3 inch sieve will not be classified as oversized.

9.8.3 Construction

- .1 Clearing and Grubbing of gravel deposit(s) and quarry area(s) access roads and stockpile site(s), shall conform to the requirements for Clearing and Grubbing (Division 9 Section 1).
- .2 Excavating and disposal of material overlaying the gravel deposit(s) and quarry area(s) and the construction of access roads, shall be in accordance with the requirements for Excavation Common and Embankments (Division 9 Sections 2 and 4).
- .3 Before gravel can be placed either on the road or in stockpile(s), approval must be received from the Engineer.
 - (a) For placement of gravel on the road, the roadbed surface shall be smooth-riding and free from potholes and ruts. Scarifying and blading shall be performed as directed by the Engineer.
 - (b) The hauling shall be uniformly spread over the width of the traffic lanes to produce uniform compaction. The Contractor will maintain the haulroads at his own expense.
 - (c) The gravel shall be dumped and spread uniformly on the roadbed surface at the rate specified by the Engineer.
 - (d) When gravel is used to backfill sub-excavated areas, and for backfill material around culverts, the backfill operation will be in accordance with the requirements for Embankment (Division 9 Section 4).
 - (e) Stockpile site(s) shall be firm and level and be clean of all deleterious material. The stockpile(s) shall be shaped as directed by the Engineer and constructed in layers not exceeding three (3) feet in depth over the entire stockpile area. Stockpiles shall be kept free from snow and ice during the construction.

9.8.4 Measurement

The quantity of CRUSHED, SCREENED and/or PIT RUN GRAVEL to be measured for payment, will be the number of tons of material produced, loaded and placed in accordance with this specification and accepted by the Engineer.

Measurement for Gravel Haul will be in accordance with the requirements for Gravel Haul (Division 9 Section 9).

The clearing, grubbing and/or stripping of gravel deposits and stockpile sites and the construction of access roads will be measured for payment under the appropriate unit price table items.

The removal of snow and ice as specified in Article 9.8.3.3 (e) is considered incidental to the construction and no separate measurement for payment will be made therefor.

9.9.1 Description

This item consists of the authorized hauling of material measured for payment under the classification of gravel.

9.9.2 Materials

Not applicable.

9.9.3 Construction

Not applicable.

9.9.4 Measurement

The quantity of HAUL to be measured for payment will be the number of ton miles of gravel acceptably delivered.

The quantity will be computed by multiplying the weight of the material in tons by the haul distance in miles along the designated route between the point of loading and the designated delivery point.

For the purpose of this Specification, the designated delivery point shall be considered as the center of the project mile, except:

- (a) If a section is shorter than one mile, the designated delivery point will be the center of that section.
- (b) If sections within a project mile are to be constructed at varying rates of application, the designated delivery point will be the center of each such section within the mile.

9.10.1 Description

This item consists of loading, transporting and distributing water required for the construction of the highway.

9.10.2 Materials

The Engineer will approve the source of water.

The water shall be free from undesirable quantities of organic matter and mineral salts.

9.10.3 Construction

Watering equipment shall consist of watertight tanks mounted on adequately powered trucks. The water shall be applied through a spray bar of such design as to provide a uniform unbroken spread of water the full width of the spray bar. A suitable device for positive shutoff of the spray bar shall be so located as to permit control from the cab.

The Engineer will determine the quantity of water to be applied and the rate of application.

9.10.4 Measurement

The quantity of WATER to be measured for payment, will be the number of 1,000 gallon units of water acceptable loaded, transported and distributed.

Measurement will be made at the point of delivery. The volume of water will be computed from the volumetric capacity of the tank.

9.11.1 Description

This item consists of constructing a protective covering of sacked soil-cement or approved stone, with or without mortar on an earth bed or granular filter blanket in accordance with these specifications. Rip-rap shall be constructed at the locations and in conformity with the lines, grades and dimensions shown on the Plans or as designated by the Engineer.

9.11.2 Materials

The Contractor shall supply all materials.

- .1 Stone Rip-Rap: Rip-rap materials shall be of approved quality and shall consist of sound, hard and dense stones, boulders or quarry rocks resistant to the action of air and water and free from seams, cracks or other structural defects.

- a) Hand-placed rip-rap material for Corrugated Metal Pipe Culverts, ditch blocks and ditch checks shall consist of stones, boulders or quarry rocks having dimensions of not less than six (6) inches in any one direction.
- b) Rip-rap materials for Structural Plate Culverts, bridges, and channel bank protection shall consist of stones, boulders or quarry rocks meeting the requirements for "Heavy Rip-Rap."

HEAVY RIP-RAP

Weight of Stones (lbs.)	Percentage
800 - 1,200	40 - 60
400 - 800	20 - 40
50 - 400	10 - 30
Under 50	0

9.11.2 Materials
cont'd

or meeting the requirements for "Armour
Rip-Rap":

ARMOUR RIP-RAP

Weight of Stones (lbs)	Percentage
1,200 - 2,000	60 - 70
400 - 1,200	20 - 30
200 - 400	10 - 20
Under 200	0

Spalls shall be supplied to fill open joints.
Filter blanket material shall be approved by
the Engineer.

Sand for mortar shall conform to the latest
C.S.A. Specifications for Aggregate for
Masonry Mortar A 82.56 unless otherwise
instructed by the Engineer.

Cement for mortar shall be Portland Cement
conforming to the latest C.S.A. Specification
A 5, (Type 1) unless otherwise instructed by
the Engineer.

.2 Sacked Soil-Cement Rip-Rap

- a) The soil material will consist of a
sand and/or gravel from a source selected
by the Engineer.
- b) Sacks shall be manufactured from
minimum 10 ounce burlap and shall be
approximately 20 inches by 36 inches
measured inside the seams when the
sack is laid flat. The capacity of each
sack shall be approximately 1.25 cubic
feet.
- c) The cement shall be Portland Cement
conforming to the latest C.S.A.
Specification A5, Type 1.

9.11.3 Construction .1

Preparation of Foundation

- a) Hand-Placed Rip-Rap: Aprons and slopes
to be rip-rapped shall be excavated as
shown on the plans or as specified by

9.11.3 Construction
cont'd

the Engineer to provide adequate foundation upon which the rip-rap shall rest. The foundation bed shall be fine graded to form a uniform and even surface. Depressions shall be filled and thoroughly compacted.

- b) Hand-Placed Grouted Rip-Rap: Preparation of foundation shall be performed as .1 (a) above.
- c) Random Rip-Rap: If required, a shelf or ledge shall be excavated to permit dumping of the stones.
- d) Sacked Soil-Cement Rip-Rap: Preparation of foundation shall be performed as .1 (a) above.
- e) Filter Blanket: Filter blankets shall be constructed at locations shown on the Plans or where directed by the Engineer, and to the lines and grades as staked by the Engineer.

.2 Placing

- a) Hand-Placed Rip-Rap: Stones shall be placed by hand to cover the required length, width and thickness. Stones shall be firmly bedded into the slope and against adjoining stones with spalls used to fill the voids. The larger stones shall be placed in the bottom rows. The largest dimension of the stones shall be perpendicular to the slope, unless such dimension is greater than the specified thickness of the rip-rap.
- b) Hand-Placed Grouted Rip-Rap: The stones shall be placed as specified in .2(a) above. The surface of the stones shall be thoroughly wetted before applying the mortar. The spaces between the stones shall be filled with cement mortar with the outer faces of the stones left exposed. The mortar shall be composed of one (1) part Portland Cement and three (3) parts of sand, of such consistency that it can be placed with a mason's trowel. After completing the grouting,

9.11.3 Construction
cont'd

the exposed surfaces of the stones shall be thoroughly brushed to remove the cement mortar. The outer stones shall project two (2) to four (4) inches above the grouted surface.

Grouted rip-rap shall be cured using curing compounds, burlap, a blanket of earth kept wet for seventy-two (72) hours, or by sprinkling with a fine spray every two (2) hours during the daytime for a period of three (3) days.

- c) Random Rip-Rap: Random rip-rap shall be dumped onto the surface to be rip-rapped; sufficient hand and/or machine work shall be performed to produce a uniform depth and surface of the finished rip-rap.
- d) Sacked Soil-Cement Rip-Rap: The Engineer will designate the amount of cement to be used in the preparation of the soil-cement mixture. The soil and cement shall be dry mixed in a manner which, in the opinion of the Engineer, is acceptable for uniformly distributing the cement throughout the soil. Each burlap sack shall be filled with approximately one (1) cubic foot of soil-cement mixture and securely tied at the top in a manner meeting with the acceptance of the Engineer. If the sacks are not to be immediately placed into their final position, they shall be kept dry. Upon placing into the work, each sack shall be packed into conformance with the prepared base and adjacent sacks already in place. Additional courses of sacks shall be placed to obtain the required depth within the area staked or designated by the Engineer. If being placed in the summer, the sacks shall then be thoroughly soaked with a gentle spray of water and kept moist for twenty-four (24) hours by sprinkling, covering with moist earth or other approved means.

9.11.3 Construction
cont'd

When placing sacked soil-cement rip-rap during the summer months the Contractor may wet mix the soil-cement mixture providing the filled sacks are immediately placed into the work and kept moist for a period of twenty-four (24) hours.

9.11.4 Measurement

The quantity of rip-rap which will be measured for payment will be the number of cubic yards of rip-rap of the types specified in Division 1, Section 1 and provided for in the Unit Price Table, accepted in the completed work by the Engineer. The measurement will be based on the volume of rip-rap in its final position.

In addition the following related work items will be measured for payment:

- .1 The supply and transportation of soil material for the sacked soil-cement will, for the purpose of payment, be measured as PIT RUN GRAVEL and HAUL OF PIT RUN GRAVEL.
- .2 The supply and transportation of filter blanket material will, for the purpose of payment, be measured as PIT RUN GRAVEL and HAUL OF PIT RUN GRAVEL.
- .3 The transportation of stone rip-rap material will, for the purpose of payment, be measured as HAUL OF PIT RUN GRAVEL.
- .4 Portland Cement for sacked soil-cement rip-rap will be measured as the number of 80 pound bags of cement acceptably supplied, delivered and incorporated into the soil-cement mixture.

All other work and materials required for acceptably completing the rip-rap installations, with filter blankets where directed, will not be measured separately for payment but will be considered incidental to the work measurements outlined above.

9.12.1 Description

This item consists of the removal and disposal of snow and ice from the right of way, borrow areas and embankments, in accordance with these specifications.

9.12.2 Materials

Not applicable.

9.12.3 Construction

.1

Removal of Snow and Ice

- a) Snow shall be removed from areas being excavated.
- b) Solid ice encountered during the excavation of earth material, shall be removed as directed by the Engineer.
- c) Prior to placing the embankment, snow and ice shall be removed from the area within the limits of the embankment unless otherwise directed by the Engineer. The removal of snow and ice shall be carried out so as to cause minimum disturbance to the natural ground cover.
- d) During the placing of material, the embankment shall be kept free of snow and ice.

.2

Snow and Ice Removal Equipment

The Snow and Ice Removal Equipment shall consist of a crawler tractor of minimum net flywheel horse power of 101, equipped with a dozer blade. The blade shall be equipped with two height adjustable mushroom type shoes of a design approved by the Engineer.

The Snow and Ice Removal Equipment shall be equipped with an approved time recording device which accurately records the number of hours the machine is in operation.

9.12.3 Construction .2
cont'd

It will be the Contractor's responsibility to ensure that the device is properly mounted and maintained, that the cards are accurately identified, as to date, and shift, and to daily deliver said cards to the Engineer.

The Engineer will record the number of operating hours for the machine and both the Engineer and the Contractor will certify daily that such records are correct.

9.12.4 Measurement .1

The quantity of SNOW AND ICE REMOVAL as specified in paragraph (c) to be measured for payment, will be the number of approved hours the Snow and Ice Removal Equipment is operated removing snow and ice.

Removal of snow as specified in paragraphs 9.12.3.1 (a) and (d) will not be measured separately for payment but will be considered incidental to the construction under other Unit Price Table items.

Removal of ice as specified in 9.12.3.1 (b) will be measured for payment in Excavation Common or Channel Excavation Common (Specification 9.2 and 9.3).

9.13.1 Description.

This item consists of supplying vehicles for the use of the Engineer and his representatives.

.1 Type and Equipment

- a) Vehicles shall be of the types and number specified in Division 1, Section 1.
- b) Vehicles shall be maintained in good running order, equipped with heater, defroster, right and left hand mirrors, windshield washers, permanent type anti-freeze, spare wheel, heavy duty bumper jack, wheel wrench, all-weather mud and snow tires on rear and spare wheels, directional signals with two-way flasher, full width front seat, first aid kits, and licensed in accordance with Territorial regulations.

.2 Delivery and Return of Vehicles

- a) The vehicles shall be delivered to a location designated by the Engineer. From the time of delivery, they shall be deemed to be in the possession of the Crown until returned to the Contractor.
- b) The Engineer may, at any time or times, return any or all of the vehicles to the Contractor by advising the Contractor's representative in writing. From the date of such advice to the Contractor's representative the specified vehicles shall be deemed to be in the possession of the Contractor.
- c) The Contractor shall, upon written request from the Engineer, redeliver to him any vehicles returned to the Contractor.
- d) The Engineer may require the Contractor to furnish vehicles until final measurements have been completed.

9.13.3 Rental
Conditions

.1 Damage and Repairs

- a) All vehicles supplied pursuant to this contract are at the risk of the Contractor whether in the possession of

9.13.3 Rental
Conditions
cont'd

the Contractor or the Crown, and the Contractor shall not make any claim or demand, or bring any action or other legal proceedings against the Crown in respect of damage to any such vehicle, including damage caused by the negligence of an officer or servant of the Crown while acting within the scope of his duties.

- b) All repairs to vehicles supplied under this contract will be performed expeditiously by the Contractor.

- .2 Protection: The Contractor, for himself, his heirs, executors and administrators, hereby undertakes to indemnify and save harmless, the Crown, and officers, servants and agents of the Crown from and against all manner of actions, causes of action, suits, debts, duties, agreements, claims and demands whatsoever which may hereafter exist or be made for or by reason of any cause, matter or thing whatsoever arising out of these terms of rental and the transportation or operation of equipment herein referred to.

9.13.4 Measurement

The quantity of vehicles for use by the Engineer which will be measured for payment, will be the actual number of months and fractions thereof that the vehicles are in possession of the Engineer and are in acceptable operating condition. All costs of supply, operation and maintenance of the vehicles and ancilliary equipment will be incidental to the Unit Prices bid for the vehicles.