

Geotechnical Report for USFWS Fish Passage  
Improvements – Copper River Highway, Cordova, Alaska  
Northern Region Materials Section (NRMS) Review Comments – Steve McGroarty  
April 9, 2019

Geotechnical investigation appears thorough with adequate drilling and sampling and very thorough photographic documentation and laboratory testing of samples.

Geotechnical recommendations and conclusions provided by Northern Geotechnical Engineering were based on an assumption that all pipes would be bottomless arches. NRMS strongly recommends culverts or arches with closed bottoms be used for all pipes in this project. We recommend the report be revised based on the assumption that closed bottom multi-plate culverts or arches will be used. In these review comments, reference to a culvert means a close-bottomed culvert or arch.

The report indicates that if the design of the culverts is significantly different from the assumed open-channel box culvert design, they will revise their recommendations accordingly. NRMS would be happy to review and comment on any revised geotechnical report. We submit the following comments on the report and offer geotechnical recommendations for foundation design for consideration based on the assumptions listed below.

Section 6.2 Earthworks: The report indicates that “any material removed during the initial site grading and excavation activities, which does not contain any organic / deleterious material, and has relatively low silt content (less than 15 percent passing the #200 sieve), can be reused on site as structural fill”. It is unclear exactly where this “structural fill” material is proposed to be used; however, we recommend that foundation material under the culvert be Selected Material, Type A (0-6 % P200) passing the 2-inch sieve or Subbase, Grading F and that culvert Embedment Material be Selected Material, Type A passing the 2-inch sieve. Embedment Material is defined as material located between vertical planes 18-inches outside the horizontal projection of the outermost diameter of the pipe, horizontal planes located 12-inches above and below the outermost diameter of the pipe or to the depth shown on the plans. Outside of the Embedment Material zone, the backfill can be Selected Material, Type B (0-10 % P200) up to 3.5-feet below the road surface with Selected Material, Type A and Aggregate Surface Course above that.

The report does not allow determination of culvert inlet depths with respect to depth below the road surface; drill logs should be reviewed during individual culvert design to evaluate culvert foundation design. I have assumed the creek level is approximately equal to the water level in the drill holes, creek channels are 2-feet deep and bottom of culverts will be 2-feet below the bottom of the channel. The bottom of the culvert foundation is therefore assumed to be 1 to 2-feet below the bottom of the culvert or 5 to 6-feet below the water level in the drill holes.

If the material at 1 to 2-feet below the design elevation for the bottom of the culvert is expected to be medium dense or better sand or gravel, I recommend that design excavation limit be 1-foot below the base of the culvert or arch. Remove any unsuitable material and replace with Selected Material, Type A. If base of excavation at 1-foot below bottom of culvert can be Proof-Rolled, Proof Roll the base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts.

If base of excavation cannot be Proof-Rolled, excavate an additional 1-foot, Proof Roll if possible, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding. (Selected Material, Type A passing the 2-inch sieve can be substituted for Subbase, Grading F.) Where the material differed at the expected base of excavation between the two test holes, I based design recommendations on the weaker material.

I recommend that all culvert excavations be dewatered so that the base of the excavation can be Proof-Rolled and culvert foundations, bedding and backfill can be compacted “in-the-dry”. If the groundwater table prevents dewatering the base of the excavation to allow for Proof-Rolling and placement of foundation material and bedding in the dry with normal dewatering methods, I suggest that you consider excavation of an additional foot of foundation soils and placement of 1-foot of Porous Backfill, with non-woven Stabilization Geotextile above and below the Porous Backfill, to be routed to a sump at the outlet for dewatering efforts. Do not place geotextile over the upstream vertical plane of the Porous Backfill layer. If a layer of Porous Backfill is placed as part of the dewatering efforts, the inlet end of this Porous Backfill layer should be exposed in a cross-trench dug after completion of the culvert and backfilled with Selected Material, Type C with a minimum of 15% P200 to minimize the risk of short-circuiting of water under, rather than through, the culvert during periods of low-flow.

COP1 – Approximate culvert foundation level soils appears likely to be in loose to medium dense Poorly Graded Sand with Silt or Poorly Graded Sand with Silt and Gravel. Assume base of excavation is 2-feet below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. Proof Roll base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

COP9 – Approximate culvert foundation level soils appear likely to be in medium dense Poorly Graded Sand with Gravel or medium dense to loose Silty Sand or loose Sandy Silt. Assume base of excavation is 2-feet below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. Proof Roll base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

COP20 - Approximate culvert foundation level soils appears likely to be loose to medium dense Well Graded Gravel with Sand. Assume base of excavation is 2-feet below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. Proof Roll base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

COP22 - Approximate culvert foundation level soils appears likely to be medium dense Well Graded Gravel with Sand to dense Poorly Graded Sand with Gravel. Assume base of excavation is 1-foot below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. Proof

roll base of excavation. Place 15-foot wide Reinforcement Geotextile Type - 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts.

COP25 - Approximate culvert foundation level soils appears likely to be loose Sand with Gravel to medium dense Gravel with Sand. Assume based of excavation is 1-foot below bottom of culvert. Proof roll base of excavation. Remove any unsuitable material and replace with Selected Material, Type A. If base of excavation at 1-foot below bottom of culvert can be Proof-Rolled, Proof Roll base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts. If base of excavation cannot be Proof-Rolled, excavate an additional 1-foot, Proof Roll, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

COP33 - Approximate culvert foundation level soils appears likely to be very loose Silty Sand to medium dense Poorly Graded Sand with Gravel. Excavate 2-feet below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. Proof roll base of excavation. Place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

COP43 - Approximate culvert foundation level soils appears likely to be loose to very loose Silty Sand. Excavate 2-feet below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. Proof roll base of excavation. Place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

COP44 - Approximate culvert foundation level soils appears likely to be medium dense Well Graded Sand with Silt and Gravel to medium dense Well Graded Gavel with Sand, but could be loose Poorly Graded Sand with Silt and Gravel. Assume excavation to 1-foot below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. If base of excavation at 1-foot below bottom of culvert can be Proof-Rolled, Proof Roll base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts. If base of excavation cannot be Proof-Rolled, excavate an additional 1-foot, Proof Roll, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

COP45 - Approximate culvert foundation level soils appears likely to be very loose Silty Sand. Excavate 2-feet below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. Proof roll base of excavation. Place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

CAB2 - Approximate culvert foundation level soils appears likely to be loose Well Graded Sand with Silt and Gravel to medium dense Well Graded Gravel with Sand. Assume excavation to 1-foot below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. If base of excavation at 1-foot below bottom of culvert can be Proof-Rolled, Proof Roll base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts. If base of excavation cannot be Proof-Rolled, excavate an additional 1-foot, Proof Roll, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile – Type 2, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

SHER - Approximate culvert foundation level soils appears likely to be loose poorly Graded Sand with Gravel to medium dense Well Graded Sand with Silt, but could be loose Silty Sand. Assume excavation to 1-foot below bottom of culvert. Remove any unsuitable material and replace with Selected Material, Type A. If base of excavation at 1-foot below bottom of culvert can be Proof-Rolled, Proof Roll base of excavation, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts. If base of excavation cannot be Proof-Rolled, excavate an additional 1-foot, Proof Roll, place 15-foot wide Reinforcement Geotextile - Type 2 parallel to and centered under the culvert centerline, place and compact 1-foot of Subbase Grading F as two 6-inch lifts, place a second layer of Reinforcement Geotextile, place and compact an additional 1-foot of Subbase, Grading F as two 6-inch lifts as culvert bedding.

Specifications for material types referenced above are below:

Embedment Material: Embedment Material consists of bedding, and backfill to 12 inches above the pipe. Use Selected Material, Type A (Subsection 703-2.07) passing the 2-inch sieve for embedment material between vertical planes 18 inches outside the horizontal projection of the outer most diameter of the pipe, horizontal planes located 12 inches above and below the outermost diameter of the pipe or to the depth shown on the Plans.

**703-2.07 SELECTED MATERIAL.** Meet the following requirements for the type specified. Obtain the Engineer's approval for the intended purpose, prior to use on the project.

1. **Type A.** Aggregate containing no muck, frozen material, roots, sod or other deleterious matter and with a plasticity index not greater than 6 as tested by ATM 204 and ATM 205. Meet the following gradation as tested by ATM 304:

<u>Sieve</u>	<u>Percent Passing by Weight</u>
No. 4	20-60%
No. 200	0-6%, determined on the minus 3-inch portion of the sample

2. **Type B.** Aggregate containing no muck, frozen material, roots, sod or other deleterious matter and with a plasticity index not greater than 6 as tested by ATM 204 and ATM 205. Meet the following gradation as tested by ATM 304:

<u>Sieve</u>	<u>Percent Passing by Weight</u>
No. 200	0-10% determined on the minus 3-inch portion of the sample

3. **Type C.** Earth, sand, gravel, rock, or combinations thereof containing no muck, peat, frozen material, roots, sod, or other deleterious matter and is compactable under the provisions of Subsections 203-3.04 or 203-3.05.

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**703-2.09 SUBBASE.** *Add the following:*

**Subbase, Grading F.** Aggregate containing no muck, frozen material, roots, sod or other deleterious matter and with a plasticity index not greater than 6 as tested by ATM 204 and ATM 205. Table 703-8 and the first paragraph of Subsection 703-2.09 do not apply to Grading F. Meet the following gradation as tested by ATM 304:

<u>Sieve</u>	<u>Percent Passing by Weight</u>
2 in	100%
No. 4	15-65%
No. 200	0-6%

**703-2.10 POROUS BACKFILL MATERIAL.** Gravel consisting of crushed or naturally occurring granular material containing not more than 1 percent clay lumps or other readily decomposed material (AASHTO T 112). Meet the grading requirements of Table 703-10 as determined by ATM 304.

**TABLE 703-10  
AGGREGATE GRADATION FOR POROUS BACKFILL MATERIAL**

<b>SIEVE</b>	<b>PERCENT PASSING BY WEIGHT</b>
3 in.	100
1 in.	0-10
No. 200	0-5

**703-2.03 AGGREGATE FOR BASE AND SURFACE COURSE.** Crushed stone or crushed gravel, consisting of sound, tough, durable pebbles or rock fragments of uniform quality. Free from clay balls, vegetable matter, or other deleterious matters. Meet Table 703-1:

**TABLE 703-1  
AGGREGATE QUALITY PROPERTIES FOR BASE AND SURFACE COURSE**

PROPERTY	BASE COURSE	SURFACE COURSE	TEST METHOD
L.A. Wear,%	50, max.	45, max.	AASHTO T 96
Degradation Value	45, min.	45, min.	ATM 313
Fracture,%	70, min.	70, min., 1 Face	ATM 305
Liquid Limit	---	35, max.	ATM 204
Plastic Index	6, max.	10, max.	ATM 205
Sodium Sulfate Loss,%	9, max. (5 cycles)	9, max. (5 cycles)	AASHTO T 104

Meet Table 703-2 aggregate gradation requirements, as determined by ATM 304:

**TABLE 703-2  
AGGREGATE GRADATION FOR BASE AND SURFACE COURSE**

Percent Passing By Weight

SIEVE	GRADATION			
	BASE COURSE		SURFACE COURSE	
	C-1	D-1	E-1	F-1
1-1/2 in.	100			
1 in.	70-100	100	100	100
3/4 in.	60-90	70-100	70-100	85-100
3/8 in.	45-75	50-80	50-85	60-100
No. 4	30-60	35-65	35-65	50-85
No. 8	22-52	20-50	20-50	40-70
No. 50	6-30	6-30	15-30	25-45
No. 200	0-6	0-6	8-15	8-20

**203-3.06 COMPACTION BY PROOF ROLLING.** *Add the following:* Proof-roll the base of excavation and where the embankment crosses previously undisturbed ground, prior to placing new embankment material, to the extent that ensures the first lift of material placed upon it can be compacted to the specified density. Omit proof rolling only as approved by the Engineer and as necessary to prevent liquefaction of surface soils.

### SECTION 630 GEOTEXTILE FOR EMBANKMENT AND ROADWAY SEPARATION, STABILIZATION AND REINFORCEMENT

**630-1.01 DESCRIPTION.** Prepare ground surface, and furnish and place geotextiles for separation, stabilization, and/or reinforcement as shown on the Plans.

**630-2.01 MATERIALS.** Use materials that conform to the following:

Geotextiles and Sewn Seam Strength

Subsection 729-2.01

### **630-3.01 CONSTRUCTION.**

1. Surface Preparation. Prepare ground surface by removing stumps, brush, boulders, and sharp objects. Fill holes and ruts over 3 inches deep, with material shown on the Plans or as approved by the Engineer.
2. Geotextile Placement. Unroll geotextile directly onto the prepared surface. Stretch geotextile to remove any creases, folds or wrinkles. Do not drag the geotextile through mud or over sharp objects that could damage the geotextile. Do not expose geotextiles to sunlight for longer than 14 days after removal of protective covering. Do not allow geotextiles to get wet prior to installation.
  - a. Geotextile, Reinforcement placed under culverts shall be placed perpendicular to the road centerline (i.e. parallel to the culvert centerline), with one 15-foot wide piece of geotextile centered under the culvert centerline. Seams parallel to the road centerline (i.e. perpendicular to the culvert centerline) shall not be allowed.
4. Material Placing and Spreading. During placing and spreading of material, maintain a minimum depth of 6 inches of cover material at all times between the geotextile and the wheels or tracks of the construction equipment. Limit the size and weight of construction equipment to reduce rutting in the initial lift above the geotextile to not greater than 3 inches deep to prevent overstressing the geotextile.

Place the cover material and spread in only one direction for the entire length of the geotextile. On weak subgrades limit height of dumped cover material to prevent localized subgrade and/or geotextile failure.

Compact using a smooth drum roller. Do not allow construction equipment to make sudden stops, starts, or turns on the cover material. Do not allow turning of vehicles on the initial lift of cover material above the geotextile. Fill any ruts over 3 inches deep occurring during construction with material shown on the Plans; do not grade adjacent material into rut; and compact to the specified density.

5. Geotextile Repair. Repair and replace damaged geotextile (torn, punctured, or disturbed at the overlaps or sewn joints). For damage evidenced by visible geotextile damage, subgrade pumping, intrusion, or embankment distortion, remove the backfill around and under the damaged or displaced area, and repair with material matching the damaged material. Make patches overlap or sew patches to the existing geotextile.
  - a. Reinforcement. Overlay torn area with geotextile with a minimum 3 foot overlap around the edges of the torn or damaged area. Ensure the patch remains in place when cover material is placed over the affected area.

**630-4.01 METHOD OF MEASUREMENT.** By multiplying plan neat line width by the measured length in final position parallel to installation centerline along the ground surface. No allowance will be made for overlap, whether at joints or patches.

## **SECTION 729 GEOSYNTHETICS**

### **729-2.01 GEOTEXTILE FOR SUBSURFACE DRAINAGE, SEPARATION, STABILIZATION, EROSION CONTROL AND EMBANKMENT REINFORCEMENT.**

1. Subsurface Drainage. Meet AASHTO M 288 for Subsurface Drainage, except provide a minimum permittivity of 0.50 sec-1, and meet Class 2 Strength Property Requirements.
2. Separation. Meet AASHTO M 288 for Separation, except provide a minimum permittivity of 0.50 sec-1, and meet Class 3 Strength Property Requirements.
3. Stabilization. Meet AASHTO M 288 for Stabilization, except provides a minimum permittivity of 0.50 sec-1, and meet Class 1 Strength Property Requirements.
4. Erosion Control. Meet AASHTO M 288 for Permanent Erosion Control and meet Class 1 Strength Property Requirements.
5. Reinforcement. Meet the requirements in Table 729-1 for Type 1 or Type 2.

Package, label, handle and store geotextile materials according to ASTM D 4873.



**TABLE 729-1  
GEOTEXTILE REINFORCEMENT PROPERTIES**

Property	Test Method	Units	Requirement <sup>a</sup>	
			Type 1	Type 2
Grab Tensile	ASTM D4632	lb.	200/200	400/400
Grab Elongation	ASTM D4632	% (MD)	10	10
Wide Width Tensile	ASTM D4595	lb/in. (ultimate)	200/200	400/400
Wide Width Tensile	ASTM D4595	lb/in. (@ 5% strain)	100/100	200/200
Seam Breaking Strength	ASTM D4632	lb./in.	180	360
Puncture	ASTM D6241	lb.	500	1500
Trapezoidal Tear	ASTM D4533	lb.	100	150
AOS	ASTM D4751	U.S. sieve size	#30b	#30b
Permittivity	ASTM D4491	sec <sup>-1</sup>	0.40	0.40
Flow Rate	ASTM D4491	gal./min./ft <sup>2</sup>	10	10

a Minimum Average Roll Values (MARV) in machine direction (MD) / cross-machine direction (XD) unless otherwise specified.

b Maximum average roll value