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June 18, 2003

Mr. Dave Martinson
U.S. Army Corps of Engineers, Alaska District
CEPOA-EN-CW-PF
Post Office Box 6898
Anchorage, AK 99506-6898

RE: Evaluation of Project Cost Reductions and Suitability of a Culvert, Feasibility Study of Aquatic Ecosystem Restoration, Chester Creek, Anchorage, Alaska

Dear Dave:

This letter report presents our findings on possible cost cutting measures for the project as well as the suitability of a culvert to replace the railroad bridge and culvert design requirements.

1.1 SUITABILITY OF A CULVERT

A separate informational paper addressing the suitability of a culvert has been prepared by HDR Alaska and is attached to this document. The paper indicates that the use of a culvert instead of a bridge will not significantly change the channel conditions encountered by migrating fish during non-tide conditions. The use of the culvert may restrict some of the higher tide access depending on the culvert diameter. The paper recommends a minimum culvert size of 16 ft. diameter; this results in tide exceedance of the top of the culvert 15% of the time. The paper also noted that although the velocities are higher in the culvert than an open channel condition, they are still below ADF&G allowable criteria.

1.2 CULVERT DESIGN

The attached paper addressing the suitability of a culvert also addresses the design criteria for the culvert size and location. The hydraulic analysis that was conducted indicates that any pipe that minimizes submergence, 14 foot to 18-foot diameter, will convey the 100- and 500-year events adequately. Additional analysis will be required to determine if a 16-foot diameter culvert is appropriate or if an 18-foot diameter culvert is required to reduce the chance of scouring out the constructed channel. Construction of the creek channel inside the culvert will maintain the required fish passage and habitat requirements of the project. It should be noted that a culvert is actually beneficial in that it will reduce wave action on the exposed face of the Westchester Lagoon dam. The wide high tide opening of a railroad bridge would expose a large portion of the dam fill to wave action from Knik Arm. A culvert opening will attenuate these waves. This will reduce the wave action potential on the dam face and reduce protection requirements.

A study addressing fish passage and the use of culverts was done by Inter-fluve, Inc. and is also attached to this document. The paper summarizes the different design approaches used in the Pacific Northwest for fish passage through culverts and the culvert issues applicable to Chester Creek.

Also considered in the culvert design was the required earthwork in and around the railroad embankment. The invert elevation of the proposed channel under the railroad tracks is –2.8 ft MSL Two feet of rip rap is required to form the stream channel in the culvert, resulting in the invert of the culvert at –5 ft MSL. Two feet of bedding is required below the base of the culvert, resulting in an excavation elevation of –7 ft MSL. The top of the railroad embankment is at 34 MSL and the approximate elevation of native materials below the embankment is 9 ft MSL. Therefore, in order to install the culvert it is estimated that up to 100 ft of the 25 ft high railroad embankment and an additional 16 ft of in-situ material (presumably inlet silts and sands) will have to be removed. The railroad has tentatively agreed to providing a 48-hour window before or after the gravel season (gravel season is May 15 to October 15; see letter from Mr. Tom Brooks, ARRC, date May 21, 2003, attached). During this window construction can occur without train traffic. This will allow the contractor to work without interruption and relieve the project from constructing a shoofly which would be required to prevent disruption to train service during construction of a bridge. This should be sufficient time for the contractor to do the culvert installation without the need for a shoofly however construction sequencing should be looked at more closely if the culvert option is selected. During this 48-hour window the contractor will have to do the earthwork necessary for installing the culvert and then re-establish the railroad embankment and track.

The ARRC has agreed to maintain the culvert structure provided the design incorporates an allowance for a second track. (see letter from Mr. Tom Brooks, ARRC dated May 21, 2003, attached). This design assumes a 120-foot long culvert that will meet the width requirements for a second track (on the outboard side).

The work site is effected by tidal fluctuations. The bedding for the culvert and the bottom portion of the culvert will be installed below the low tide level. In other words the contractor will have to shore off the work so they are not working below water. Prior to installing the culvert, utilities will have to be relocated. The utility relocation initially was to be handled under a separate contract. However, there is a potential cost savings for the utility relocation work if one contractor does all the work thereby reducing mobilization costs. The relocation of the utilities will have to occur prior to the culvert installation as the design grade of the culvert conflicts with the existing location of the utilities.

An open-bottomed culvert, a round culvert and a pipe arch were all considered in this evaluation. An open bottomed culvert requires a foundation. Given the allowable work window, the soil conditions and the difficulty added by tidal fluctuations, it would not be possible to build a poured-in-place foundation. A piling foundation could be used but this would ultimately require the construction of a shoofly to prevent disruption to train service. The shoofly adds a large expense to the project and therefore the open-bottomed culvert was eliminated as an option. The pipe arch is limited by the maximum allowable cover and the E80 design loading (required for train loading). A pipe arch shape can not handle the 20+ ft of cover that is required and therefore was eliminated as an option. This leaves the round culvert. A 16 ft diameter, 0.25 inch thick, round culvert will meet the E80 loading criteria and the required cover criteria. An aluminum culvert has been selected for its corrosion resistance.

An agency meeting took place on December 19, 2002 to discuss the proposed culvert design. The meeting was attended by the USACE, TNH, HDR, MOA, ADF&G, USFWS, ARRC and NRCS. Mr. Rob Sampson (NRCS) suggested installing the culvert at zero grade to widen the channel at the inlet. He also suggested that a hydraulic analysis of the flow velocities in the culvert be done for the tidal flows. Both of these suggestions have been accepted and incorporated.

1.3 OVERALL DESIGN

The following options were considered in the cost reduction evaluation:

1. Installation of an aluminum structural plate culvert instead of a railroad bridge;
2. Removal of the architectural fence along the bike path; and
3. Removal of the viewing platforms from the bike trail bridge.

The original construction cost estimate was approximately $5,200,000. We reviewed the detailed MCACES estimate prepared by HMS, Inc. and determined that the stand-alone cost of the railroad bridge was approximately $2,820,000. This includes all aspects of bridge construction (i.e., contractor mobilization, materials, railroad shoofly, trackwork, etc.) and not just the structure itself. The cost for installation of an aluminum structural plate culvert was estimated at $520,000. By substituting the culvert for the railroad bridge, the total project cost would be reduced to $2,900,000. We estimated that removal of the architectural fence from the project would provide a savings of $149,500. Removal of the viewing platforms from the bike trail bridge saved an estimated $40,000. If additional cost savings are required, the architectural fence could be removed from the project. That would reduce the total project cost to $2,750,500. As noted above, removal of the viewing platforms from the bike trail bridge would save approximately $40,000. However, the cost savings is outweighed by the safety issues. We anticipate people wanting to stop on the bike trail bridge and look at the weir and the fish movement. Removing the viewing platforms would cause a bottleneck effect and potential for injury to bike trail users. For this reason we recommend leaving the bike trail bridge as designed.

Attached are the preliminary culvert drawings and backup for the revised construction cost estimates discussed above.

If you have any comments or questions, please feel free to contact me.

Sincerely,

TRYCK NYMAN HAYES, INC.

Ted B. Trueblood
President

Enclosures: HDR Alaska, Inc. memo, Chester Creek Culvert Evaluation
Inter-Fluve, Inc. memo, PNW design guidelines for culverts in intertidal zones
Cost estimate backup
Drawings
Letter from Mr. Tom Brooks, ARRC, dated May 21,2003.

To	Ted Trueblood
From	Dan Billman
Date	January 12, 2003
Subject	Chester Creek Culvert Evaluation

HDR Alaska Memorandum

The Chester Creek fish passage 30% design project contains a trestle for the Alaska Railroad Crossing of the new creek channel. The estimated construction cost of the trestle causes the project to be beyond current project funding. The Corps of Engineers has directed the project team to evaluate whether replacing the trestle with a culvert can meet project aquatic habitat improvement goals and funding constraints. Our portion of this work included the four tasks. These were evaluating the suitability of a culvert for fish passage in this location; determining the culvert size and required fish passage enhancements; and verifying a culvert can be incorporated into the current channel design; and attending a meeting to discuss the results. This memorandum presents the results of this work.

1.1 Culvert Suitability

The 'design fish' for the channel has been coho salmon, although trout and other salmon species will use the channel. The current trestle and channel design present no artificial barriers to migration salmon. Once returning adult salmon reach the downstream end of the new channel, its design should provide upstream migration and holding opportunities. Out-migrating salmon fry have the opportunity to access the new creek channel at any stage of the tide and the opportunity to hold within the channel where pools. At high tide the channel will be flooded forming a large pool. As the tide recedes, the channel will be exposed and have pool and cascade morphology.

Replacing the trestle with a culvert will replace about 123 feet of trapezoidal channel with a circular culvert. Any recommended culvert should be large diameter: 14 feet to 18 feet. The proposed channel slope through the railroad embankment will remain as currently planned. No change will be made. The culvert slope may parallel the channel slope or be set at zero slope, flat. To provide culvert stability and maintain fish habitat, the bottom of the culvert will be buried 3 feet below the proposed channel bottom. The culvert will be lined with the same channel bed rip rap material as is proposed up- and downstream of the culvert. Depending on the selected culvert diameter (14 feet to 18 feet), the channel bottom width in the culvert will range from 11 to 13.4 feet wide; the proposed channel bottom width is 11 feet. The proposed lower flow thalweg channel will be constructed in the culvert. Therefore, during non-tide conditions, a culvert will not significantly change the channel conditions encountered by migrating fish.

During previous fish passage evaluations for Chester Creek (by MOA DPW in 1996), it was noted by ADF&G that returning salmon would benefit from being able to find the creek channel at high tide. The present creek culvert is submerged at approximate elevation 3 MSL. Mean high tide (MHT) is approximately elevation 11 MSL. ADF&G recommended that additional fish access be provided at MHT. This was satisfactorily solved in the 1996 proposed improvements by placing a bank of culverts at MHT through the railroad fill.

Using a trestle for the railroad provides unrestricted access to the lagoon at high tide. A culvert used in place of the trestle can restrict some of the higher tide access depending on the culvert diameter. Analysis of tidal data to prepare a tide exceedance curve was done. This curve plots the percentage of time a certain tide level is exceeded. Table 1 shows how often tide levels will flood the top of the seaward end of various size culverts. Selecting a culvert that can economically be constructed to provide the most tide coverage will be important in maximizing fish access to the lagoon. The culvert size will have no impact on out migrating fish.

Table 1 Culvert Submergence and Tidal Exceedance

Culvert Size, feet	Bottom Elevation Knik Arm End, MSL[1]	Top Elevation Knik Arm End, MSL	Tide Exceedance, %
10	-6.6	3.4	45
12	-6.6	5.4	34
14	-6.6	7.04	25
16	-6.6	9.4	15
18	-6.6	11.4	7

[1] Assumes 3 foot bury below channel bottom.

The channel velocities at the trestle location will determine some of the fish use of this area. During an outgoing tide the flooded channel and the creek discharge will flow through the channel or culvert under the trestle. Assuming a tidal run of 34 feet, channel velocities at the trestle would be on the order of 0.1 to 0.2 feet per second during normal summer creek flows and 0.1 to 0.3 feet per second during the mean annual flood. With the same tidal fall and a 16-foot diameter culvert with 4.5 feet of channel material in the bottom, velocities in the culvert would range between 1.1 and 1.6 feet per second during normal summer flows and 1.5 to 2.5 during the mean annual flood. These should be compared to the ADF&G maximum allowable culvert velocity of 2.5 feet per second for juvenile coho salmon passage for a culvert of this length. Therefore while the culvert velocities are higher than the open channel condition, they do not exceed allowable ADF&G criteria.

Based on the information contained in the attached memorandum and the discussion above, the culvert should be 16 feet diameter, or larger, if it is possible to construct it in this location. A culvert of this diameter will allow construction of the design channel in the bottom of the culvert. It will minimize the time the crown is submerged thus causing little disruption in fish passage during high tides. Culvert tidal velocities will not exceed ADF&G criteria for juvenile salmon. Such a culvert can be used to enhance the aquatic habitat of the area and meet project goals.

1.2 Culvert Design

Our hydraulic analysis of the culvert indicates that any pipe that minimizes submergence, 14 foot to 18-foot diameter, will convey the 100- and 500-year events adequately. All culverts will have the proposed channel substrate and riprap mixture installed in them. This was accounted for in culvert capacity analyses. During the 500-year event velocities through a 16-foot diameter may reach values that arte at the upper limits of rip rap design values. The culvert may need to be 18-foot diameter to reduce the chance of scouring out the constructed channel. Additional analysis is required before selection of the final culvert size. Construction of the creek channel inside the culvert will maintain the required fish passage and habitat requirements of the project.

A culvert will change some materials quantities. Channel riprap and geotextile liner will not be used where the railroad embankment eliminates the channel. This will reduce the rip rap by 150 cubic yards and reduce the geotextile by 700 square yards. Each end of the culvert will require rip rap erosion protection. Assuming a 5-foot wide rip rap apron around each end of the culvert, approximately 48 cubic yards of rip rap will be required.

Using a culvert instead of a trestle will reduce wave action in the exposed dam face. The wide high tide opening of the trestle will expose a large portion of the dam fill to wave action from Knik Arm. Storm waves can exceed 6 feet, crest to trough. With a trestle opening the dam face will require protection from these waves. A culvert opening will attenuate these waves by being a smaller opening and because, as the opening increases in size as the tide falls, waves will break on the mud flat before they can enter the culvert. This will reduce the wave action potential on the dam face and reduce protection requirements.

Chester Creek Habitat Restoration
Tidal Flow Rates Through Railroad Culvert

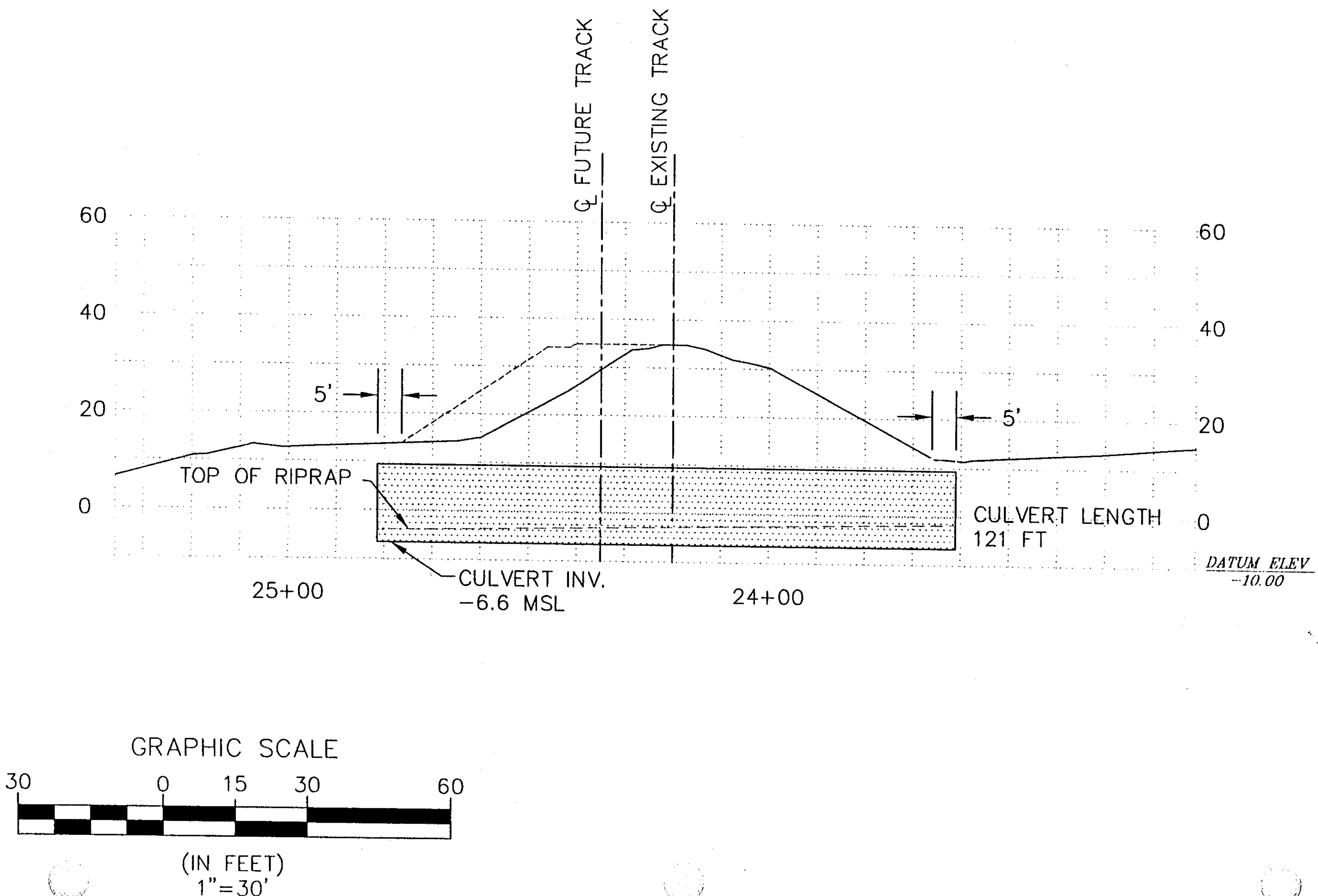
Culvert length	123	feet						
Maximum tide depth at culvert entrance	14	feet						
Maximum channel length	720	feet						
Tide drop rate per foot	660	seconds						
Channel slope	0.019444							
Summer creek flow	20	cfs						
Mean annual flood	60	cfs						
Culvert diameter, feet	16	feet	area	201	square feet	radius	8	feet
Fill in culvert bottom	4.5	feet	area	46	square feet			

Channel depth, feet	14	13	12	11	10	9	8	7	6	5	4	3
Channel length, feet	720	669	617	566	514	463	411	360	309	257	206	154
Average channel area, square feet	1,232	1,105	984	869	760	657	560	469	384	305	232	165
Channel volume, cubic feet	887,040	738,771	607,269	491,606	390,857	304,097	230,400	168,840	118,491	78,429	47,726	25,457
Volume per foot drop, cubic feet		148,269	131,503	115,663	100,749	86,760	73,697	61,560	50,349	40,063	30,703	22,269
Tide outflow rate, cfs		225	199	175	153	131	112	93	76	61	47	34
Outflow rate with normal creek flow, cfs		245	219	195	173	151	132	113	96	81	67	54
Oputflow rate with mean annual flood, cfs		285	259	235	213	191	172	153	136	121	107	94
500-year event, cfs		420	420	420	420	420	420	420	420	420	420	420
Culvert flow area, square feet		155	155	149	140	129	115	101	86	70	54	38
Trestle channel velocity at normal creek flow, fps		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Trestle channel velocity and mean annual flood, fps		0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3
Trestle 500-yr velocity, fps		0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.8	1.0	1.4
Culvert velocity at normal summer flow, fps		1.6	1.4	1.3	1.2	1.2	1.1	1.1	1.1	1.2	1.2	1.4
Culvert velocity at mean annual flood, fps		1.8	1.7	1.6	1.5	1.5	1.5	1.5	1.6	1.7	2.0	2.5
Culvert 500-yr velocity, fps		4.2	4.0	4.0	4.1	4.3	4.6	5.1	5.8	6.9	8.6	11.9
Juvenile coho passage velocity, fps		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Chester Creek Culvert elevations under ARR
All elevations MOA datum

Culvert size	Channel bottom at Knik Arm	Culvert bottom Knik Arm	Culvert top at Knik Arm	Tidal Exceedance	Channel bottom at rail centerline	Culvert bottom rail centerline	Channel bottom at Lagoon	Culvert bottom lagoon	Culvert top lagoon	Culvert top lagoon tidal elevation	Tidal Exceedance
10	-3.6	-6.6	3.4	55%	-2.4	-5.4	-1.2	-4.2	5.8	23.2	67%
12	-3.6	-6.6	5.4	66%	-2.4	-5.4	-1.2	-4.2	7.8	25.2	78%
14	-3.6	-6.6	7.4	75%	-2.4	-5.4	-1.2	-4.2	9.8	27.2	87%
16	-3.6	-6.6	9.4	85%	-2.4	-5.4	-1.2	-4.2	11.8	29.2	95%
18	-3.6	-6.6	11.4	93%	-2.4	-5.4	-1.2	-4.2	13.8	31.2	99%

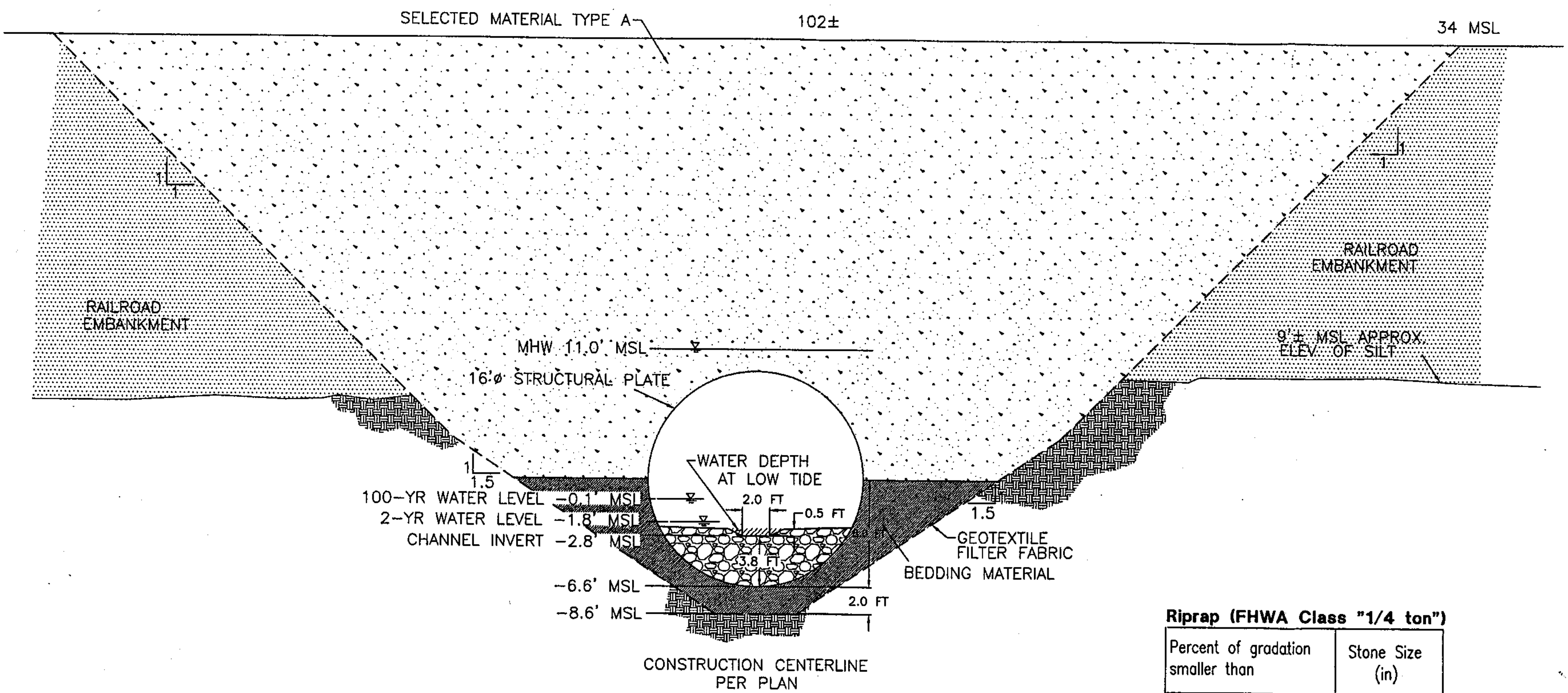
Note: Channel bottom elevations from table 1 sheet 14



PLOTTED: 01/14/03

DRAWING NAME: 00143-003_SITE

PROJECT No. & LCTN: M:\00143-003\CIVIL



Riprap (FHWA Class "1/4 ton")

Percent of gradation smaller than	Stone Size (in)
100	27
50	21.6
15	11.4

Note: Size from preliminary design is approximate to provide channel stability for hydraulic conditions and assumed ice forces.

Size will be specified during final design.

CULVERT CROSS SECTION AT STA 24+20

NOT TO SCALE

NOTE: SECTION OF CULVERT IS TAKEN AT APPROXIMATE CENTERLINE OF RAILROAD EMBANKMENT

US ARMY CORPS OF ENGINEERS ALASKA DISTRICT

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ANCHORAGE, ALASKA

DACA85-99-R-0019

ANCHORAGE, ALASKA
CHESTER CREEK
ECOSYSTEM RESTORATION
CULVERT
CROSS-SECTION

Reference number: C1