Supplement I.5-1

Supplement to Attachment I.5 of Appendix I

October 30, 2019

Revision	Description	Author		Quality Check		Independent Review	
0	RAI Response	SMM	10/28/19	JNE	10/30/19	NWH	10/30/19

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In response to RAI 4.4-2, Stantec conducted a sedimentation analysis of site diversion channels as outlined in NUREG-1623, Appendix E.

1.0 METHOD

Using the design and analysis procedures from NUREG-1623, Appendix E, Stantec evaluated the volume of sedimentation that would be expected in the North Diversion Channel over a 1,000-year time period. Stantec evaluated sheet and rill erosion, estimated sediment yield through a sediment-delivery ratio, and calculated the trap efficiency for each reach of the North Diversion Channel. After evaluating the sedimentation, Stantec evaluated the new channel capacity. Due to the lack of large observed gullies, Stantec assumed that the volume of gully erosion contributing to the North Diversion Channel will be negligible compared to the volume of sheet and rill erosion.

1.1 SHEET AND RILL EROSION

Pursuant to Appendix E of NUREG-1623, Stantec calculated the sheet and rill erosion using the Universal Soil Loss Equation (USLE) from Wischmeier and Smith (1978):

$$A = RKLSCP$$ **Equation 1**

Where:

A	=	Total Soil Loss per Unit Area [tons/acre]
R	=	Rainfall Erosivity Factor [unitless]
K	=	Soil Erodibility Factor [tons/acre]
LS	=	Slope Length-Steepness Factor [unitless]
C	=	Cropping-Management Factor [unitless]
P	=	Conservation Support Practice Factor [unitless]

NUREG-1623 outlines solving Equation 1 using the following procedure:

- Gather topographic, soil type, and land use information. Subdivide the domain into sub-watershed. For each sub-watershed determine the drainage area, runoff length, average slope, soil type, and percentage of canopy cover and ground cover.
- Determine the mean annual rainfall erodibility factor R for the specific site location
- Determine the soil erodibility factor K from soil samples for each sub-watershed

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- Determine the slope length-steepness factor LS from the runoff length and average slope
- Determine the cropping-management factor C from the ground and canopy cover data
- Determine the conservation support practice factor, P
- Multiply the factors from the initial steps to calculate the mean specific annual soil erosion loss in tons per acre per year
- Multiply the mean specific annual erosion loss from the previous step by the drainage area for each sub-watershed to obtain the mean annual soil erosion loss for each sub-watershed
- Multiply the mean annual soil erosion loss from the previous step by 1,000 years to determine the expected soil erosion loss in the next 1,000 years

1.1.1 Topographic, Soil type, and Land Use Information

Stantec used the same topographic data and subbasin delineations used in Attachment I.1 in this analysis. Stantec used subbasins 41, 36, 34, 32, 33, and 37 as source sub-watersheds for the North Diversion Channel. Soils information was estimated using a test pit TP-4 taken from Dilco Hill as described in Attachment I.3 of Appendix I. The location on Dilco Hill is the best available sediment information for soil from an undisturbed, contributing watershed. Stantec used aerial photography and site photographs to determine the ground and canopy cover on each sub-watershed. Figure 1 shows each contributing watershed and the drainage paths used to contribute sediment yield.

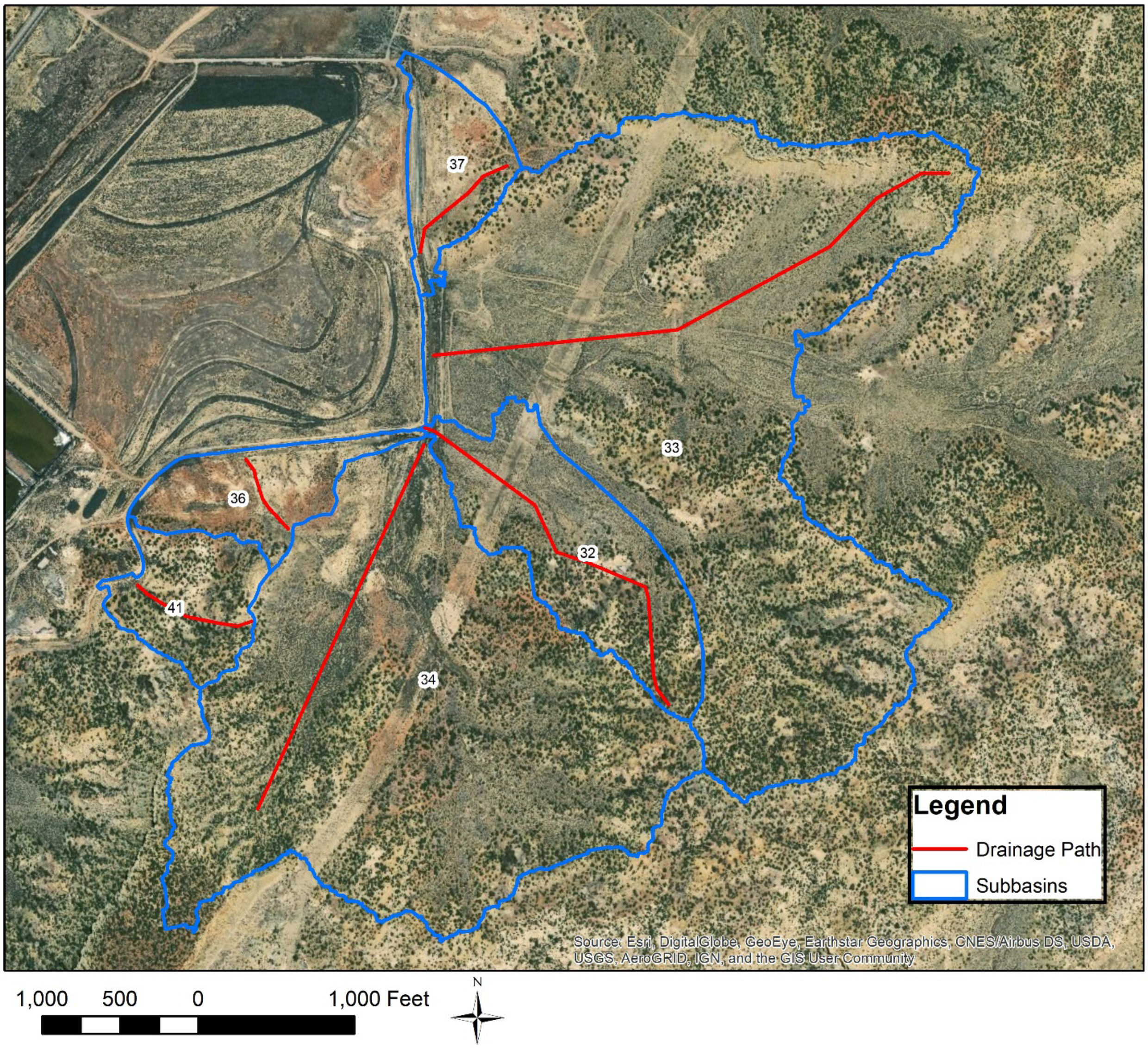

Figure 1: Contributing Subbasins and Drainage Paths

1.1.2 Mean Annual Rainfall Erodibility Factor, R

Stantec determined the mean annual rainfall erodibility factor R for the site by interpolating between values on the isorodent map provided by Wischmeier and Smith (1978). The figure is replicated below with Figure 2 showing the interpolated value of 36.4.

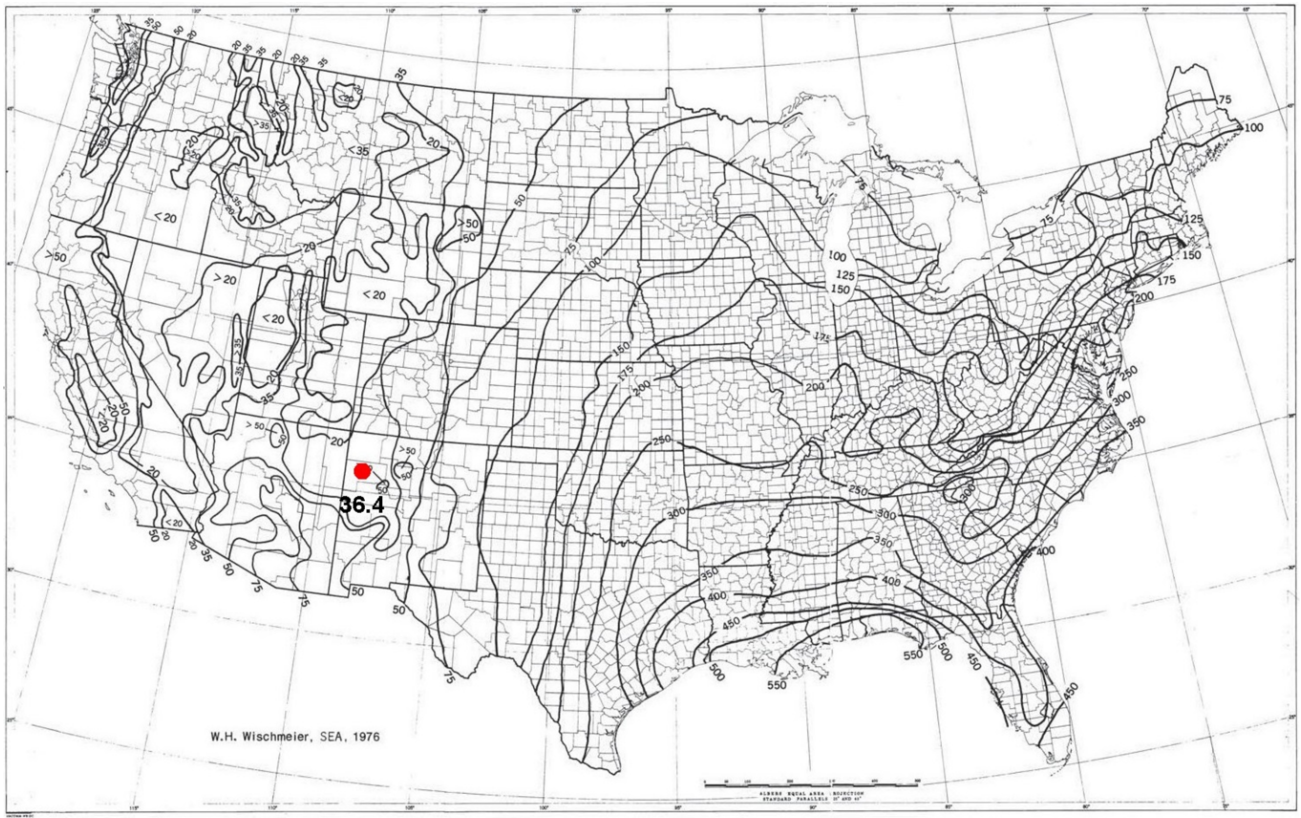

FIGURE 1.—Average annual values of the rainfall erosion index.

Figure 2: Interpolated R value from United States Isorodent Map, Adapted from Wischmeier and Smith (1978)

1.1.3 Soil Erodibility Factor, K

Stantec determined the soil erodibility factor using the TP-4 test pit taken near the repository site as referenced in Appendix I Attachment I.3. The soil erodibility factor is estimated from a nomograph by Wischmeier and Smith (1978) which relates the soil erodibility factor to the percent fines, percent sand, percent organic matter, soil structure, and soil permeability. The soil erodibility factor is 0.43 based on 52 percent fines, 0 percent organic matter, fine granular soil structure, and slow permeability as shown on Figure 3.

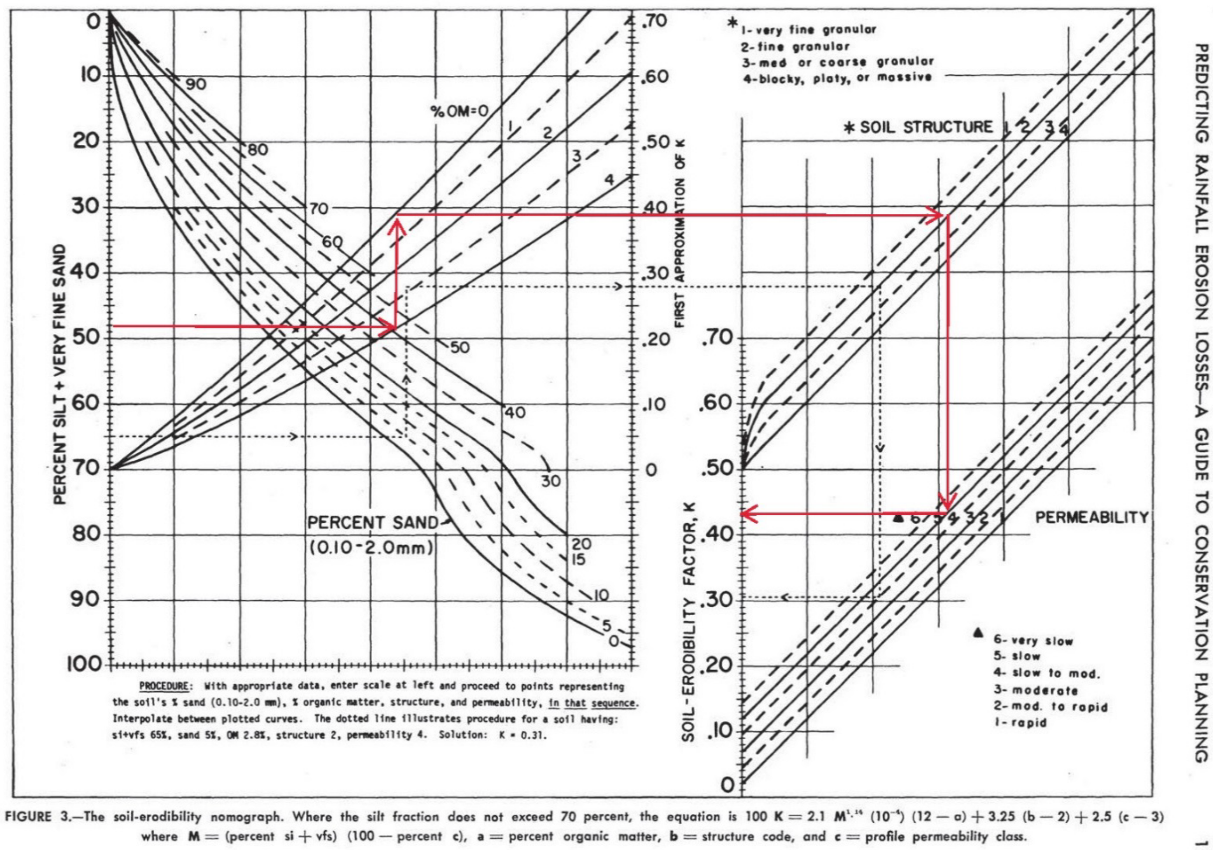

Figure 3: Soil-Erodibility Nomograph for Source Sediment, Adapted from Wischmeier and Smith (1978)

1.1.4 Slope Length-Steepness Factor, LS

Stantec determined the slope length-steepness factor (LS) based on Equation E-4 from NUREG-1623 (Equation 2) using lengths and slopes along alignments shown in Figure 1.

$$LS = \sqrt{l}\,(0.0076 + 0.53s + 7.6s^2) \qquad \textbf{Equation 2}$$

Where:

LS	=	Slope Length-Steepness Factor
l	=	Slope length [ft]
s	=	Runoff Slope [ft/ft]

The calculated LS for each watershed is listed in Table 1.

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Table 1: Length-Steepness Factor Calculation

Reach	Watershed ID	Length	Slope	LS
Upper	41	804	0.111	4.56
	36	533	0.074	2.05
Middle	34	2564	0.055	3.02
	32	2596	0.065	3.81
	33	3620	0.073	5.26
Lower	37	825	0.083	2.99

1.1.5 Cropping-Management Factor, C

Stantec determined the cropping-management factor (C) from Wischmeier and Smith (1978), using the table for permanent pasture, range, and idle land (Table 2). After reviewing site photographs, Stantec selected a C value of 0.042, which corresponds to land with no appreciable canopy and 60 percent ground cover of grassy vegetation.

Table 2: Cropping-Management Factor for Permanent Pasture, Range, and Idle Land, from Wischmeier and Smith (1978)

Vegetative canopy: Type and height[2]	Vegetative canopy: Percent cover[3]	Type[4]	Percent ground cover: 0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

1.1.6 Conservation Support Practice Factor, P

Stantec used a conservation support practice factor (P) of 1 because there is no conservation support practice being used.

1.2 ESTIMATED SEDIMENT YIELD

From the gross erosion estimated from sheet and rill erosion, Stantec estimated the total amount of sediment delivered to the outlet of each watershed using a sediment-delivery ratio. Stantec estimated the sediment-delivery ratio as a function of drainage area for each subbasin using a relationship provided by Boyce (1975), which is shown in Figure 4. The product of the sediment-delivery ratio and the sheet and rill erosion is the total amount of sediment to reach the channel.

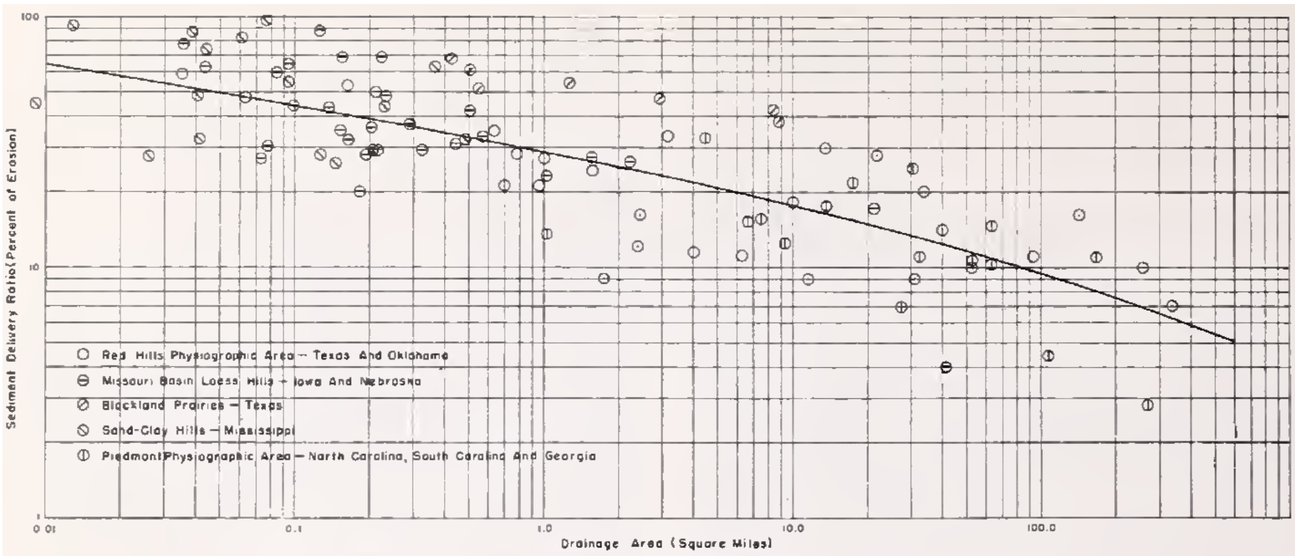

FIGURE 1.—Sediment-delivery ratio versus size of drainage area.

Figure 4: Sediment-Delivery Ratio Versus Size of Drainage Area, from Boyce (1975)

1.3 TRAP EFFICIENCY

Stantec estimated the trap efficiency within each reach using the trap efficiency procedure described in Section 3.5 of NUREG-1623 based on the particle size distribution of test pit TP-4, which is discussed in Attachment I.3 of Appendix I. Accordingly, the trap efficiency is calculated based on Equation 3 for each size fraction that will settle within each reach. The composite trap efficiency is the sum of the products trap efficiency and size fraction for each size fraction of inflowing sediment (Equation 4). The total sediment accumulation in a channel is the product of the composite trap efficiency and the estimated millennium sediment yield estimated through sheet and rill erosion and the sediment-delivery ratio.

$$T_{Ei} = 1 - \exp\left(-\frac{Xw_i}{hV}\right) \qquad \textbf{Equation 3}$$

Where:

T_{Ei}	=	Fractional Trap Efficiency, i
X	=	Reach length [ft]
w_i	=	Settling Velocity for a given size fraction, I [ft/s]
h	=	Mean Flow Depth [ft]
V	=	Mean Flow Velocity [ft]

Method

$$T_E = \sum T_{Ei} * f_i \qquad \textbf{Equation 4}$$

Where:

T_E = Composite Trap Efficiency for incoming sediment

T_{Ei} = Fractional Trap Efficiency, i

f_i = Percent Fraction of total sediment mass

The settling velocity for each size fraction was estimated from Table E-4 from NUREG-1623 (Table 3). Stantec used the 10-year mean flow depth and flow velocity for each channel as an estimate of the dominant discharge for channel formation. For ephemeral streams and channels, which typically lack sustained flows, the 5-year to 10-year storms are typical design storms which govern channel formation through sedimentation and erosion (Mussetter, Lagasse, & Harvey, 1994).

Table 3: Settling Velocities (mm/s) for Given Sediment Size Classes from NUREG-1623

Class Name	Particle Diameter (mm)	ω_0 at 10° C (mm/s)
Cobble		
Large	>128-256	1,357
Small	>64	>959
Gravel		
Very coarse	>32-64	678
Coarse	>16-32	479
Medium	>8-16	338
Fine	>4-8	237
Very Fine	>2-4	164
Sand		
Very coarse	>1-2	109
Coarse	>0.5-1	66.4
Medium	>0.25-0.5	31.3
Fine	>0.125-0.26	10.1
Very fine	>0.0625-0.125	2.66
Silt		
Coarse	>0.031-0.0625	0.67[a]
Medium	>0.016-0.031	0.167[a]
Fine	>0.008-0.016	0.042[a]
Very fine	>0.004-0.008	0.010[a]
Clay		
Clay	<0.002	<2.6×10^{-3}[a]

[a]Note that flocculation is possible.

Method

Stantec accounted for sediment that would exit an upstream reach to a more downstream reach by calculating new particle size distributions and composite trap efficiencies for sediment as it travels downstream. Stantec calculated a new particle size distribution based on the trap efficiency of the upstream reach using Equation 5.

$$f_{new,i} = \frac{f_{oi}(1 - T_{Ei})}{1 - T_E} \qquad \textbf{Equation 5}$$

Where:

$f_{new,I}$ = Fraction (by mass) of a given size fraction i to the downstream reach

f_{oi} = Initial Fraction (by mass) of a given size fraction i

T_{Ei} = Trap Efficiency for a given size fraction i

T_E = Composite Trap Efficiency for the Reach

1.4 HYDRAULIC ANALYSIS FOR CAPACITY

Stantec performed the capacity analysis for the North Diversion Channel using the same hydraulic model and methods described in Attachment I.5 of Appendix I.

In the capacity analysis for the North Diversion Channel, Stantec identified a critical sub-reach within the upper, middle, and lower reach of the channel where Stantec assumed all sedimentation in the reach will be deposited. Stantec selected the critical reach as a segment between two cross-sections of the HEC-RAS model where sediment is most likely to be deposited based on channel slope and cross-sectional flow area as shown in Attachment I.5 of Appendix I. Table 4 shows the critical sub-reaches.

Table 4: Critical Sub-Reaches for Each Reach of the North Diversion Channel

Reach	Critical Sub-Reach Start Station (ft)	Critical Sub-Reach End Station (ft)	Critical Sub-Reach Length (ft)
Upper	5565.413	5324.104	241
Middle	3449.419	3066.667	383
Lower	2386.789	2202.104	185

The critical sub-reach for the upper channel is selected because the slope between station 5565 and 5324 is milder than the upstream sub-reach. Sediment is likely to settle in the transition from a steep slope to a mild slope. The critical sub-reach for the middle channel is selected because this sub-reach is both milder than the upstream sub-reaches and the cross-sectional areas are gradually widening from station 3449 to 3067. Wider channels with milder slopes are expected to cause more sedimentation. The critical sub-reach for the lower channel is selected because it has the mildest slope in the Lower North Diversion Channel.

The difference between the model used in Attachment I.5 of Appendix I, and this model is that Stantec edited only the cross-sections within the critical sub-reaches identified in Table 4 and re-interpolated all interpolated cross-sections. The edited cross-sections input to the model are summarized in *Attachment A*.

2.0 RESULTS

2.1 NORTH DIVERSION CHANNEL

2.1.1 Sheet and Rill Erosion

The estimated millennium gross erosion for the upper, middle, and lower reaches of the North Diversion Channel are approximately 70,800 tons, 1,019,000 tons, and 29,900 tons, respectively as shown in Table 5.

Table 5: Sheet and Rill Millennium Erosion on North Diversion Channel

Reach	Watershed ID	Area (mi^2)	Total Soil Loss per Unit Area, A (tons/acre)	Gross Erosion (tons/year)	Millennium Gross Erosion (tons)	Total Millennium Gross Erosion (tons)
Upper	41	0.0252	3.00	48.39	48,387	70,844
	36	0.0256	1.35	22.46	22,458	
Middle	34	0.2300	1.99	292.78	292,777	1,019,276
	32	0.0552	2.51	88.46	88,462	
	33	0.2881	3.46	638.04	638,037	
Lower	37	0.0237	1.97	29.85	29,851	29,851

2.1.2 Estimated Sediment Yield and Trap Efficiency

Based on Sediment Delivery Ratios developed using Figure 4, Stantec estimated the millennium sediment yield within the upper, middle, and lower reaches of the North Diversion Channel as approximately 38,000 tons, 391,000 tons, and 16,000 tons, respectively as shown in Table 6.

Results

Table 6: Estimated Sediment Yield in North Diversion Channel

Reach	Watershed ID	Area (mi^2)	Millennium Gross Erosion (tons)	SDR	Millennium Sediment Yield (tons)	Total Millennium Sediment Yield (tons)
Upper	41	0.0252	48,387	0.54	26,129	38,256
	36	0.0260	22,458	0.54	12,127	
Middle	34	0.2300	292,777	0.38	111,255	390,675
	32	0.0551	88,462	0.49	43,346	
	33	0.2881	638,037	0.37	236,074	
Lower	37	0.0237	29,851	0.55	16,418	16,418

The trap efficiency for the upper, middle, and lower reaches were determined by assuming the material gradation described for the TP-4 test pit (Attachment I.3 of Appendix I) represents all soils in the North Diversion Channel watershed. The total millennium sediment trapped are approximately 25,000 tons, 198,000 tons, and 17,000 tons, respectively. The calculations for trap efficiencies and sediment trap calculations are shown in Table 7, Table 8, Table 9, Table 10, and Table 11. Table 7 gives average hydraulic properties of the channel from the hydraulic model described in Attachment I.5 of Appendix I.

Table 7: North Diversion Channel Reach Hydraulic Characteristics from Hydraulic Model (see Attachment I.5)

Reach	Reach Length (ft)	Average Flow Depth (ft)	Average Velocity (ft/s)
Lower	1243	2.8	9.4
Middle	1247	2.0	3.3
Upper	2486	1.4	2.8

The hydraulic characteristics of the channel in each reach were used to find the fractional trap efficiency using Equation 3 in Table 8**.**

Table 8: Calculation of Fractional Trap Efficiency (T_{Ei})

Reach	Length (ft)	Average Flow Depth (ft)	Average Velocity (ft/s)	Size Range (mm)	Settling Velocity (mm/s)	% fraction, f_i	Fractional Trap Efficiency, T_{Ei}
Upper	2486	1.4	2.8	19.05 - 9.525	338	1	1.0
				9.525 - 6.35	237	1	1.0
				6.35 - 2	164	3	1.0
				2 - 1.18	109	2	1.0
				1.18 - 0.6	66.4	2	1.0
				0.6 - 0.3	31.3	3	1.0
				0.3 - 0.15	10.1	11	1.0
				0.15 - 0.075	2.66	25	0.9959
				0.075 - 0.03	0.67	20.8	0.7490
				0.03 - 0.005	0.042	10	0.0830
				0.005 - 0.002	0.01	6	0.0204

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				0.002 - 0.001	0.0026	15.2	0.0054
Middle	1247	2.0	3.3	19.05 - 9.525	338	1	1.0
				9.525 - 6.35	237	1	1.0
				6.35 - 2	164	3	1.0
				2 - 1.18	109	2	1.0
				1.18 - 0.6	66.4	2	1.0
				0.6 - 0.3	31.3	3	1.0
				0.3 - 0.15	10.1	11	0.9981
				0.15 - 0.075	2.66	25	0.8081
				0.075 - 0.03	0.67	20.8	0.3402
				0.03 - 0.005	0.042	10	0.0257
				0.005 - 0.002	0.01	6	0.0062
				0.002 - 0.001	0.0026	15.2	0.0016
Lower	1243	2.8	9.4	19.05 - 9.525	338	1	1.0
				9.525 - 6.35	237	1	1.0
				6.35 - 2	164	3	1.0
				2 - 1.18	109	2	1.0
				1.18 - 0.6	66.4	2	1.0
				0.6 - 0.3	31.3	3	0.9920
				0.3 - 0.15	10.1	11	0.7892
				0.15 - 0.075	2.66	25	0.3364
				0.075 - 0.03	0.67	20.8	0.0981
				0.03 - 0.005	0.042	10	0.0065
				0.005 - 0.002	0.01	6	0.0015
				0.002 - 0.001	0.0026	15.2	0.0004

Equation 4 uses the fractional trap efficiency from Table 8 to calculate the composite trap efficiency to determine new size fractions travelling to a downstream reach from Equation 5 in Table 9. These new size fractions are used to calculate composite trap efficiencies in downstream reaches in Table 10. Each color in Table 9 and Table 10 represents a different slug of sediment within a reach, where each slug is transported downstream from the Upper Reach to Middle, and finally to Lower.

Table 9: Calculation of Composite Trap Efficiency, Part 1

Reach	Sediment Origin	Size Range (mm)	% fraction, f_i	Fractional Trap Efficiency, T_{Ei}	f_i x T_{Ei}	Composite Trap Efficiency	% Fraction Sent Downstream, $f_{new,i}$
Upper	Watershed	19.05 - 9.525	1	1.0	0.01	0.645	0
		9.525 - 6.35	1	1.0	0.01		0
		6.35 - 2	3	1.0	0.03		0
		2 - 1.18	2	1.0	0.02		0
		1.18 - 0.6	2	1.0	0.02		0
		0.6 - 0.3	3	1.0	0.03		0
		0.3 - 0.15	11	1.0	0.11		2.80E-08
		0.15 - 0.075	25	0.9959	0.25		0.29
		0.075 - 0.03	20.8	0.7490	0.16		14.71
		0.03 - 0.005	10	0.0830	0.01		25.84
		0.005 - 0.002	6	0.0204	0.00		16.56
		0.002 - 0.001	15.2	0.0054	0.00		42.6
Middle	Watershed	19.05 - 9.525	1	1.0	0.01	0.506	0
		9.525 - 6.35	1	1.0	0.01		0

		6.35 - 2	3	1.0	0.03		0
		2 - 1.18	2	1.0	0.02		0
		1.18 - 0.6	2	1.0	0.02		0
		0.6 - 0.3	3	1.0	0.03		0
		0.3 - 0.15	11	0.9981	0.11		0.042
		0.15 - 0.075	25	0.8081	0.20		9.71
		0.075 - 0.03	20.8	0.3402	0.07		27.77
		0.03 - 0.005	10	0.0257	0.00		19.71
		0.005 - 0.002	6	0.0062	0.00		12.07
		0.002 - 0.001	15.2	0.0016	0.00		30.71
Lower	Watershed	19.05 - 9.525	1	1.0	0.01	0.312	-
		9.525 - 6.35	1	1.0	0.01		-
		6.35 - 2	3	1.0	0.03		-
		2 - 1.18	2	1.0	0.02		-
		1.18 - 0.6	2	1.0	0.02		-
		0.6 - 0.3	3	0.9920	0.03		-
		0.3 - 0.15	11	0.7892	0.09		-
		0.15 - 0.075	25	0.3364	0.08		-
		0.075 - 0.03	20.8	0.0981	0.02		-
		0.03 - 0.005	10	0.0065	0.00		-
		0.005 - 0.002	6	0.0015	0.00		-
		0.002 - 0.001	15.2	0.0004	0.00		-

Table 10: Calculation of Composite Trap Efficiency, Part 2

Reach	Sediment Origin	Size Range (mm)	% fraction, f_i	Fractional Trap Efficiency, T_{Ei}	f_i x T_{Ei}	Composite Trap Efficiency	% Fraction Sent Downstream, $f_{new,i}$
Middle	Upper	19.05 - 9.525	0	1.0	0.000	0.061	0
		9.525 - 6.35	0	1.0	0.000		0
		6.35 - 2	0	1.0	0.000		0
		2 - 1.18	0	1.0	0.000		0
		1.18 - 0.6	0	1.0	0.000		0
		0.6 - 0.3	0	1.0	0.000		0
		0.3 - 0.15	2.80E-08	0.9981	0.000		5.60E-11
		0.15 - 0.075	0.29	0.8081	0.002		0.06
		0.075 - 0.03	14.71	0.3402	0.050		10.33
		0.03 - 0.005	25.84	0.0257	0.007		26.8
		0.005 - 0.002	16.56	0.0062	0.001		17.52
		0.002 - 0.001	42.6	0.0016	0.001		45.28
Lower	Middle	19.05 - 9.525	0	1.0	0.000	0.062	-
		9.525 - 6.35	0	1.0	0.000		-
		6.35 - 2	0	1.0	0.000		-
		2 - 1.18	0	1.0	0.000		-
		1.18 - 0.6	0	1.0	0.000		-
		0.6 - 0.3	0	0.9920	0.000		-
		0.3 - 0.15	0.042	0.7892	0.000		-
		0.15 - 0.075	9.71	0.3364	0.033		-
		0.075 - 0.03	27.77	0.0981	0.027		-
		0.03 - 0.005	19.71	0.0065	0.001		-
		0.005 - 0.002	12.07	0.0015	0.000		-

		0.002 - 0.001	30.71	0.0004	0.000		-
Lower	Upper	19.05 - 9.525	0	1.0	0.000	0.013	-
		9.525 - 6.35	0	1.0	0.000		-
		6.35 - 2	0	1.0	0.000		-
		2 - 1.18	0	1.0	0.000		-
		1.18 - 0.6	0	1.0	0.000		-
		0.6 - 0.3	0	0.9920	0.000		-
		0.3 - 0.15	5.6E-11	0.7892	0.000		-
		0.15 - 0.075	0.06	0.3364	0.000		-
		0.075 - 0.03	10.33	0.0981	0.010		-
		0.03 - 0.005	26.80	0.0065	0.002		-
		0.005 - 0.002	17.52	0.0015	0.000		-
		0.002 - 0.001	45.28	0.0004	0.000		-

These composite trap efficiencies are used to calculate the total millennium sedimentation within each reach in Table 11.

Table 11: Total Millennium Sediment Trapped

Reach	Millennium Sediment Yield (tons)	Composite Trap Efficiency	Tons from Upper Reach	Composite Trap Efficiency from Upper	Tons from Middle Reach	Composite Trap Efficiency from Middle	Total (tons)
Upper	38,256	0.645	0	0	0	0	24,679
Middle	390,675	0.506	13,577	0.061	0	0	198,419
Lower	16,418	0.312	12,752	0.013	193081.3043	0.062	17,213

2.1.3 Hydraulic Analysis

Stantec assumed a sediment bulk density of 20 tons per cubic foot, or 100 pounds per cubic foot, following the bulk density of sediment assumed in the example from Section 2.2 of Appendix E of NUREG-1623. Table 12 shows the resulting volume of sediment.

Table 12: Volume of Sediment Accumulated in each North Diversion Channel Reach

Reach	Critical Sub-Reach Start Station (ft)	Critical Sub-Reach End Station (ft)	Critical Sub-Reach Length (ft)	Volume of Sediment (ft^3)
Lower	5565.413	5324.104	241	861
Middle	3449.419	3066.667	383	9,921
Upper	2386.789	2202.104	185	1,234

Stantec set the elevations of sediment in each critical reach to have an average sediment accumulation matching Table 12. Stantec ran the steady state HEC-RAS model with assumed maximum roughness values used for Attachment I.5 of Appendix I. Stantec used the maximum roughness values from

Attachment I.5 of Appendix I as a worst-case scenario for the 1,000-year design life for the channel. The only alteration from the model used in Attachment I.5 of Appendix I is changing cross-sections in the critical sub-reaches, which are shown in Table 12. Figure 5 shows the hydraulic model results with the millennial sediment aggradation. Even in the aggraded condition, there is still at least 0.9 feet of freeboard throughout the channel during the PMF event. The performance in the maximum roughness condition confirms channel capacity in a sedimented channel condition.

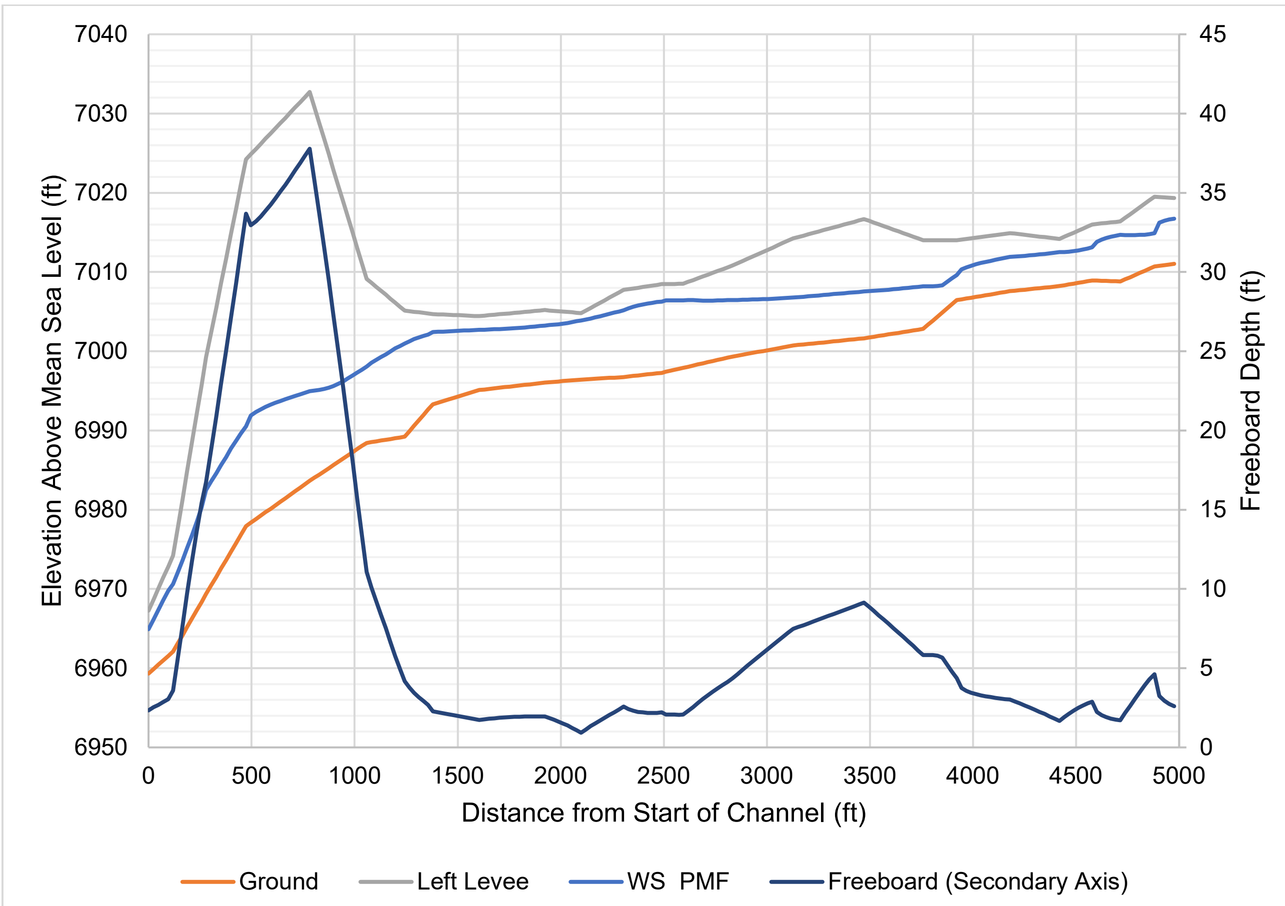

Figure 5: Plot of North Diversion Channel Water Surface Profile at Maximum Roughness

3.0 CONCLUSION

The analysis shows that the North Diversion Channel is expected to maintain capacity for the Probable Maximum Flood after 1,000 years of sedimentation. The analysis considers increased roughness that could occur as vegetation establishes in the channel by accounting for higher Manning's roughness.

4.0 REFERENCES

Boyce, R.C. (1975). Sediment Routing with Sediment-Delivery Ratios. *Present and Prospective Technology for Predicting Sediment Yields and Sources*, 61 - 65.

Mussetter, R. A., Lagasse, P.F., and Harvey, M.D. (1994). *Sediment and Erosion Design Guide for the Albuquerque Metropolitan Arroyo Flood Control Authority.* Fort Collins, CO: Resource Consultants and Engineers, Inc.

Wischmeier, W. H., and Smith, D.D. (1978). *Predicting Rainfall Erosion Losses: A Guide to Convservation Planning.* United Stantes Department of Agriculture.

ATTACHMENT A

Altered Model Cross-Sections

SUPPLEMENT I.5-1

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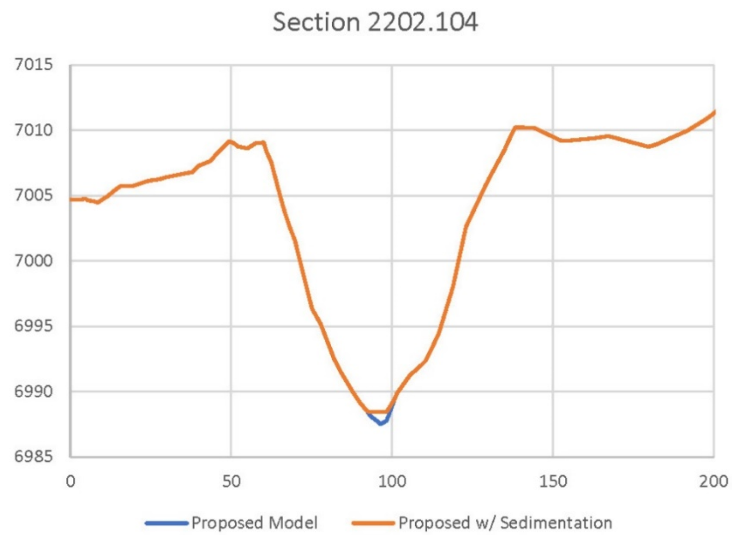

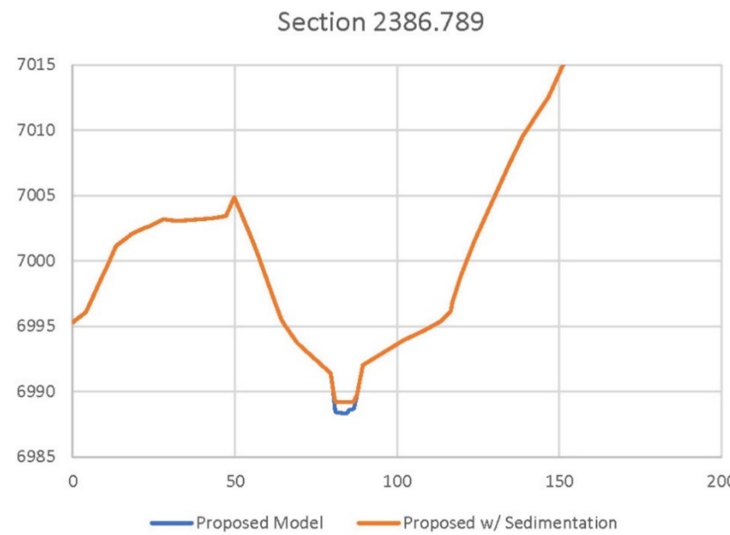

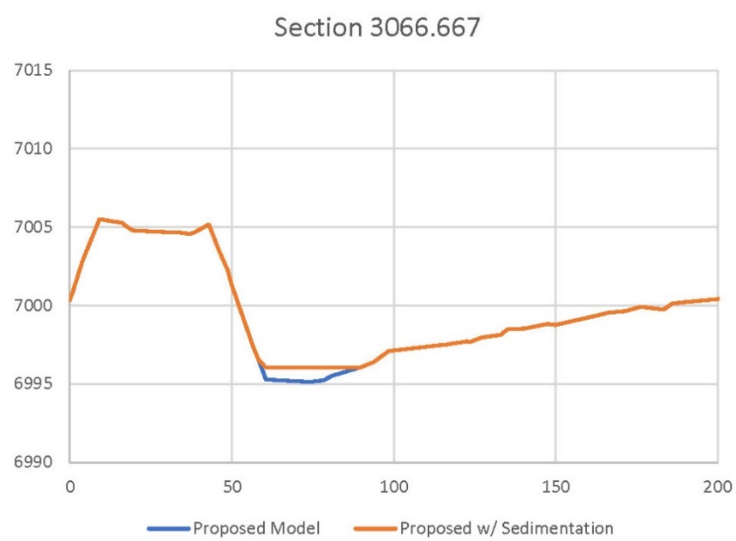

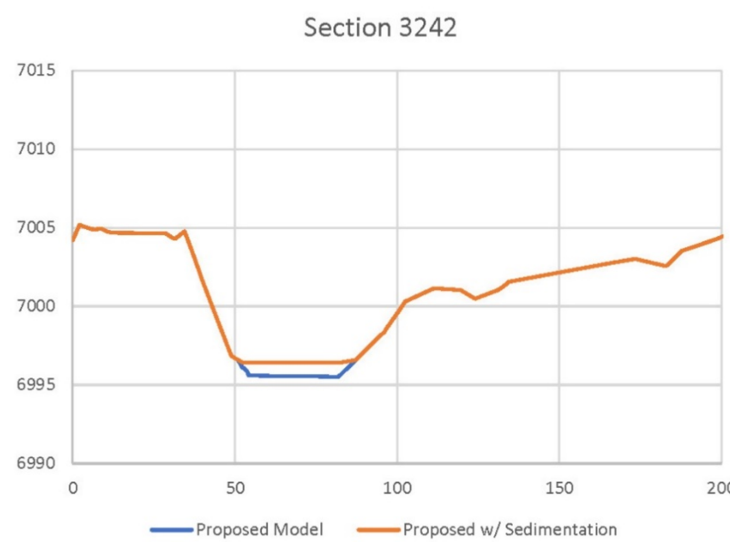

SUPPLEMENT I.5-1

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